Volume-II
(Technical Specification)

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(TECHNICAL SPECIFICATIONS)

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SECTION 1

GENERAL REQUIREMENTS

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GENERAL REQUIREMENTS

Drawings

The Engineer's Drawings

The Bid Drawings included in the Bid Documents and which will form part of the Drawings to be used for the construction of the Works, show the work to be carried out in accordance with the Contract in sufficient detail for the Contractor to fully plan his activities.

The Engineer may issue, the Bid Drawings mentioned as above as construction drawings and any additional construction drawings when required for further details, clarifications or modifications.

The Contractor shall be required to perform the work in accordance with such further drawings and specifications at the applicable rates tendered in the priced Bill of Quantities for such work or work of a similar nature. Although the Drawings may be prepared to scale, work shall be based upon dimensions shown on the Drawings and not on dimensions scaled from the Drawings. The Drawings when read in conjunction with the specifications and instructions that may be issued from time to time by the Engineer, will show sufficient dimensions, specific details and typical details to define the various features of the work but the details necessary for the construction of any part of the work may have to be deduced from several Drawings. Revision of any drawing details considered essential shall be provided by the Engineer prior to carrying out of the specific works.

Two (2) full size prints of the Drawings mentioned above and one (1) transparent copy will be issued by the Engineer to the Contractor in accordance with the construction program required under the provisions of this specifications Clause 1-1.6.2 - Construction program.

On receipt of these Drawings, the Contractor shall check them carefully and advise the Engineer in writing of any discrepancies, errors or omissions and full instructions will be furnished to the Contractor should any discrepancies, errors or omissions be found.

Contractor's Drawings

Based on Engineer's construction drawings Contractor shall prepare working drawings based on actual survey and site conditions showing further details and sections.

The working drawing and shop drawings required to be submitted to the Engineer for approval

in accordance with Specification, shall be suitable for microfilming and shall consist of one transparency of durable plastic, one print and copies of design calculations, specification and parts catalogs in duplicate. All drawings submitted for approval shall be signed, checked and approved by the Contractor prior to submission. The drawings shall be signed by a competent professional Engineer in the relevant discipline responsible for the design and shall be submitted in accordance with provision of this Specification's Clause 1-1.4 - Submittal Procedures.

Each drawing submitted by the Contractor shall be both in ISO paper size A1 and A3.

Within thirty (30) days after receiving such designs, design calculations, parts catalogues, specifications and detailed drawings, the Engineer shall signify his approval or request modifications. The Contractor shall modify the designs and drawings as may be required by the Engineer.

The work shall be constructed in accordance with the approved drawings, and a copy of such drawings shall be kept on the Site at all times until the completion of the Contract. All drawings on which changes are made shall have the revisions clearly marked.

Construction, fabrication or manufacture of any portion of the Works shall not commence until the design and drawings have been approved and thereafter no change shall be made to any drawings so approved without the permission of the Engineer. Permission to make such changes shall be requested by sending one (1) transparency and one (1) print of each revised drawing for approval, explaining the reason for such a change.

At least thirty (30) days prior to starting construction of any concrete lift or other placement, the Contractor shall submit lift or other placement drawings to the Engineer for approval. Lift or other placement drawings shall be to such scale as to show clearly all recesses openings and embedded work.

Drawings showing the proposed method of construction and other drawings additional to those referred to herein above required by the Technical Specifications shall also be submitted by the Contractor to the Engineer for approval.

Any work done prior to the approval of drawings shall be at the Contractor's own risk. The Engineer shall have the right to request any additional details and to require the Contractor to make any changes in the design which are necessary to conform to the provisions and intent of the design and the Technical Specification without additional cost to the Employer. The approval of the drawings by the Engineer shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory. Approval by the Engineer of the Contractor's drawings shall not be held to relieve the Contractor of the obligation to meet all the requirements of the Technical Specifications or of the responsibility for

the correctness of the Contractor's drawings or of the responsibility for correct fitting of assembled parts in final position or of the responsibility for the adequacy of method of construction.

Any additional drawings, which the Contractor requires to interpret the Drawings to construct the Works or in compliance with this Sub-Clause shall be prepared by the Contractor, and all costs shall be borne by the Contractor. No separate payment shall be made for working, shop, reinforcement lift drawing submitted by the Contractor.

Project Meetings

Preconstruction Conference

The Contractor shall attend a pre-construction conference scheduled by the Employer. Work shall not commence prior to the conference.

The Contractor shall address project orientation, personnel contact, safety issues, permits, deficiencies, and the location of the Contractor's office.

Project Meetings

The Contractor shall attend project meetings scheduled by the Employer and Engineer.

A Monthly Progress Report shall be submitted with the progress schedule including list of skilled personnel, unskilled labour, and list of essential equipments deployed during the month and shall address potential factors of delay, deficiencies, material delivery schedules, submittals, and safety issues.

There shall be regular coordination between Environment and Social Supervisor provided by the Contractor and Environment and Social Inspectors of the Employer.

Submittal Procedures

Scope

The Contractor is required to submit various documents and materials for Engineer’s review, approval and information in accordance with this Clause and other Sections of the Technical Specifications. Requirements of this Clause apply to, and are a component part of, each Section of the Technical Specifications.

Submittals

Standard approved transmittal form shall be used to transmit each submittal. Submittal Description (SD): Drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials to be furnished by the Contractor explaining in detail specific portions of the work required by the contract.

The following items, SD-01 through SD-12, are descriptions of data to be submitted for the Project. The requirements to actually furnish the applicable items will be called out in each Specification.

1. Preconstruction Submittals

Submittals which are required prior to a notice to proceed on a new contract: Submittals required prior to the start of the next major phase of the construction on a multi-phase contract. Schedules or tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work, submitted prior to contract notice to proceed or next major phase of construction.

2. Shop Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, detail of fabrications, layout of particular elements, connections, and other relational aspects of the work.

3. Product Data

Data composed of catalog cuts, brochures, circulars, Specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

4. Samples

Physical Samples, including both fabricated and un-fabricated, of materials, products, and units of work as complete units or as portions of units of work.

5. Design Data

Design calculations, mix design analyses, or other data, written in nature, and pertaining to a part of the work.

6. Test Reports

Written reports of a manufacturer's findings of his product during field inspections, attesting that

the products are installed in accordance with the manufacturer's installation instructions, shop drawings, or other manufacturer's requirements. Written reports by the Contractor or his subcontractors including daily logs reporting on the progress of daily activities or attesting that the work has been installed in accordance with the contract plans and Specifications.

7. Certificates

A document, required of the Contractor, or through the Contractor by way of a supplier, installer or manufacturer, the purpose of which is to further the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verification of quality.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

8. Manufacturer's Instructions

Preprinted material describing installation of a product, system, or material, including special notices and material safety data sheets, if any concerning impedances, hazards, and safety precautions.

9. Manufacturer’s Field Reports

A written report, which includes the findings of a test, made at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation. Report must be signed by an authorized official of a testing laboratory or agency and must state the test results; and indicate whether the material, product, or system has passed or failed the test.

10. Operation and Maintenance Data

Data intended to be incorporated in an operations and maintenance manual.

11. Execution Records

Records of execution, construction and installation.

12. Closeout Submittals

Special requirements necessary to properly close out a construction contract. For example, as-built record drawings, manufacturer's help and product lines necessary to maintain and install equipment. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

Preparation

a. Marking

Prepare, review and stamp with Contractor's approval all specified submittals.

Permanently mark each submittal to identify it by contract number; transmittal date; Contractor's, Subcontractor's, and supplier's name, address(s) and telephone number(s); submittal name; Specification or drawing reference; and similar information to distinguish it from other submittals. Submittal identification shall include space to receive the review action by the Engineer.

b. Drawing Format

Drawing submittals shall be prepared on ISO A3 size, except for full size patterns or templates. A soft copy of all drawings shall be submitted on CD-R. The Contractor’s working, shop and design drawings shall be both in ISO A3 sizes. The Drawings shall be prepared to accurate size, with scale indicated, unless other form is required. Drawing reproducible shall be suitable for microfilming and shall be of a quality to produce clear, distinct lines and letters. The Drawings shall have dark lines on a white background.

Copies of each drawing shall have the following information clearly marked thereon:

(a) Job name, which shall be the general title of the contract drawings.

(b) Date of the drawings and revisions.

(c) Name of Contractor.

(d) Name of Subcontractor.

(e) Name of the item, material, or equipment detailed thereon.

(f) Submittal number (e.g., first submittal to last submittal) in a uniform location adjacent to the title block.

(g) Technical Specification section to which submittal applies.

(h) The Project contract number shall appear in the margin, immediately below the title block.

The Drawings shall be numbered in logical sequence. Contractor may use his own number system. Each drawing shall bear the number of the submittal in a uniform location adjacent to the title block. The Project Contract Number shall appear in the margin, immediately below the title block, for each drawing.

A blank space, no smaller than 100 millimeter shall be reserved on the right hand side of each sheet for the Engineer's disposition stamp.

c. Data Format

Required data submittals for each specific material, product, unit of work, or system shall be collected into a single submittal and marked for choices, options, and portions applicable to the submittal. Marking of each copy of product data submitted shall be identical.

d. Samples

Samples shall be physically identical with the proposed material or product to be incorporated in the work, fully fabricated and finished in the specified manner, and full scale. Where variations in color, finish, pattern, or texture are inherent in the material or product represented by the sample, multiple units of the sample, showing the near-limits of the variations and the "average" of the whole range not less than 3 units, shall be submitted. Each unit shall be marked to describe its relation to the range of the variation. Where samples are specified for selection of color, finish, pattern, or texture, the full set of available choices shall be submitted for the material or product specified. Sizes and quantities of samples shall represent their respective standard unit.

Submission Requirements

a. Schedules

Within 30 calendar days of notice to proceed, provide, for approval by the Engineer, the following schedule of submittals:

(i) A schedule of shop drawings and technical submittals required by the Specifications and drawings. Indicate the Specification or drawing reference requiring the submittal; the material, item, or process for which the submittal is required; the "SD" number and identifying title of the submittal; the Contractor's anticipated submission date and the approval need date.

(ii) A separate schedule of other submittals required under the contract but not listed in the Specifications or drawings. Schedule will indicate the contract requirement reference; the type or title of the submittal; the Contractor's anticipated submission date and the approved need date (if approval is required).

(iii) Submittals called for by the contract documents will be listed on one of the above schedules. If a submittal is called for but does not pertain to the contract work, the Contractor shall include the submittal in the applicable schedule and annotate it "N/A" with a brief explanation. Approval of the schedules by the Engineer does not relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the schedules or marked "N/A".

(iv) Re-submit copies of both schedules and annotate monthly by the Contractor with actual submission and approval dates. When all items on a schedule have been fully approved, no further re-submittal of the schedule is required.

b. Drawings Submittals

Submit translucent reproducible copy and 3 blackline or blueline opaque prints of each drawing. 1 print, marked with review notations by the Engineer, will be returned to the Contractor. All required installation; fabrication and connection drawings shall be submitted and approved prior to the start of work detailed on these drawings.

c. Data Submittals

Submit three (3) complete sets of indexed and bound product data. One set, marked with review notations by the Engineer, will be returned to the Contractor.

d. Samples

Submit one (1) set of identified samples. A copy of the transmittal form, marked with review notations including selections by the Engineer, will be returned to the Contractor.

Samples that are intended or permitted to be returned and actually incorporated in the work are so indicated in the individual sections of the Specification. These samples will be returned to the Contractor, at his expense, to be clearly labeled, with installation location recorded. Samples shall be in undamaged condition at the time of installation.

Where mockups and similar large samples are required by individual sections of Specification, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Otherwise, and except as indicated in the individual Section

of the Technical Specifications, the requirements for samples shall be complied with and a transmittal form shall be processed for each mockup, to provide a record of the activity.

Engineer's Review

a. Review Notations

Engineer will review submittals and provide pertinent notation within 30 calendar days after date of submission. Submittals will be returned to the Contractor with the following notations:

(i) Submittals marked "approved" authorize the Contractor to proceed with the work covered.

(ii) Submittals marked "approved as noted" authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections. Notes shall be incorporated prior to submission of the final submittal.

(iii) Submittals marked "return for correction" require the Contractor to make the necessary corrections and revisions and to re-submit them for approval in the same routine as before, prior to proceeding with any of the work depicted by the submittal.

(iv) Submittals marked "not approved" or "disapproved" indicate noncompliance with the contract requirements and shall be re-submitted with appropriate changes. No item of requiring a submittal shall be accomplished until the submittals are approved or approved as noted.

(v) Contractor shall make corrections required by the Engineer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the Bid Drawings or the Technical Specifications; notice as required under the Clauses 13 and 20 of General Conditions of Contract shall be given to the Engineer. Approval of the submittals by the Engineer shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Contractor shall be responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Engineer requiring rejection and removal of such work at the Contractor's expense.

(vi) If changes are necessary to approved submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change shall be accomplished until the changed submittals are approved.

b. Sample Approval

Furnish, for the approval of the Engineer, samples required by the Technical Specifications or by the Engineer. Shipping charges shall be paid by the Contractor. Materials or equipment requiring sample approval shall not be delivered to the site or used in the work until approved in writing by the Engineer.

Each sample shall have a label indicating:

(a) Name of project

(b) Name of Contractor

(c) Material or equipment

(d) Place of origin

(e) Name of producer and brand

(f) Specification section to which samples applies

(g) Samples of furnished material shall have additional markings that will identify them under the finished schedules.

Contractor shall submit to the Engineer two samples of materials where samples are requested. Transmit to the Engineer with each sample a letter, original and two copies, containing the above information.

Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify any contract requirements. Before submitting samples, the Contractor shall assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Materials and equipment incorporated in the work shall match the approved samples. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make of that material. Engineer reserves the right to disapprove any material or equipment which previously has proved unsatisfactory in service.

Variations from contract requirements shall be specifically pointed out in transmittal letters. Failure to point out deviations may result in the Engineer requiring rejection and removal of such work at no additional cost to the Employer.

Samples of various materials or equipment delivered on the site or in place may be taken by the Engineer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Contractor shall replace such materials or equipment to meet contract requirements.

Approval of the Contractor's samples by the Engineer shall not relieve the Contractor of his responsibilities under the Contract.

Progress Schedule

a. Bar Chart

(i) Submit the progress chart, for approval by the Engineer, at the Preconstruction Conference in one reproducible and 4 copies.

(ii) Prepare the progress chart in the form of a bar chart utilizing form "Construction Progress Chart" or comparable format acceptable to the Engineer.

(iii) Include no less than the following information on the progress chart:

- Break out by major headings for primary work activity.
- A line item break out under each major heading sufficient to track the progress of work.
- A line item showing contract finalization task which includes punch list, clean-up and demolition, and final construction drawings.
- A materials bar and a separate labor bar for each line item. Both bars will show the scheduled percentage complete for any given date within the contract performance period. Labor bar will also show the number of men (man-load) expected to be working on any given date within the contract performance period.

The estimated cost and percentage weight of total contract cost for each materials and labor bar on the chart.

Separate line items for mobilization and drawing submittal and approval. (These items are to show no associated costs.)

(iv) Update the progress schedule in one reproduction and 4 copies every 30 calendar days throughout the contract performance period.

b. Project Network Analysis

Submit the initial progress schedule within 21 calendar days of notice to proceed. Schedule shall be updated and resubmitted monthly beginning 7 calendar days after return of the approved initial schedule. Updating shall entail complete revision of the graphic and data displays incorporating changes in scheduled dates and performance periods. Redlined updates will only be acceptable for use as weekly status reviews.

Contractor shall provide a single point contact from his on-site organization as his Schedule Specialist. Schedule Specialist shall have the responsibility of updating and coordinating the schedule with actual job conditions. Schedule Specialist shall participate in weekly status meetings and present current information on the status of purchase orders, shop drawings, off-site fabrication, materials deliveries, Subcontractor activities and any problem, which may impact the contract performance period.

Include the following in the project network analysis:

(i) Graphic display shall be a standard network or arrow diagram capable of illustrating the required data. Drafting shall be computer generated on standard on 279 by 432 millimeter minimum sheets with separate overview and detail breakouts. Provide a project network analysis that is legible with a clear, consistent method for continuations and detail referencing. Clearly delineate the critical path on the display. Clearly indicate the contract milestone date on the project network analysis graphic display.

(ii) Data shall be presented as a separate printout on paper or, where feasible, may be printed on the same sheet as the graphic display. Data shall be organized in a logical coherent display capable of periodic updating.

(iii) Data shall include verbal activity descriptions with a numerical ordering system cross referenced to the graphic display. Additionally, costs (broken down into separate materials and labor costs), duration, early start date, early finish date, late start date, late finish date, and float shall be detailed for each activity. A running total of the percent completion based on completed activity costs versus total contract cost shall be indicated. A system for indicating scheduled versus actual activity dates and durations shall be provided.

(iv) Schedule shall be of sufficient detail to facilitate the Contractor's control of the job and to allow the Engineer to readily follow progress for portions of the work.

Status Report on Materials Orders

Within 30 calendar days after notice to proceed, submit, for approval by the Engineer, an initial material status report on all material orders. This report will be updated and re-submitted every 30 calendar days as the status on material orders changes.

Report shall list, in chronological order by need date, materials orders necessary for completion of the contract. The following information will be required for each material order listed:

(a) Material name, supplier, and invoice number.

(b) Bar chart line item or CPM activity number affected by the order.

(c) Delivery date needed to allow directly and indirectly related work to be completed within the contract performance period.

(d) Current delivery date agreed on by supplier.

(e) When item d exceeds item c, the effect that delayed delivery date will have on contract completion date.

(f) When item d exceeds item c, a summary of efforts made by the Contractor to expedite the delayed delivery date to bring it in line with the needed delivery date, including efforts made to place the order or subcontract with other suppliers.

Road Access to the Site

Road Access

The site is accessible from Quetta via metalled road. Duki is the Tehsil Headquarter and is only a 33 kilometer from the Project. An all-weather metalled road connects Duki with the main Manzai Yat-abad and a gravel road connects it with the area irrigated from Weir.

Practicability of Use

The Contractor shall ascertain for himself the practicability of using the existing roads for access.

Protection and Strengthening of Existing Facilities

The highways, roads and bridges have widely varying load limits, and the Contractor shall be

responsible for determining the load limits existing at and during Contract period and ensuring that his Constructional Plant does not exceed such limits. Before moving any heavy construction traffic onto highways, roads and bridges, the Contractor shall make suitable arrangements with the appropriate Government authorities and obtain their approval for the passage of such traffic. Where the authorities require and specify any special protection or strengthening of highways, roads or bridges, the Contractor shall submit to the Engineer his proposals for such work after their approval by the authority concerned and shall carry out this work to the satisfaction of the Engineer. Separate payment will not be made for any special protection or strengthening required by Government authorities and carried out at the direction of the Engineer. All costs payment shall be deemed to be included in the rates and lump sum prices in the priced Bill of Quantities.

Use of Bituminous Sealed Roads

The Contractor shall not travel tracked vehicles or plant on any bituminous sealed road surface. Rubber tyred vehicles conforming to applicable load restrictions will be permitted to use bituminous sealed roads.

Additional Roads

All additional roads required by the Contractor as access and haul roads on the Site shall be provided by the Contractor in accordance with Clause 1-1.15 of this Specification.

Project Schedule

Commencement, Execution and Completion of Works

The Contractor shall commence work under the Contract in accordance with Sub-Clause 8.1.1 of the General Conditions of Contract.

Pursuant to Sub-Clause 8.1 of the General Conditions of Contract, the Contractor shall execute for mandatory completion of the different sections of the Works listed in the Appendix as Implementation Schedule within the number of days specified herein under taken from the day of issue of the Engineer's written order to commence the Works.

Contractor's Construction

The Contractor shall submit a revision of the construction program attached to the Bid for approval. The submission shall be in accordance with the provisions of Sub-Clause 1-1.6 of this

section. The program shall be prepared according to Sub-Clause 1-1.6.3 of this section.

Whenever the Contractor proposes to change the Construction program he shall immediately advise the Engineer in writing and if the Engineer considers the change is a major one the Contractor shall submit a revised program for approval. If such a change in the construction program affects the Engineer's design and drawings program, the Employer will not be responsible for the consequences of the late issue of any drawings which are attributable to that change.

If the Contractor falls behind the approved construction program he shall, within fourteen (14) days of the date of such default, submit a revision of the Construction program showing the proposed measure to complete the Permanent Works on time, for approval.

When requested by the Engineer, the Contractor shall promptly furnish a detailed sub-program of the Construction program for particular sections of the Permanent Works.

Requirements of Construction

a. General Requirements

The Contractor shall designate an authorized representative who shall be responsible for the preparation of all required Construction program reports. The scheduling of construction shall be the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors, and Contractor’s Designers, and suppliers working on the project shall also contribute in developing and maintaining an accurate Construction program. The approved Construction program shall be used to measure the progress of the work, to aid in evaluating time extensions.

b. Computer Software

The computer software system utilized by the Contractor to produce the Construction program shall be capable of providing all requirements of this specification. Failure of the Contractor to meet the requirements of this specification shall result in the disapproval of the program. Manual methods used to produce any required information shall require approval by the Engineer.

c. Use of the Critical Path Method

The Critical Path Method (CPM) of network calculation shall be used to generate the Construction program. The Contractor shall provide the Construction program in the Precedence Diagram Method (PDM) format on Primavera/MS Project software.

d. Level of Detail Required

The Construction program shall include an appropriate level of detail. Failure to develop or update the Construction program or provide data to the Engineer at the appropriate level of detail, as specified by the Engineer, shall result in the disapproval of the program. The Engineer will use, but is not limited to, the following conditions to determine the appropriate level of detail to be used in the Construction program.

(i) Design and Permit Activities

Design and permitting activities, including necessary conferences and follow-up actions and design package submission dates, shall be integrated into the Program.

(ii) Procurement Activities

Tasks related to the procurement of long lead materials or equipment shall be included as separate activities in the Construction. Long lead materials and equipment are those materials that have a procurement cycle of over 90 days. Examples of procurement process activities include, but are not limited to: submittals, approvals, procurement, fabrication, and delivery.

(iii) Critical Activities

The following activities shall be listed as separate line activities on the Contractor's Construction:

a) Submission and approval of mechanical/electrical layout drawings.

b) Submission and approval of O & M manuals.

c) Submission and approval of as-built drawings.

d) Performance Verification testing.

e) Other systems testing, if required.

f) Pre-final inspection.

g) Correction of punch list from pre-final inspection.

h) Final inspection.

(iv) Engineer and Employer’s Activities

Engineer, Employer or other agency activities that could impact progress shall be shown. These activities include, but are not limited to: approvals, design reviews, environmental permit approvals by State regulators and inspections.

(v) Responsibility

All activities shall be identified in the Construction Program by the party responsible to perform the work. Responsibility includes, but is not limited to, the subcontracting firm or contractor work force, performing a given task. Activities shall not belong to more than one responsible party.

(vi) Work Areas

All activities shall be identified in the Construction Program by the work area in which the activity occurs. Activities shall not be allowed to cover more than one work area. The work area of each activity shall be identified by the Work Area Code.

Construction Program Submissions

The Contractor shall provide the submissions as described below. All necessary data disks, reports, and network diagrams required for each submission shall be provide with the program.

a. Preliminary Construction Program Submission

The Preliminary Construction program, defining the Contractor's planned operations for the first 60 calendar days shall be submitted for approval within 20 calendar days after the Noticed to Proceed, (NTP) is acknowledged. The approved preliminary program shall be used for payment purposes not to exceed 60 calendar days after NTP.

b. Initial Construction Program Submission

The Initial Construction program shall be submitted for approval within 40 calendar days after NTP. The program shall provide a reasonable sequence of activities which represent work through the entire project and shall be at a reasonable level of detail.

c. Periodic Program Updates

Based on the result of progress meetings, specified in "Periodic Progress Meetings," the Contractor shall submit periodic program updates. These submissions shall enable the Engineer to assess Contractor's progress. If the Contractor fails or refuses to furnish the information and

Construction program data, which in the judgment of the Engineer or authorized representative is necessary for verifying the Contractor's progress, the Contractor shall be deemed not to have provided an estimate upon which progress payment may be made.

Performance Security and Insurance

Performance Security

Sub-Clause 4.2 of the General Conditions of Contract specifies the Contractor providing an irrevocable bank guarantee or a bond for the due performance of the Contract.

Insurance

Clause 18 of the General Conditions of Contract requires that the Contractor shall take out certain insurances relating to the Contract.

The Contractor shall provide the following three types of Insurances:

(i) Insurance of Works and Contractors Equipment

(ii) Insurance against Accident to Workmen.

The insurances drawn shall be in accordance with the requirements stated under insurance in General Conditions of Contract. The Insurance Policies drawn shall be approved by the Engineer.

Materials to be furnished by the Contractor

The Contractor shall furnish all materials required for the execution of the Works.

Unless specifically stated otherwise, any reference in the Technical Specifications or on the Bid Drawings to trade names or catalogue numbers or to a particular manufactured product does not imply that the article or product so mentioned is the only one that may be supplied or used. Any reference so made is purely given as a standard of the quality, class, type and finish of the items specified to be used. Articles or products of similar type and quality produced by other manufacturers shall be submitted by the Contractor for approval.

All materials that will become part of the Permanent Works shall be new and shall conform to the Technical Specification. Where the requirements for any materials are not stated in the Technical Specifications, the material shall conform with the appropriate and most recent Pakistani and/or American and/or British Standard Specification or such other specifications as

may be approved.

When a separate item, which includes the furnishing of any materials, is provided in the priced Bill of Quantities, the cost of furnishing, transporting, storing and handling such materials shall be deemed to be included in the rate or lump sum tendered for that item in the priced Bill of Quantities.

Where no separate item is provided in the priced Bill of Quantities for furnishing any materials required to be furnished by the Contractor the cost of furnishing, transporting, storing and handling such materials shall be deemed to be included in the rate or lump sum tendered in the priced Bill of Quantities for the items for which the materials are required.

The Contractor shall make diligent effort to procure the specified materials, but where, because of priorities or other causes materials required by the Specification are not available, approved substitute materials may be used, which approval will state the amount of price adjustment, if any, to be made. The Engineer's decision as to whether substitution will be permitted and as to what substitute materials may be used will be final, binding and conclusive.

Materials and equipment furnished by the Contractor, which will be incorporated in the Permanent Works, shall be subject to inspection, examination and test as provided in the Contract. To allow sufficient time to provide for inspection, examination and testing, the Contractor shall submit at the time of issue, copies in duplicate of all orders, including drawings and other pertinent information, covering the materials and equipment to be furnished by the Contractor, or shall submit other evidence in the event of such orders being issued verbally or by letter, to the Engineer. The inspection, examination and testing of materials and equipment or the waiving of inspection, examination and testing thereof shall in no way relieve the Contractor of the responsibility for furnishing materials and equipment meeting the requirements of the Technical Specifications.

The responsibility for so ordering and delivering materials and manufactured articles and samples that they may be tested sufficiently far in advance of the work as not to delay it shall rest upon the Contractor and he shall not be entitled to any time credit for delays occasioned by his neglect to order sufficiently well in advance or to payment of any costs he may incur as the result thereof.

Standard Specifications

Standards

Except as otherwise specified in the Technical Specifications, all materials and workmanship shall comply in all respects with the requirements of the appropriate specifications and codes

issued by Pakistani and/or the British Standards Institution and/or American or such equivalent standards of other such countries as may be approved and current at the date of Invitation for Tenders as may be applicable to any part of the Permanent Works. If, after the date of Invitation for Tenders, there is an amendment to a standard specification relevant to the Contract, the Engineer will direct whether the amendment is to apply.

Copies of Standards, Codes and References

The Contractor shall have available in his site office at all times at least one (1) copy of every standards, codes and references referred to in this Specification.

Separate payment will not be made for compliance with this Clause and all such costs shall be deemed to be included in the rates and lump sums tendered in the priced Bill of Quantities for the items for which the standards and codes are applicable.

Setting-Out Works

The Contractor shall be solely responsible for the correct setting out of the Works and shall employ experienced qualified surveyors acceptable to the Engineer for this purpose.

The Engineer will establish free of charge to the Contractor necessary reference marks to define datum lines and the reduce levels of suitably located reference bench-marks to enable the Contractor to set out the Permanent Works. Any reference marks damaged as the result of action by the Contractor will be replaced by the Engineer at the expense for the Contractor.

The Contractor shall furnish all materials, labour and equipment including stakes, templates, patterns, platforms and special labour that may be required in setting out any part of the Works.

Separate payment will not be made for complying with the provisions of this Clause and all costs shall be deemed to be included in the various rates and lump sums tendered in the priced Bill of Quantities.

The Engineer may make checks as the Work progresses to verify lines or lines and grades established by the Contractor and to determine the conformance of the work as it progresses with the requirement of the Technical Specifications and the Drawings. Such checking by the Engineer shall not relieve the Contractor of his responsibility to perform all work in accordance with the Drawings and the Technical Specifications and the lines and grades given therein.

Safety Precautions

General

The Contractor shall comply with any Safety instruction given by the Engineer. The Contractor shall prepare comprehensive health and safety plan. In the performance of the Works, the Contractor shall exercise every reasonable precaution to protect persons or property from injury. The Contractor shall erect and maintain all necessary temporary fencing, barricades, barriers, signs and lights and provide fire alarm, fire extinguishing and fire-fighting services at strategic points on the Site. The Contractor shall adopt and enforce such rules and regulations as may be necessary, desirable or proper to safeguard the public and all persons engaged in the work and its supervision.

Safety Officer

The Contractor shall constantly assign, during the progress of the Works, an employee qualified in safety, and familiar with the type of work being performed, whose assignment shall include initiation of measures for the protection of health and the prevention of accidents and who shall see, by personal inspection, that all safety rules and regulations are enforced. The Contractor shall hold regularly scheduled safety meetings at least once each month with his Engineers, supervisors and foremen. When directed additional meetings will be held. The Contractor shall keep the Engineer advised as to when these meetings are to be held and shall provide the Engineer with a copy of the proposed agenda.

The Safety Officer shall impart health and safety training to the site personnel.

Safety Measures

With limits the generality of Sub-Clause 4.8 of General Conditions of Contract, the Safety measures taken by Contractor shall include but shall not be limited to the following:

(a) Temporary Fencing – The Contractor shall erect, maintain and remove suitable and approved temporary fencing to enclose such areas of the Permanent Works and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under the Contract, to the satisfaction of the Engineer. Where any temporary fence has to be erected alongside a public road, footpath, etc., it shall be of the type required by and shall be erected to the satisfaction of the Government authority concerned.

(b) Lighting –The Contractor shall provide sufficient lighting in all places where work is in progress:

(i) Safe working conditions are provided both for the Contractor's personnel, sub-contractor's personnel and for personnel of the Engineer;

(ii) The Works can be constructed in complete compliance with the Contract; and

(iii) A complete inspection of all Works in progress can be made by the Engineer.

(c) The Contractor shall supply a suitable instrument to the Engineer for measuring the intensity of illumination. The instrument shall comply with BS 667.

(d) Illumination for areas or operations not listed in the above table shall conform to the requirements of the Lighting Guide, Building and Civil Engineering, Site Illuminating Engineering Society, London.

(e) All mobile equipment or plant used during night operations, as and when approved by the Engineer, shall be equipped with sufficient lights and reflectors to ensure safe working conditions.

(f) Not less than fourteen (14) days before the start of night operations, the Contractor shall submit his proposals for lighting in the areas in which he proposes to work at night to the Engineer. The Contractor shall modify the proposals if required by the Engineer, and shall not begin operations at night until the proposals for lighting (in an amended form if required) have been approved.

(g) Approval of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.

(h) Work in the vicinity of electrical equipment – in the interest of safety and security, the Contractor shall complete the erection of any safety fencing around electrical and mechanical apparatus by the time that the said apparatus is connected to any electricity supply.

(i) Explosives – in the use, handling and storage of explosives, the Contractor shall comply with the guidelines given in Section 5, Excavation and Miscellaneous Earthworks of this Specification and with all statutory regulations of Pakistan. The Contractor's attention is drawn to the fact that, depending on the nature of work in progress, the Engineer may require the Contractor to discontinue the handling or use of explosives during the approach and progress of severe thunderstorms in which case all persons shall be removed form danger areas to a place of safety during such periods.

(j) Safety Instructions – the Contractor shall at his own cost supply and issue to his employees and those of his subcontractors and the staff of the Engineer printed booklets, of pocket-size, on the scale of one per person, in English and in other languages used by his employees at Site, instructions based on good practice. Within sixty (60) days of the Engineer's written order to commence the Works at Site, proof copies of the booklet shall be submitted for approval before printing and amendments shall be made to the booklet to his entire satisfaction. The Contractor shall issue the booklet immediately after printing as required by this Clause and ensure that all employees are fully conversant with the instructions. Safety instructions shall deal with all safety including:

(i) Protective clothing, headgear and footwear;

(ii) Use of lifting equipment;

(iii) Use of drilling equipment;

(iv) Contract with and use of electrical equipment;

(v) Use and storage of explosives;

(vi) Compressed air;

(vii) Welding;

(viii) Routine for accidents or fires; and

(ix) Watchmen, warning notices and barriers.

The Contractor shall allow for 20 booklets for the use of the Engineer.

(k) The Contractor shall provide for the Engineer and Engineer's supervisory staff the protective clothing, headgear and footwear necessary for the proper discharge of their duties on Site.

(l) Accident Reports – the Contractor shall promptly report to the Engineer in the form to be prescribed, all accidents involving death or serious injury to staff or workmen, and furnish monthly reports of all accidents to staff or workmen involving loss of time, giving such information as may be prescribed by the Engineer.

(i) The Contractor shall provide all necessary signs for the works. These shall include, but not be limited to:

- use of sirens before blasting and a all-clear indication
- standard road signs;
- warning signs;
- danger signs;
- control signs;
- safety signs; and
- direction signs.

(ii) Wording on all signs shall be in English and Urdu and other approved languages. The size, colour, lettering and location of all signs will be subject to approval and attention shall be paid to international signs.

(iii) The Contractor shall maintain all signs placed by him as well as those placed by the Employer.

(iv) If the Engineer considers that the system of signs provided by the Contractor is inadequate to ensure safety, or unsatisfactory in other respects, the Contractor shall add to, amend, or otherwise change the system to the satisfaction of the Engineer.

(v) The Contractor shall at his own cost make suitable replacement as directed by the Engineer in case of loss or damage to any signs provided by the Contractor under this Sub-Clause.

(vi) The Contractor shall at his own cost adopt such measures as the Engineer may consider reasonable and necessary to minimize nuisance from dust, noise or other disturbance created while or in carrying out the Works.

Separate payment will not be made for complying with the provisions of this Clause and all costs shall be deemed to be included in the various rates and lump sum prices in the priced Bill of Quantities.

Hours and Days of Working

As per Sub-Clause 6.5 of the General Conditions of Contract the Contractor is not permitted to work during the night or on locally recognized days of rest. However, in special cases, he may be allowed to work during the night or on locally recognized days of rest with prior permission of

the Engineer.

Before commencement of work on the Contract, the Contractor shall notify the Engineer, in writing, of the hours and of the number of shifts that he proposes to work and shall give at least 48 hour's notice to the Engineer of any changes to such hours of working and / or number of shifts that may be necessary during the currency of the Contract.

Resources Reports

During the course of construction, the Contractor shall submit on the first day of each week a detailed list by trade classification of manpower employed during the report period and a list of all major items of Constructional Plant on Site to the Engineer.

Temporary Works

The Employer will allocate to the Contractor free of cost an area of land at the Site within which the Contractor shall accommodate his work force and set up all services and facilities required for the construction of the Work on Site.

The Contractor's proposals for the details of erection and construction of all Temporary Works shall be in accordance with the proposals submitted with the Bid and approved in the Letter of Acceptance or with such modifications as approved from time to time.

Temporary Works shall include but not be limited to the work covered in Sub-Clauses 1-1.16 to 1-1.27, both inclusive, of this Specification, Contractor's offices and accommodation, building, temporary fences, sanitary facilities, fixed construction facilities including but not limited to workshops, compressed air stations, electric power, water supply, telecommunications and construction and maintenance of access roads required for the execution of the Works and clean-up of the Site on completion.

The Contractor shall submit for approval drawings and full particulars of all Temporary Works, which he intends to construct at least thirty (30) days before he desires to commence constructing such works. Approval of any such proposals from the Contractor shall not relieve the Contractor of any of his responsibility for the sufficiency of the Temporary Works for their intended purpose. The Contractor shall also obtain any necessary approval from local statutory or other Government authorities before commencing construction. Such work shall not be started without prior approval.

Construction facilities on which interim payments have been made shall be maintained in good order and shall not be demolished, removed form the Site or otherwise disposed of without prior approval.

No house, office, store, workshop or other habitable building will be permitted underneath or within 3 m of the nearest point in plan of the uninsulated overhead conductor of low or medium voltage of an electricity supply main.

On completion of the Works, all Temporary Works whether existing or constructed by the Contractor, unless otherwise specified or directed shall be removed from the Site. The Contractor shall make safe all areas affected by Temporary Works and reinstate natural drainage. The Contractor shall finish, reinstate, clean up and relinquish parts of the site at the end of the Maintenance Period or such earlier times as directed. Buildings and facilities removed from the Site will remain the Contractor's property.

Separate payment will not be made for Temporary Works and complying with the provisions of this Sub-Clause and Sub-Clauses 1-1.16 to 1-1.27 unless included in Bill of Quantities as such.

Temporary Access and Haul Roads

General

The Contractor shall design, construct and maintain all temporary access and haul roads (including associated drainage and stream crossing facilities) to the various working sites and designated borrow and disposal areas and quarry sites as required for the Works.

The temporary access and haul roads may be constructed at times to suit the Contractor's construction except where the requirements of Sub-Clause 1-1.6 of this Specification apply.

The Contractor shall submit for approval drawings, design and full particulars of all temporary access roads, which he intends to construct at least thirty (30) days before he desires to commence constructing such temporary access roads. Approval of any such proposals by the Engineer shall not relieve the Contractor of any of his responsibility under this Contract.

Heavy Construction Traffic

The Contractor's heavy construction traffic or tracked equipment shall not traverse any public roads or bridges, unless the Contractor has made arrangements with the Authorities concerned and the approval of the Engineer to such arrangements has been obtained.

Maintenance of Roads

The Contractor shall be wholly responsible for the maintenance of all temporary access and haul roads constructed by him or as specified in this Contract.
In maintaining these roads the Contractor shall:

(a) Keep clear and in good working order at all times all road structures, bridges, culverts, drains and other waterways;

(b) Patch potholes with approved materials, keep the road surface in good repair and perform any grading and necessary resurfacing;

(c) Maintain all fender posts, guide posts, guard posts, fencing, signs, signposts and other roadside structures;

(d) Take reasonable and necessary measures to minimize nuisance from dust created while or in carrying out the Works.

Use of Roads by Others

During the period of the Contract, the Employer will be engaged on other works in the vicinity of the Works covered by the Technical Specifications, and the Contractor shall allow the Engineer or persons authorized by the Engineer free use of all temporary access and haul roads.

The payment will only be made if so permitted through item of work in the Bill of Quantities for full compliance with requirements of this Sub-Clause.

Electric Power

The Contractor shall make his own arrangements for the supply and distribution of electricity to provide for power and light for the Contractor's camp accommodation and camp amenities, workshops, stores, offices, including the Project Site Office, laboratories and all other facilities necessary for the execution of the Works.

The power supply shall be three-phase, four-wire, 50 Hz, 415 V (ph-ph) for power and 240 V (ph-N) for lighting and small power and shall comply with the regulations of local power supply authorities. Facilities shall be provided to permit the isolation of individual supply points while maintaining supply to the remainder of the system. Unless otherwise provided, the Contractor shall install a meter at the Project Site Office.

Not less than sixty (60) days prior to the installation for supply and distribution of electricity as

required under this Sub-Clause, the Contractor shall submit in full detail his proposals and drawings for approval.

Unless otherwise directed, on the completion of the Works, the Contractor shall remove from the Site the installation for electricity supply provided by him and the electrical distribution systems in and amongst the Contractor camps, offices, stores, workshops and other areas.

Separate payment will not be made for complying with the requirements of this Clause.

Telecommunications

The Contractor shall make his own arrangements for the required telecommunication services.

The Contractor shall provide and operate an independent automatic external telephone connection with exchange access to each of the rooms in the Project Site Office along with four (4) numbers of mobile telephones.

In addition to the above service, the Contractor shall provide and operate a communications system for the purpose of intercommunication within the Site area but without exchange access. Such intercommunication shall consist of eight (8) units of 2-channel walkie-talkie and will cover the following;

Communication between the Contractor and the Engineer at Site; and Communications between all offices and working points within the scope of the Contract

The walkie-talkies shall be of a make and model approved by the Engineer and shall become the property of the Employer at the end of the Contract. The Contractor shall obtain the required license to operate the walkie-talkies and shall keep them in regular and proper service.

The payment will be made for complying with the requirements of this Sub-Clause up to the Lump Sum Price quoted in the Bill of Quantities with no any additional payment.

Water Supply

The Contractor shall make his own arrangements for the supply of adequate safe drinking water. The Contractor shall comply with all rules and regulations that may be made by the authorities having jurisdiction, and by the Engineer, regarding the taking of water from the Anambar River and its tributaries.

If any need should arise that the Contractor requires to obtain water from other sources, the water should be tested for impurities contents and approved by the Engineer. Any additional cost incurred will not be paid but will be deemed to be included in the various rates of the priced

Bill of Quantities.

The Contractor shall be responsible for the supply and reticulation of all water for his own use and to the Engineer's residential camp, Project Site Office and Field Offices. Water supplied for domestic use shall be potable.

The Contractor's methods of storage of water for construction purposes shall be in accordance with the proposals approved by the Engineer.

Separate payment will not be made for the provision for water supply.1-1.19 Sewerage

The Contractor shall provide and install an approved treatment process for disposal of sewage from all offices, camps and other buildings constructed by the completion of this Contract.

The Contractor shall construct, operate and maintain at the site temporary toilet facilities complete with adequate water borne water closets, urinals and hand-basins, septic tanks, absorption trenches or other sewerage disposal installations, for all site personnel.

The temporary toilet facilities shall meet the requirements of the Government health authority. The location of these facilities and their construction shall be as approved.

Sewage from temporary facilities shall be disposed of in a hygienic manner as approved.

Separate payment will not be made for complying with the requirements of this Clause.

Garbage Disposal

The Contractor shall undertake the collection of and disposal of all garbage from within the area of both the Permanent and Temporary Works including from the Engineer's residential camp Project Site Office. Garbage collections shall be made at least twice each week and shall continue until completion of the Works.

Garbage shall be disposed of in a properly constructed incinerator followed by burial of the residue in an approved location. The Contractor shall submit the proposed design and layout of garbage disposal facilities for approval.

The payment will be made for complying with the provision of this Sub-Clause, up to the Lump Sum Price quoted in the Bill of Quantities with no any additional payment.

Fire Prevention

The Contractor shall provide and maintain adequate fire-fighting equipment and take adequate fire precaution measures for the safety of all personnel, temporary and permanent works, and

shall take action to prevent damage to or destruction by fire of trees, shrubs or grasses.

Separate payment will not be made for the provision of fire prevention measures.

First Aid and Medical Facilities

General

The Contractor shall in all respects be fully responsible for ensuring necessary first-aid services to his employees and employees of his subcontractors, including transport for injured personnel to hospital or other appropriate accommodation as and when required.

Staff

To enable the fulfillment of his obligations under this Clause, the Contractor shall engage qualified resident first-aid staff, provide and maintain an Ambulance to move serious patients or victims of an accident to nearby Hospital.

Separate payment will not be made for first-aid and medical facilities provided by the Contractor for his employees and the employees of his subcontractors. The facility shall be also available for the use of Engineer’s staff.

Living Facilities, Camp Amenities and Recreation Facilities

Location of Construction Township

The Employer will allocate free of cost to the Contractor an area of land to be used for the construction of quarters for his own staff and camps for workmen and for other camp amenities for his employees and the employees of the Employer.

Contractor's Staff Quarters and Camps

The Contractor shall ensure that his allocated areas are at all times kept in a clean and sanitary condition, and shall provide and maintain sanitary conveniences for the use of persons employed on the Works to the extent and in the manner and at such places as shall be approved by the Engineer and by any local or other Government authority concerned, and all employees of the Contractor and his subcontractors shall be obliged to use these conveniences. Any employee found violating this requirement shall be liable to immediate termination of employment and to the refusal of further employment on the Works.

Camp Amenities

(a) The Contractor may be permitted to lease areas within his labour camp or quarter's area for his staff, or space in buildings constructed by him in these areas, for conducting such business or services as may be necessary for the convenience of his labour or staff. The Contractor may recoup from leases such rent as necessary to cover the costs of administering the provision of these businesses or services. Patronage of such businesses or employment of such services by the Contractor's employees shall be optional.

(b) All concessions or leases shall require a submission to the Engineer and the approval of the Employer. No concessions or leases shall be granted for the operation of games of chance or gambling in any form. They shall contain provisions making them subject to termination upon both completion of the Works and in the case of the business or service, being conducted in such a manner as to infringe the terms of this Sub-Clause.

(c) The charges for all goods and services at camp shops, canteens and the like shall be fair and reasonable and not in excess of the charges for similar goods and services in the area.

Recreation Facilities

(a) The Contractor shall provide construct and maintain in an approved area, recreation facilities for sports such as soccer, volley ball and tennis etc. These facilities, shall be available for the use of the Contractor and the Engineer's staff, and respective dependents.

(b) The Contractor may also at his expense, construct any additional service facilities required in the recreation area and shall ensure that the standard is at least equal to other township buildings.

(c) The Contractor shall ensure the recreation area and service facilities are at all times kept in a clean and tidy condition.

(d) Separate payment will not be made for complying with requirements of above mentioned Sub-Clause.

Security Fencing

The Contractor shall erect and maintain and keep in good repair this security fence and shall

make good any damage, at his own costs, before vacating the site on the completion of the Contract.

Separate payment will not be made for complying with requirements of abovementioned Sub-Clause.

Removal of Buildings and Facilities

The Contractor, upon completion of the works, shall dismantle and remove all buildings complete including the facilities as stated in this Sub-Clause and temporary structures erected by him as part of his construction camp, and fill in all excavated areas as directed, remove all refuse, debris and other objectionable materials and leave the camp area in a clean and rightly condition to the satisfaction of the Engineer.

Separate payment will not be made for complying with the requirements of this Sub-Clause.

Contractor's Offices, Stores and Workshops

General

(a) The Contractor shall provide and maintain such offices, stores, workshops and adequately fenced store and delivery compounds as are necessary for the execution of the Works, including all necessary services for water supply, drainage, lighting, roads, paths, parking places, sewerage and garbage disposal.

(b) On the completion of the Works, all buildings and facilities provided by the Contractor in accordance with the provisions of this Clause shall remain the property of the Contractor and shall be removed from the Site.

Separate payment will not be made for complying with the requirements of this Sub-Clause.

Flood Prevention

The Contractor shall plan his work in such a manner to ensure no flooding or pounding of water outside the construction area will occur.

Separate payment will not be made for the provision of flood prevention measures and the cost of this work shall be deemed to be included in the various rates and lump sum prices in the priced Bill of Quantities.

Security

General

(a) The Employer will specify overall security requirements for the project and the Contractor shall conform to such requirements and be responsible for such action of his personnel in respect of such requirements.

(b) The project site may be located within a Security Controlled Area and the Contractor shall conform with all requirements established by the Police/Defense Department for this area.

(c) The entry of personnel, food stuff, clothing and other items into the Security Controlled Area will be regulated by the Police Department or as directed by the Engineer.

(d) The Contractor shall obtain Police Permits to enter the Security Controlled Area for all personnel employed on the project including personnel of his subcontractors and all other persons he requires to visit the Site. Application for permits shall be lodged with the Police Department not less than fourteen (14) days prior to the date of proposed entry to the area. Applications shall include all personnel information as required by the Police Department.

Identification

(a) All Contractor's employees, representatives, and subcontractor's employees shall wear identification badges provided by the Contractor. Badges shall identify the Contractor, show an employee number, and shall be worn at all times while at the Site.

(b) All vehicles used by the Contractor shall be clearly marked with the Contractor's name, and name of project.

Site Security

The Contractor shall be responsible for the security of the works for the duration of the Contract and shall provide and maintain continuously an adequate security force to fulfill these obligations. The duties of the Contractor's security force shall include, but not be limited to, maintenance of order on the Site, provision of all lighting, fencing, guards, flagmen, and all other measures necessary for the protection of the Works within the township and elsewhere on the Site, all material delivered to the Site, the public, and all persons employed in connection with the Works, continuously throughout working and non-working periods, including nights, days of

rest and holidays, for the duration of the Contract.

Camp Security

Each entrance in the security fence surrounding camp area shall be continuously manned by the Contractor's security personnel who shall control the movement of personnel and goods into and out of the enclosed area and shall prohibit persons leaving the area between night hours except those authorized personnel employed during the night shift on the construction work.

Separate payment will not be made for complying with the requirements of this Sub-Clause.

Engineer's Site Offices, Supervision Staff Offices and Residential Houses

General

The Contractor shall design, construct, maintain and insure until completion of the Works, the buildings of single story construction of temporary nature which shall consist of the facilities complete with fixtures and equipment for sole use by the Engineer/ Engineer's staff as follows.

Engineer	1 No.
Site Engineers	2 Nos.
Material Engineer	1 No.
Supervisors	4 Nos.
Surveyors	2 Nos.
Laboratory Technician	2 No.

The space requirements are as follows.

(i) An office measuring not less than five hundred square feet (46 square meters), furnished with 4 desks with chairs, three guest chairs and lockable filing cabinets.

(ii) Four (4) furnished single residential quarters with toilet, mess facilities, potable water supply, sanitation, power supply, electric fans and lights, each measuring not less than 500 square feet (46 sq. m.) and sufficient boundary space to park at least one vehicle.

Testing Laboratory

Construction

Building materials and surface finishes used shall be appropriate for this class of work.The roofs and external walls shall have effective thermal insulation and all ceiling and internal partitions shall be effectively soundproofed. The floors shall be fitted with a heavy duty vinyl covering.

The buildings will be located on site as approved by the Engineer after consideration of the proposal by the Contractor and the Contractor shall construct drains, temporary roads, parking areas and paths as directed. Earthworks and drainage for the buildings, roads and parking areas shall be carried out to an approved standard. Car parks shall be constructed at the Project Site Office with space for twelve cars; five of these spaces shall be covered. The area surrounding the Project Site Office, laboratory shall be surrounded with chain link fencing not less than 1.8 meters high and lockable gates along with guards shall be provided at entry / exit points.

The Contractor shall submit the specifications and full construction drawings for the Project Site Office, laboratory and residential houses to the Engineer. The construction of the Project Site Office, laboratory and residential houses shall be in accordance with the layout as approved by the Engineer. The Contractor shall not commence any construction or fabrication work on the buildings or services until approval has been given by the Engineer.

The design, construction and supply of the Project Site Office, laboratory and residential houses shall include all necessary electrical installations, including switchboards and meters in accordance with the provisions of the related local unless and incase they are silent, the Regulations for Electrical Equipment of Buildings as issued by the Institution of Electrical Engineer's G.B. The artificial lighting provided in the building shall be with the provisions of IES Code for Interim Lighting (Illuminating Engineering Society London).

Services

(a) The Project Site Office, laboratory and residential houses shall be connected to the Contractor's distribution system for power and light.

(b) Communication services shall be installed in each of the room provided in the Project Site Office as required by Sub-Clause 1-1.18 of this Specification.

(c) Washroom with approved sanitary fittings shall be provided at the Project site Office.

(d) The Contractor shall install and maintain an approved sewerage installation for the Project Site Office and residential houses.

(e) The Contractor shall provide and maintain a suitable water supply to all plumbing connections in the Project Site Office and residential houses. The water supply for sinks and water cooler shall be potable water. The installation shall include such supply and storage tanks as are necessary to maintain an adequate supply of suitable water and electric water heaters storage type of 150 and 50-liter capacity for the Project Site Office.

The Contractor shall pay for all water, electricity and telephone charges consumed in the Project Site Office, laboratory and residential houses. The cost shall be included in the maintenance of the Project Office, laboratory and residential houses.

The contractor shall include the cost of maintenance of the project office, laboratory & residential houses.

Engineer's Testing Laboratory

(a) The Contractor shall provide, install and maintain on Site for the duration of the contract a laboratory in a temporary building for the exclusive use of the Engineer for testing soils, aggregate, concrete and bituminous materials. The laboratory shall be fully equipped with all utilities, furniture, apparatus and fittings appropriate to such use and in full compliance with the Engineer's instructions & as per site requirement.

(b) The Laboratory shall be located adjacent to the Engineer's Office or elsewhere if required by the Engineer, and shall consist of a hall and two offices with storage, lavatory and washing facilities. The total area of the laboratory building shall be 250 sq. m. The hall shall be divided into bitumen section, a soil and aggregates section, and a concrete section.

(c) Outside the laboratory water tanks shall be constructed for curing concrete samples, of a size and location approved by the Engineer.

(d) The laboratory shall be provided with electricity and telephone and shall be fully air-conditioned. It shall have a regular and dependable supply of water, gas and electricity available throughout 24 hours of each day.

(e) All rooms shall be provided with exhaust fans, located particularly over fume cupboards and the like.

(f) The water supply shall be maintained by an elevated or pressure tank of adequate capacity.

(g) The Contractor shall provide qualified materials technicians and qualified laboratory helpers as deemed necessary by the Engineer to assist in operating the laboratory. All costs necessary for the provision and upkeep of these personnel shall be the responsibility of the Contractor and shall be considered included in the payment herein specified for providing and maintaining the Engineer's Laboratory.

(h) The equipment & furnishings and building of Engineer's laboratory shall become the property of the employer on the date of issue of the Taking-over certificates, when the buildings shall be re-instated and repaired as necessary by the Contractor to its original condition.

(i) It shall be the responsibility of the Contractor to take samples as required by the Engineer and to provide all necessary transport, labour, tools, containers, wrappings and so forth for uplifting and dispatching samples to the Engineer's Laboratory.

(j) The Contractor shall maintain, and shall repair and replace the laboratory equipments in the event of loss or damage of these equipments during the duration of the Contract. This work is part of maintenance and the cost shall be included in the price of maintenance of the project office laboratory and no additional payment shall be made by the Employer.

Maintenance and Cleaning

(a) The Contractor shall maintain the Project Site Office, Residential Houses with all the fittings, equipments, and associated facilities provided in accordance with the provisions of this Clause and its Appendices in good order and condition including any replacement due to loss or damage until completion of the Works. Maintenance shall include the repair and making good of all faults and defects that become apparent in the buildings surface drainage, roads and paths including cleaning, electrical, plumbing, water supply and sewerage services appurtenant to the buildings and all items in the buildings provided in accordance with the provisions of this Sub-Clause and its Appendices.

(b) Maintenance shall also include the provision of expendable items such as electric light tubes and bulbs or repainting including repainting required by manifestly poor workmanship or materials in the initial supply.

(c) The Contractor shall carry out regular daily cleaning of the Project Site Office, laboratory and arrange disposal of waste from residential houses. The cost shall be included in the

maintenance of the Project Site Office, laboratory and residential houses and no additional payment shall be made by the Employer.

Separate payment will not be made for complying with the requirements of this Sub-Clause.

Insurances

The Contractor shall insure the Project Site Office, laboratory, residential houses and all associated facilities in accordance with the provisions of Clause 18.1 of the General Conditions of Contract.

No additional payment shall be made by the Employer in this regard.

Handing over of Buildings and Facilities

The Contractor, upon completion of the works, shall handover the Buildings including Project Site Office, Laboratory and Residential Houses to the employer including all the facilities provided as per the provisions of this Sub-Clause or and its appendices restored to its original condition at no extra cost.

Existing Public Utilities and Other Services

Location, Protection and Repair of Damage

The Contractor shall be responsible for locating the position of all services, including mains, overhead and underground cables, pipes, canals, sewers and drains, and where necessary shall adopt such methods of excavation as may be required by the appropriate Authorities or Owners to ensure that no damage is caused to them.

All services which are encountered in the course of the Works even though they may not be in the line of excavation but near to it shall be adequately supported, slung up, strutted or otherwise protected form injury to the satisfaction of the persons or Authority in whom they may be vested.

The Contractor shall make good, at his own expense, any damage done to existing services to the complete satisfaction of and in accordance with the instruction of the appropriate Authority or Owner concerned, and shall keep the Employer indemnified at all times from all claims, costs and expenses which may be brought against or incurred by the Employer for or on account of any damage (whether permanent, temporary or recurring) to the said services.

In the event of the Owner or responsible Authority electing to repair such damage the

Contractor shall pay the cost of his or their so doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of the account being presented the Employer reserves the right to settle the account and deduct the sum paid by him from moneys due or which may become due to the Contractor. This shall in no case relieve the responsibilities of the Contractor under this Clause.

Separate payment will not be made for complying with the requirements of this Clause and all costs shall be deemed to be included in the various rates and lump sums tendered in the priced Bill of Quantities

Diversion / Relocation of Public Utilities and Services

The diversion / relocation of any public utilities or services within or outside the Works area to permit the construction of the Works or to suit the Contractor's method or sequence of work shall be the responsibility of the Contractor. Where a service is required to be interrupted or relocated the Contractor shall notify and arrange with the appropriate Authority or Owner for all permanent and temporary diversions so required. The Contractor shall keep the Engineer fully informed of his negotiations and no final arrangements shall be made without the approval of the Engineer.

In planning his work for the diversion / relocation of Public utilities or services the Contractor shall make proper allowance for the time necessary to obtain the Engineer's approval for the work and for the appropriate Authorities or Owners to authorize the work, obtain the necessary materials and carry out the work. The Contractor shall not be entitled to any extension of time because of his making insufficient allowances for the time taken to obtain approvals and complete the work.

Due allowance shall be made by the Contractor for the effect on the phasing of the Works of alterations to existing public and private mains and services necessitated by the Works. The Contractor must ensure that such existing mains and services are not interrupted without the written consent of the appropriate Authority or the Owner of the services concerned.

The Contractor shall ensure that his program for the whole of the Works executed under the Contract is compatible with the requirements of the Service Authorities and the specifications and the Conditions of Contract. During the execution of the Works, he shall coordinate all services diversion operations with the remainder of the Works in close liaison with the Service Authorities and shall make such adjustments to his program as are from time to time necessary to accommodate the actual progress achieved with the temporary and permanent diversions undertaken.

Separate payment will not be made for complying with the requirements of this Sub-Clause and

all costs shall be deemed to be included in the various rates and lump sums tendered in the priced Bill of Quantities.

Relocation of Privately Owned Services

If any privately Owned Services for water, electricity, drainage sewerage or telephones, passing through the site will be affected by the Works, the Contractor shall provide an approved equivalent alternative service in full working order to the satisfaction of the owner of the service and the Engineer, before the cutting of the existing service.

Separate payment will not be made for complying with the requirements of this Sub-Clause and all costs shall be deemed to be included in the various rates and lump sums tendered in the priced Bill of Quantities.

Traffic Safety and Control (Traffic Safety Measures)

The Contractor shall provide, erect and maintain such traffic signs, lamps barriers and traffic control signals and such other measures as may be necessitated by the construction of the Works in accordance with this Specification and in the local traffic safety rules. Where the circumstances of any particular case are not covered by the recommendations the Contractor shall submit proposals for dealing with such situations to the Engineer for approval. Compliance with this Clause shall not relieve the Contractor of any of his other obligations and liabilities under the Contract and under the relevant provision of the Road Traffic Ordinance.

The Contractor shall, after consultation with any statutory or other authority concerned, submit to the Engineer for his approval a program based on such consultation showing the scheme of traffic management he proposed for carrying out the Works before commencing any work which affects the use of public highway or road and then furnish such further details and information as necessitated by the Works or as the Engineer may require.

The Contractor shall not commence any work which affects the public road until all traffic safety measures necessitated by the work are fully operational.

The traffic signs, lamps, barriers and traffic control signals shall be in accordance with the requirements of the Traffic Signs (Size, Color and Type) Rules current at the date of the execution of the work and the local traffic safety rules.

Traffic signs and road danger lamps shall comply with the provisions of Section 12, Road Work, except that the flashing rate for flashing lamps shall be within the range 120-150 flashes per minute.

The minimum luminous intensity of the lamps shall be 0.5 candelas for steady lamps, 1.0

candela for ripple lamps at their peak, and 1.5 candelas for flashing lamps at their peak.

The Contractor shall keep clean and legible at all times signs, lamps, barriers and traffic control signals and he shall position, re-position, cover or remove them as necessitated by the progress of Works.

Separate payment will not be made for complying with the requirements of this Clause and all costs shall be deemed to be included in the various rates and lump sums tendered in the priced Bill of Quantities.

Transport for Engineer's Staff

The providing of vehicles is provisional and subject to the assessment of the requirements by Engineer, and will be accordingly ordered in writing by Engineer.

All vehicles shall be air conditioned, comprehensively insured and of the following types.

Two Nos. 4 Wheel Drive diesel engine Double Cab Pickup of the capacity not less than 3000 cc, Toyota or equivalent. Replacement vehicles shall be provided when normal vehicles are not available such as during periods of servicing, maintenance or repair for more then 24 hours.

The contractor shall also provide drivers (including shift drivers as required) all fuel oil and necessary service maintenance throughout construction period and extended period thereof.

The failure on part of the contractor to provide these facilities, shall entitle the employer to hire all required such facilities and recover the spent charges from the monthly payment of the contractor.

Survey Equipment for the Engineer

The Contractor shall provide and maintain during the period of the Contract for the exclusive use of the Engineer for any purpose in connection with the Contract surveying equipment in accordance with the following:

1 No. Total Station with tripod

1 No. Quick Stand with Prism

1 No. Precise Levels (Automatic type), with tripod, magnification 34X

2 Nos. Levelling Staff with graduations in metric units

2 Nos. Steel measuring tapes 100 m long

3 Nos. Steel measuring tapes 20m long

3 Nos.	Hand tapes 3 m (lockable in pocket)
4 Nos.	Measuring rods(4m)
18 Nos.	Ranging rods with tripods
6 Nos.	Club hammer 2 kg
6 Nos.	Sledge hammer 4 kg
2 Nos.	Survey Umbrellas
3 Nos.	Aluminium Straight Edges 3.0m long
3 Nos.	Aluminium Straight Edges 5.0m long
3 Nos.	Spirit Levels, 30 cm long

The contractor shall make available one (1) qualified surveyor and required numbers of helpers as and when required by the Engineer Representative. After completion of the project all the equipment will be property of the Employer.

The equipment shall be maintained by the Contractor and kept in good working order and correct adjustment during the period of the Contract.

All equipment shall be suitable for working in metric units.

The Contractor shall make suitable replacement as directed by the Engineer in case of any loss or damage to the equipment provide by Contractor under this Clause. No extra payment shall be made for such replacements that shall be deemed to be covered under maintenance of Survey Equipments.

Upon completion of the Contract or at such time as it is no longer required by the Engineer for the Works the surveying equipment provided under this Clause shall remain the property of the Employer.

Assistance to Engineer

Provision of Labour

The Contractor shall provide at all times during the period of the Contract, for the exclusive use of the Engineer, such labour, either continuously or form time to time, as may be required by the Engineer in carrying out his duties in connection with the Contract, namely:

(i) In checking the setting out of the Works;

(ii) In measuring the Works;

(iii) In carrying out tests;

(iv) Embankment cum concrete Laboratory Assistance

(v) As messengers in connection with the Works; and

(vi) As watchmen over the Project Site Office and equipment.

Separate payment will be made for fulfilling the requirements of this Sub-Clause. The costs shall be covered in the various rates tendered in the priced Bill of Quantities.

Contractor's Duty Staff

At least one responsible senior representative of the Contractor shall be immediately available at all times and he shall be on the Site during normal working hours. The representative shall be reasonably proficient in English as required in relevant Clauses of the Special Conditions of Contract. To such representative shall be delegated full authority to confer with the Engineer's Representative or his deputy and to take all steps and to issue all those instructions which may be required in an emergency to ensure the safety of all personnel of the Works and of all the Employer's and other property on the Site and in the immediate vicinity thereof.

The Engineer may from time to time at his discretion after taking into consideration all the prevailing conditions allow some relaxation of this Clause but such relaxation shall be made only with the Engineer's written permission and subject to any special conditions which the Engineer may then require.

Separate payment will not be made for complying with the requirements of this Clause.

Photographic Records

Colour Photographs & Slides

The Contractor shall procure a digital camera approved by the Engineers take colour progress photographs and slides under the direction of the Engineer of the works before during and after construction viewed form the same position. The number of photographs taken each month for the Engineer's selection shall not be less than 36.

The Contractor shall provide the Engineer, within seven (7) days of the following month proof copies of the photographs taken which shall be 120mm by 90mm in size, together with the colour negatives.

The date the photograph was taken, the description and the negative number shall be recorded on the reverse side of each print.

After selection by the Engineer, one copy of each of the photographs selected shall be supplied to the Engineer together with their negatives in an approved album provided by the Contractor.

In addition, during the construction of the Works, the Contractor shall provide the Engineer with colour photographs for record purposes taken under the direction of the Engineer. These record photographs shall be supplied as two (2) prints, each not less than 290mm by 200mm in size together with the colour negative. The reverse of each print shall be inscribed with the signatures of the Contractor and Engineer, or their authorized representatives for the purposes of attestation and will be retained by the Employer. Additional prints similarly attested may be retained by the Contractor. The date, caption, description and negative number shall also be recorded on the reverse side of each print. Negatives and prints shall not be retouched. The copyright of all photographs shall belong to the Employer.

Video Film

a) The Contractor shall produce an edited and narrated video film in colour of not less than 90 minutes duration, showing all the major phases in the construction of the Project. The film shall be edited by a specialist experienced in the production of documentary video films. On completion of the project, two sets of the so completed video films shall be provided to the Employer and one to the Engineer. Also video compact disc shall be provided to the Employer.

b) The Contractor shall within thirty (30) days of the Engineer's written order to commence work, submit for approval the name of the specialist proposed to carry out the work and details of his previous experience.

c) The copyright of the video-film shall belong to the Employer.

Amenities to be preserved

The Contractor shall cause the least possible interference with existing amenities whether natural or man-made. No trees shall be felled except on the instructions of the Engineer, and clearance of the Site shall be kept to the minimum necessary in the Work and Temporary Works.

Impounding of Reservoir

Impounding shall not commence until the Engineer has issued a written permission. The

manner in which the reservoir is filled in so far as it is within the control of the Contractor, shall comply strictly with the terms and conditions laid down by the Engineer together with the permission for impounding.

Separate payment for Reservoir Impounding will not be made for complying with the requirements of this Clause and all coats shall be deemed to be included in the various rates and lump sums tendered in the priced Bill of Quantities.

Measurement and Payment

Performance Security

Payment

The cost of providing the Performance Security will be borne by the Contractor.

Insurances

Measurement

The item requires three types of Insurances. The break-up of Lump sum of proposed by Contractor and approved by the Engineer shall be the basis for payment.

Payment

Payment for cost of three types of Insurances will be made on the basis of approved break-up of the lump sum price tendered thereof in the priced Bill of Quantities, which provides for all the cost of complying with the requirements of the General/Special Conditions of Contract. The Employer shall not pay any additional amount for contractor’s compliance with the related requirements of Conditions of Contract.

Mobilization and Demobilization

Measurement

The breakup of Lump sum price as proposed by the contractor and approved by the Engineer shall be the basis for payment.

Payment

Payment for mobilization and demobilization shall be made on the basis of approved break-up of the lump sum price tendered thereof in the priced Bill of Quantities, which provide for all the cost of complying with the requirements of the General and Special Conditions of Contract. The Employer shall not pay any additional amount for contractor's compliance with the related requirements of General Conditions of Contract.

Engineer's Site Office, Laboratory, Field Offices and Residential Houses

Measurement

(a) The accommodation, office services and maintenance shall be made in arrears on monthly basis shall be the basis of payment for each month

Payment

Payment for the provision of the Engineer's accommodation and office facilities and attendance on the Engineer and his staff shall be made monthly in arrears for the months that the Engineer certifies that the Contractor has provided the services.

Unit of Measure

Unit of measure for: a) Man-Month

Maintain and Operate Transport for Engineer's Staff

Measurement

Measurement for payment for transport for Engineer's staff shall be on the basis of vehicles supplied under orders from the Engineer and shall be deemed to include for each vehicle the fixed costs, depreciation, cost of fuel and oil, all maintenance cost, road tax, comprehensive insurance, licenses and the provision of full time competent drivers for all passenger carrying vehicles.

Payment

Payment for provision and maintenance of transport for the Engineer's staff will be made at the

applicable rate per month as quoted by the Contractor in priced Bill of Quantities.

Unit of Measure

Unit of measure: vehicle-month

Telecommunications System

Measurement

The contractor shall provide a break-up of Lump sum, which will be approved by Engineer for payment.

Payment

The break-up approved by Engineer shall be the basis of payment and shall include cost of replacement of any component if damaged in use.

Unit of Measure

Unit of measure: Lump sum

Operatives for Engineer

Measurement

Measurement shall be the different persons working with Engineer as required on monthly basis.

Payment

Payment shall be made on the rates quoted in the price of Bill of Quantities for different categories working during the month.

Unit of Measure

Unit of measure: Man-month

Photographic Records

Measurement

The contractor shall submit a break-up of his Lump sum price, which covers full requirements as specified and shall be approved by the Engineer. This approved break-up shall be the basis for payment.

Payment

Payment for provision of colour record, progress photographs, slides, video documentary film and video compact disk as specified, will be made as per the approved break-up of the Lump Sum tendered therefor in the priced Bill of Quantities. The Lump sum includes coloured record photographs, progress photographs for Monthly Progress Reports & slides, along with the cost of negatives, prints, and photo albums for photographs as required.

Further the Lump Sum will include the cost of shooting, editing, sound recording and the commentary in English etc all as required in the production of documentary video film from start to completion of the Project by an approved specialist, and providing three copies of the video film all as specified. Also cost of video compact disk produced & delivered to Employer is included in the Lump Sum price tendered.

Payment for the provision of video films is also part of the lump sum and will be made on the basis of the above approved break-up and shall include the cost of shooting, editing, sound recording, commentary and recorded digital compact video disk.

Unit of Measure

Unit of measure: Lump sum

Project Sign Board

Measurement

Measurement shall be number of Boards installed as directed by the Engineer.

Payment

Payment shall be made at the rate quoted in Priced Bill of Quantities.

Unit of Measure

Unit of measure: Number

Cost of Engineer's Telephone Calls

Measurements and Payment

Measurement and payment for the telephone calls of Engineer & his staff shall be made on actual call bills under the requirements of Clause 6 – Provisional Sums, of the Conditions of Contract.

SECTION 2

EXCAVATION AND MISCELLANEOUS EARTHWORK

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SECTION 2

EXCAVATION AND MISCELLANEOUS EARTHWORK

EXCAVATION AND MISCELLANEOUS EARTHWORK

GENERAL

Scope

This section covers the requirements for clearing, stripping, and excavation for foundations, borrows areas, quarries and for other works of this project and construction of miscellaneous earthworks other than that covered under Section 7, Embankment Construction for Dam.

References

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(1995) Standard Test Method for Materials Finer than 75-micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(2001) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2001) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 33	(2003) Concrete Aggregates.
ASTM C 88	(1999a) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D 1140	(2000) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone

	Method
ASTM D 1557	(2002) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2434	(1968; R 2000) Permeability of Granular Soils (Constant Head)
ASTM D 2487	(2000) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2001) Standard Test Methods for Density of Soil and
Soil-Aggregate in Place by Nuclear Methods	(Shallow Depth)
ASTM D 2937	(2000e1) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(2001) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3282	(1993; R 1997) Standard Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D 3740	(1994) Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction
ASTM D 422	(1963; R 2002) Particle-Size Analysis of Soils
ASTM D 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 698	(2000a) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 2	2000) Standard Specification for Sampling of Aggregates
AASHTO M 145	(1991; R 1995) Recommended Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 180	(1997) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T 87	(1986; Rev 1993) Standard Method for the Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2003) Safety -- Safety and Health Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926 (2001) Safety and Health Regulations for Construction

Definitions

Satisfactory Materials

Satisfactory materials for road fill shall mean AASHTO M 145, (ASTM D 3282) Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.

Satisfactory materials for grading shall be comprised of stones less than 200 mm, except for fill material for pavements and roads which shall be comprised of stones less than 75 mm in any dimension.

Unsatisfactory Materials

Unsatisfactory soil materials for road fill shall mean AASHTO M 145, Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, peat and other highly organic soil, and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

For other fills, the materials, which do not comply with the requirements for satisfactory

materials, are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. The Engineer shall be notified of any contaminated materials.

Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as Cohesionless only when the fines are nonplastic. Testing required for classifying materials shall be in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

Hard/Unyielding Materials

Weathered rock, dense consolidated deposits, or conglomerate materials, not included in the definition of "rock", with stones greater than 100 mm in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 0.4 cubic meter in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

Unstable Material

Unstable material is defined as any material that is too wet to properly support the utility pipe, conduit, or appurtenant structure.

Select Granular Material

Select granular material is defined as any material classified as GW, GP, SW, and SP by ASTM

D 2487 where indicated. Coefficient of permeability shall be a minimum of 0.01 mm per second when tested in accordance with ASTM D 2434.

Initial Backfill Material

Initial backfill is defined as select granular material or satisfactory materials free from rocks 75 mm or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 75 mm in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

Expansive Soils

Expansive soils are defined as soils that have a plasticity index equal to or greater than 25 percent when tested in accordance with ASTM D 4318.

Trees

The line of demarcation between brush and trees, for the purpose of distinguishing clearing requirements, is that trees, as used, will be considered as that woody growth not falling within the limits of brush as defined below.

Brush

Brush is that growth, which is less than 50 mm in diameter, measured 150 mm from the ground on the uphill side and is less than 2 m in height measured from the ground on the uphill side.

Structures to be removed

The term "structures to be removed" shall include buildings or portions thereof, walls, silos, storm or root cellars, cisterns, wells, windmills, pit silos, water towers, etc. Structures shall be removed or filled to the ground surface.

Submittals

The following shall be submitted for Engineers review and approval in accordance with Clause 1-1.4 - Submittal Procedures:

1. Preconstruction Submittals

Shoring

Blasting

Submit 15 days prior to starting work.

2. Product Data

Utilization of Excavated Materials

Rock Excavation,

Opening of any Excavation or Borrow Pit or Quarry

Procedure and location for disposal of unused satisfactory material and quarry. Proposed source of borrow material. Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas.

3. Test Reports

Testing

Borrow Site and Quarry Testing

Within 24 hours of conclusion of physical tests, copies of test results, including calibration curves and results of calibration tests. Results of testing at the borrow site.

4. Certificates

Testing

Qualifications of the commercial testing laboratory or Contractor's testing facilities.

5. Preconstruction Submittals

Construction Equipment List shall be submitted

Contractor shall record Existing Conditions prior to starting work in accordance with the Clause 5-1.7 - Existing Conditions of this section.

6. Test Reports

Test Reports shall be submitted for Soil Test results within 7 calendar days. Test reports shall be submitted according to Sub-Clause 5-1.5.3 - Quality Control Testing during Construction of this section.

7. Certificates

Certificates of Compliance for Proposed Soil Materials shall be submitted according to Sub-Clause 5-1.5.2 - Tests for Proposed Soil Materials of this section.

Certificates of Compliance for Compost shall be submitted indicating grade and compliance with state and local regulations.

Sampling and Testing

Soil Test and Inspection Service

Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil-testing service approved by the Engineer shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials; sampling and testing soil materials proposed for use in the work, and field-testing facilities for quality control during construction period.

Testing agencies shall conform to the requirements of ASTM D 3740.

Tests for Proposed Soil Materials

Materials shall be approved by the Engineer prior to start of work.

Soil materials proposed for use in the work shall be tested as follows:

Table 2-1

Material	**Requirement**	**Test Method**	**Number of Tests**
Satisfactory soil materials	Sampling	AASHTO T 2	Three from each source of materials to determine conformance to Definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis is of fine and coarse aggregates	ASTM C 136	
	Amount of material passing 75 micrometer sieve	ASTM C 117	
	Liquid Limit	ASTM D 4318	

	Plastic limit and plasticity index	ASTM D 4318	
	Mechanical analysis	ASTM D 4318	
	Moisture density relations	ASTM D 1557, Method D	As required to determine moisture-density requirement of materials from each source.
	Los Angeles abrasion of coarse aggregates	ASTM C 131	One for each soil material from each source if called for in reference specification
	Magnesium sulfate soundness test	ASTM C 88	

Quality Control Testing During Construction

Soil materials shall be tested during construction as follows:

Table 2-2

Material	Requirement	Test Method	Number of Tests
Soil materials Specified	Sieve analysis is of fine and coarse aggregates	ASTM C 136	One daily for each soil material from each source; additional test whenever there is any apparent change
	Amount of material passing 75 micrometer sieve	ASTM C 117	
Soil materials prior to compaction	Moisture density relations of soil	ASTM D 1557, Method D	One for each subgrade soil material except under backfill for structures; One for each backfill and

			fill material from each source
Soil Material-in-place after compaction	Density of Soil-in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922, Nuclear Method (when Approved by Engineer)	At least three daily for each subgrade soil material except under backfill for structures, and for each layer and backfill and fill material; additional test whenever there is any change in moisture conditions

Test Reports

No soil material shall be used until test reports have been reviewed and approved by the Engineer.

Evaluation of Test Results

Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if not more than one density test in five has a value more than 2 percentage points below the specified density.

Construction Equipment List

Construction Equipment List of all major equipment to be used shall be submitted.

Existing Conditions

Existing Conditions shall be recorded, in the presence of the Engineer, and shall include all structures and other facilities adjacent to areas of alteration or removal. Such records shall contain the location of existing utilities, the elevation of the top of foundation walls, the location and extent of cracks and other damage, and a description of surface conditions that exist prior to the start of work. Copies of the record shall be submitted and the conditions prior to starting work shall be verified.

Subsurface Data

Subsurface soil data is available with client for contractor's review. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

Clearing

Areas to be cleared shall include, but not be restricted to:

(i) Borrow areas and quarries,

(ii) Surfaces of stockpiles,

(iii) Disposal areas outside the reservoir area,

(iv) Areas to be backfilled, and

(v) Areas to be occupied by the permanent and temporary construction

Classification of Excavation

Excavation specified shall be done on a classified basis, in accordance with the following designations and classifications.

Common Excavation

Common excavation shall include the satisfactory removal and disposal of all materials not classified as rock excavation.

Rock Excavation

Rock excavation shall include blasting, excavating, grading, and disposing of material classified as rock and shall include the satisfactory removal and disposal of boulders 1/2 cubic meter or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting; and hard materials (see Definitions). The removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic meter in volume that

may be encountered in the work shall be included in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, such material shall be uncovered and the Engineer notified by the Contractor. The Contractor shall not proceed with the excavation of this material until the Engineer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Engineer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Engineer for the areas of work in which such deposits occur.

Blasting

Blasting shall be performed in accordance with EM 385-1-1 and in conformance with Government safety regulations. The Contractor shall submit a Blasting Plan, prepared and sealed by a registered professional engineer that includes calculations for overpressure and debris hazard. Blasting mats shall be provided and non-electric blasting caps shall be used. The Contractor shall obtain written approval prior to performing any blasting and shall notify the Engineer 24 hours prior to blasting. The plan shall contain provisions for storing, handling and transporting explosives as well as for the blasting operations. The Contractor shall be responsible for damage caused by blasting operations.

PRODUCTS

Backfill and Fill Materials

Materials for backfill and fill shall be free of clay clods, rock or gravel larger than 50 millimeter in any dimension, debris, waste, and other deleterious matter and shall be satisfactory soil materials as follows:

Table 2-3

Area Classification	**Backfill or Fill Materials**
In excavations, unless otherwise specified	Excavated or borrow material that has been sampled, Tested, and approved as "Satisfactory Soil Material"

Against face of structures where footing drains from top of porous fill for footing drains to indicated elevation, and from face of structure a distance equal to three footing drain diameters.	Filtering material
Against surfaces having applied waterproofing for a distance of at least 150 millimeter from surface	Sand
In foundation sub-drain trenches over porous fill drain pipe.	Filtering material
Under grassed areas	Excavated or borrow material that has been sampled, tested, and approved as "Satisfactory Soil Material"
Under walks, steps, and paved areas	Subbase material or excavated or borrow material that has been sampled, tested, and approved as "Satisfactory Soil Material"
Under building slabs and under culverts	Granular fill and sand bedding
Underdrainage of structures	Filtering material

Satisfactory Materials

The satisfactory materials for backfill are as defined in Sub-Clause 5-1.3.1 – Satisfactory Materials.

Unsatisfactory Materials

The unsatisfactory materials for backfill are as defined in Sub-Clause 5-1.3.2 – Unsatisfactory Materials.

Cohesionless Materials

Cohesionless soil materials include gravels, gravel-sand mixtures, sands, and gravelly-sands. Moisture-density relations of compacted cohesionless soils, when plotted on graphs, will show

straight lines or reverse-shaped moisture density curves.

Cohesive Materials

Cohesive soil materials include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture-density relations of compacted cohesive soils, when plotted on graphs, will show normal moisture-density curves.

Subbase Material

Subbase material shall be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, or sand.

Granular Fill

Granular fill shall be a washed, uniformly graded mixture of crushed stone or crushed or uncrushed gravel, with 100 percent passing 37.5 millimeter sieve and not more than 5 percent passing 4.75 millimeter sieve.

Filtering Material

Unless otherwise specified or shown on drawings, the filtering material shall conform to ASTM C 33 and shall be a uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand, with 100 percent passing 9.5-millimeter sieve and 2 to 10 percent passing a 150-micrometer sieve. The gradation limits of filtering material for Underdrainage of structures shall be as shown on drawings.

Sand

Sand shall be natural sand.

EXECUTION

Clearing

Clearing Requirements

All trees, stumps and brush shall be removed. Unless otherwise directed trees shall not be cut down outside areas specified in **Clause 2-1.9** - Clearing and, where directed, trees shall be protected carefully from damage by the Contractor's operations.

Felling of trees shall be restricted to the minimum practicable for the execution of the Works and the limits shall be as directed.

Equipment

A tree-crushing machine may be used at the option of the Contractor in all clearing operations.

Disposal of Material

(a) General

The material cleared from the areas shall be completely removed by transporting from Client's property or burned written the cleared areas unless otherwise approved by the Engineer. All timber from which saw logs, posts, ties or cordwood can be produced will become the property of the Contractor and in the interest of conservation it is required that the Contractor make a reasonable effort to dispose of material for these purposes. The Contractor may cut timber into convenient lengths at the site but approval must be secured prior to the operation of saw mills within the Project area. In no case shall cleared material be thrown into or left in the creeks or Nullah. After the felling operation has been completed, the timber to be burned must be decked for burning within 10 days. All felled timber shall be completely removed. Clean up of floatable debris shall be accomplished by any practical means after reservoir filling. The cutting of branches and debris remaining after clean-up, to reduce their length in order to avoid removal, will not be permitted.

(b) Burning

The material cleared may be burned within the contract area, and at any time within the contract period provided such burning does not interfere with inhabitants of the area by drastic changes in their accustomed environment, such as addition to air pollution or danger of fire. However, the

specific time, location and manner of burning shall be subject to approval from the viewpoints of air pollution, governing fire laws and safety. In the interest of conservation, the Contractor may, should he desire to do so, make available to the general public without charge, the material scheduled for burning. No burning operations shall be conducted within 30 m of any standing timber or flammable growth. The burning operations shall be subject to all public law governing such operations and the Contractor will be responsible for any damage to life and/or property resulting from fires that are started by his employees or as a result of his operations.

The Contractor shall furnish at the site adequate firefighting equipment, such as back tanks, flaps, shovels, rakes, etc., to properly equip his personnel for fighting fires. Fires shall be guarded at all times and shall be under constant surveillance until they have burned out or have been extinguished. All burning shall be so thorough that the materials will be reduced to ashes, except that occasional charred pieces of logs or branches not exceeding 100 mm in diameter and/or 2.5 m in length will be permitted to remain. Upon approval, charred material will be buried after it is determined that it could not be disposed of by methods used in the normal burning operation. All material disposed of in such manner shall be at approved locations and shall be covered within a minimum of 450 mm of earth.

(c) Burial

In certain cases, such as along drainage channels in remote areas, cleared material may be disposed of by burial in areas designated for disposal of excess excavation or spoil. When this option is used, care will be taken to insure that all such cleared material will be buried under not less than450 mm of earth. Approval will be obtained for each area selected for debris disposal for burial prior to beginning such operations. Burial is not allowed in reservoir area. Areas to be used for permanent roadways, levees or embankments will not be used for disposal of material from clearing operations. Areas for disposal of cleared materials by burial will not be located within 92 m of public road crossings or of project areas to be regularly visited by the public.

(d) Removal from Site

Except as otherwise provided, the Contractor will be permitted to remove felled and trimmed timber from the site of the work. The Contractor will be allowed to stockpile salvaged timber above elevation 137.5m at approved locations, unless otherwise approved by the Engineer. The Employer will assume no responsibility for the protection and safekeeping of such material. All stockpiled timber must be removed from Employer lands before final acceptance of the work will be made.

Debris

Combustible debris shall be burned in accordance with Sub-Clause 5-3.1.3 - Disposal Of Material. Noncombustible debris in excess of that disposed of as set forth in Sub-Clause 5-1.3.14 - Structures to be removed shall be disposed of at such locations above elevation 137.5 as may be designated by the Engineer, unless otherwise approved by the Engineer. Debris shall include trash of all kinds.

Marketable Materials

Any of the cleared materials, which the Contractor considers marketable, shall become Employer's property and shall be removed from the reservoir area.

5-3.2 Stripping of Topsoil

Where indicated or directed, topsoil shall be stripped to a depth of 150 mm. Stripping more than 150 mm shall be considered as excavation. Topsoil shall be spread on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil shall be kept separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 50 mm in diameter, and other materials that would interfere with planting and maintenance operations. Any surplus of topsoil from excavations and grading shall be removed from the site.

General Excavation

The Contractor shall perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Grading shall be in conformity with the typical sections shown and the tolerances specified in Clause

Finishing

Satisfactory excavated materials shall be transported to and placed in fill or embankment within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Such excavated material and the satisfactory material ordered as replacement shall be included in excavation. Surplus satisfactory excavated material not required for fill or embankment shall be disposed of in areas approved for surplus material storage or designated waste areas. Unsatisfactory excavated material shall be disposed of in designated waste or spoil areas. During construction,

excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

Ditches, Gutters, and Channel Changes

Excavation of ditches, gutters, and channel changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Ditches and gutters shall not be excavated below grades shown. Excessive open ditch or gutter excavation shall be backfilled with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Material excavated shall be disposed of as shown or as directed, except that in no case shall material be deposited less than 1 meter from the edge of a ditch. The Contractor shall maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

Drainage Structures

Excavations shall be made to the lines, grades, and elevations shown, or as directed. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm, level, stepped, or serrated surface. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, the bottom of the excavation shall not be disturbed. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed. Where pile foundations are to be used, the excavation of each pit shall be stopped at an elevation 300 mm above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, loose and displaced material shall be removed and excavation completed, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.

Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. The Contractor shall establish/construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and other drainage features and equipment as

required maintaining dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

Dewatering

Groundwater flowing towards or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 0.9 m of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 0.3 m below the working level. Operate dewatering system continuously until construction work below existing water levels is complete.

Requirements of Trench Excavation for Laying of Pipes

The trench for pipe laying shall be excavated as shown on drawings. Trench walls more than 1 meter high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 600 mm plus pipe outside diameter (O.D.) for pipes of less than 600 mm inside diameter and shall not exceed 900 mm plus pipe outside diameter for sizes larger than 600 mm inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Employer.

(a) Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 100 millimeters or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

(b) Excavation for Appurtenances

Excavation for manholes, catch basins, inlets, or similar structures shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

Underground Utilities

Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Report to the Engineer immediately, any damage to utility lines or subsurface construction.

Structural Excavation

Ensure that footing subgrades have been inspected and approved by the Engineer prior to concrete placement. Backfill and compact over excavations to 95 percent of ASTM D 698 maximum density.

Selection of Borrow Material

Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas selected by the Contractor. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Employer-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. No borrow shall be allowed with in 400m upstream and 300m downstream of dam and dyke. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

Opening and Drainage of Excavation and Borrow Pits

The Contractor shall notify the Engineer sufficiently in advance of the opening of any excavation or borrow pit. Except as otherwise permitted, borrow pits and other excavation areas shall be excavated providing adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavations of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

Direct payment will not be made for work carried out in accordance with this Clause. The cost of all work in the borrow areas and on the stockpile shall be included in the respective rates for various zones of earth fill.

Quarries

General

(i) The Contractor shall operate any approved quarry in accordance with this Clause to obtain material additional to that usable material available from the required excavation, for use as:

- Rip-rap
- Drainage materials for fine and coarse filters
- Concrete aggregate
- Free draining backfill
- Road base course
- Other uses in the works.

(ii) Contractor may obtain acceptable material from Employer approved outside commercial quarries, without any additional cost to the haulage and procurement.

5-3.6.2 Method of Operation

The Contractor's proposed method of working the quarries shall be in accordance with the proposed quarry plan as approved by the Engineer from time-to-time.

Nothing in this Clause shall relieve the Contractor from the responsibility for the adequacy and safety of the rock excavation operations.

Shoring

5-3.7.1 General Requirements

The Contractor shall submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Shoring shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed, as excavations are backfilled, in a manner to prevent caving.

Grading Areas

Where indicated, work will be divided into grading areas within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. The Contractor shall not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Stockpiles of satisfactory, unsatisfactory and wasted materials shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination, which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources.

Final Grade of Surfaces to Support Concrete

Excavation to final grade shall not be made until just before concrete is to be placed. Only excavation methods that will leave the foundation rock in a solid and unshattered condition shall be used. Approximately level surfaces shall be roughened, and sloped surfaces shall be cut as indicated into rough steps or benches to provide a satisfactory bond. Shales shall be protected from slaking and all surfaces shall be protected from erosion resulting from ponding or flow of water.

Ground Surface Preparation

5-3.10.1 General Requirements

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Engineer. The surface shall be scarified to a depth of 150 mm before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 150 mm, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 300 mm and compacted as specified for the adjacent fill.

Utilization of Excavated Materials

Unsatisfactory materials removed from excavations shall be disposed of in designated waste disposal or spoil areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed of in designated areas approved for surplus material storage or designated waste areas as directed. Newly designated waste areas on Employer-controlled land shall be cleared and grubbed before disposal of waste material thereon. Coarse rock from excavations shall be stockpiled and used for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. No excavated material shall be disposed of to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

Backfilling and Compaction

Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Ground surface on which backfill is to be placed shall be prepared as specified in Sub-Clause 2-3.19.2 - Preparation of Ground Surface to Receive Fill. Compaction requirements for backfill materials shall also conform to the applicable portions of Sub-clause 2-3.19.2 - Preparation of Ground Surface to Receive Fill, Clause 2-3.14 - Embankments and Sub-Clause 2-3.15.3 - Compaction shall be accomplished by sheep foot rollers, pneumatic-tired

rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

Backfill of Trench for Pipelines

Trenches shall be backfilled to the grade shown. The joints and couplings shall be left uncovered during the pressure test. The trench shall not be backfilled until all specified tests on pipeline are performed.

(a) Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.

(b) Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm loose thickness.

(c) Bedding and Initial Backfill

Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D 698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows as shown on drawings:

(i) Clean, coarse-grained sand classified as SW or SP by ASTM D 2487

(ii) Clean, coarsely graded natural gravel, crushed stone or a combination thereof having a classification of GW or GP in accordance with ASTM D 2487 for bedding and backfill as indicated. Maximum particle size shall not exceed 75 mm.

(d) Final Backfill

The remainder of the trench shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

(i) Roadways: Backfill shall be placed up to the required elevation as specified. Water flooding or jetting methods of compaction will not be permitted.

(ii) Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 300 mm loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

Backfill for Pipeline Appurtenances

After the manhole, catch basin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 14 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

Special Requirements for Excavation and Backfill

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

Water Lines

Trenches shall be of a depth to provide a minimum cover of 600 mm from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. For fire protection yard mains or piping, an additional 500 millimeters of cover is required.

Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 600 mm from the finished grade, unless otherwise indicated.

Sewage Absorption Trenches or Pits

Backfill material consisting of clean crushed rock or gravel having a gradation conforming to the requirements of gradation 4.75 mm for coarse aggregate in ASTM C 33.

Underdrainage Systems

Clean sand, crushed rock, or gravel meeting the following requirements:

(i) Perforated or Slotted-Wall Pipe: Backfill meeting requirements of Type I material as specified in Table 5-4. Place granular materials as pipe is laid and extend fit for a minimum of one pipe diameter on each side of and 450 mm above the top of the pipe. Place a layer of kraft paper on top of granular filter before continuing with the backfill.

(ii) Open Joint Pipe: Place both types of granular material specified as pipe is laid forming an aggregate filter around the pipe. Provide Type II material to envelope the pipe a minimum of one-half the pipe diameter or twice the maximum aggregate size, whichever is larger, on each side and on top of the pipe. Place Type I material next to and on top of the Type II material to provide a total fill extending at least one pipe diameter on each side of and 450 mm above the top of the pipe. Place a layer of kraft paper on top of the granular filter before continuing with the backfill.

(iii) Any Type Drain Used with Filter Fabric: Clean gravel or crushed stone or gravel conforming to ASTM C 33 coarse aggregate grading size 57, 67, or 7.

Table 2-4

ASTM D 422 Sieve Size	Type I Gradation E 11 ASTM C 33	Type II Gradation 57 ASTM C 33
	Percent Passing	Percent Passing
37.5 mm	--	100
25.0 mm	--	90 – 100
9.5 mm	100	25 – 60
4.75 mm	95 – 100	5 - 40
2.36 mm	--	0 - 20
1.18 mm	45 – 80	--
300 micrometers	10 – 30	--
150 micrometers	0 – 10	--

Embankments

Earth Embankments

Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 75 mm. The material shall be placed in

successive horizontal layers of loose material not more than 300 mm in depth. Each layer shall be spread uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, each layer shall be plowed, disked, or otherwise broken up; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical with those requirements specified in **Clause 2-3.15 - Subgrade Preparation**. Compaction shall be accomplished by sheeps foot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

Rock Embankments

Rock embankments shall be constructed from material classified as rock excavation, as defined above, placed in successive horizontal layers of loose material not more than 450 mm in depth. Pieces of rock larger than 300 mm in the greatest dimension shall not be used. Each layer of material shall be spread uniformly, completely saturated, and compacted to a minimum density of 1800 kg/cubic meter. Each successive layer of material shall adequately bond to the material on which it is placed. Compaction shall be accomplished with vibratory compactors weighing at least 10 metric tons, heavy rubber-tired rollers weighing at least 20 metric tons, or steel-wheeled rollers weighing at least 12 metric tons. Rock excavation shall not be used as fill material for the construction of pavements.

Subgrade Preparation

Proof Rolling

Proof rolling shall be done on an exposed subgrade free of surface water (wet conditions resulting from rainfall), which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade with six passes of a 13.6-meter tons, pneumatic-tired roller. Operate the roller in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km/hour. When proof rolling, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes. Notify the Engineer a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the presence of the Engineer. Rutting or pumping of material shall be undercut as directed by the Engineer and replaced with fill material. No separate payment will be made for operations of cutting and replacing of affected area.

Construction

Subgrade shall be shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut section shall be excavated to a depth of 150 mm below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified. The elevation of the finish subgrade shall not vary more than 15 mm from the established grade and cross section.

Compaction

Compaction shall be accompanied by sheep foot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

(a) Subgrade for Pavements

Subgrade for pavements shall be compacted to at least 95 - percentage laboratory maximum density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, the top 200 mm of subgrade shall be scarified, windrowed, thoroughly blended, reshaped, and compacted.

(b) Subgrade for Shoulders

Subgrade for shoulders shall be compacted to at least 95 - percentage laboratory maximum density for the full depth of the shoulder.

Shoulder Construction

Shoulders shall be constructed of satisfactory excavated or borrow material or as otherwise shown or specified. Shoulders shall be constructed as soon as possible after adjacent paving is complete. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified in Clause 2-3.15 - Subgrade Preparation above, for specific ranges of depth below the surface of the shoulder. Compaction shall be accomplished by sheep foot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. The completed shoulders shall be true to alignment and grade

and shaped to drain in conformity with the cross section shown.

Finishing

The surface of excavations, embankments, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for graded areas shall be within 30 mm of the grades and elevations indicated except that the degree of finish for subgrades shall be specified in Clause 5-3.15 - Subgrade Preparation. Gutters and ditches shall be finished in a manner that will result in effective drainage. The surface of areas to be turfed shall be finished to smoothness suitable for the application of turfing materials. Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work shall be repaired and grades re-established to the required elevations and slopes.

Subgrade and Embankments

During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until, subbase, base, or pavement is placed. The storage or stockpiling of materials on the finished subgrade will not be permitted. No subbase, base course, or pavement shall be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.

Grading Around Structures

Areas within 1.5 m outside of each building and structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

Placing Topsoil

On areas to receive topsoil, the compacted subgrade soil shall be scarified to a 50 mm depth for bonding of topsoil with subsoil. Topsoil then shall be spread evenly to a thickness of 200 mm and graded to the elevations and slopes shown. Topsoil shall not be spread when excessively wet or dry. Material required for topsoil in excess of that produced by excavation within the grading limits shall be obtained from offsite areas.

Filling and Backfilling

Preparations Prior to Backfill Placement

Excavations shall be backfilled as promptly as the work permits but not until completion of the following:

Approval of construction below finish grade

Inspection, testing, approval, and recording location of underground utilities

Removal of concrete formwork Removal of shoring and bracing; backfilling of voids with satisfactory soil material; temporary sheet piling driven below bottom of structures; and cutting off and removing of utilities in a manner that prevents settlement of the structure or utilities

Removal of trash and debris

Completion of concrete waterproofing

Preparation of Ground Surface to Receive Fill

Vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials shall be removed from ground surface prior to the placement of fills. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stripped, or broken up in such manner that fill material will bond with the existing material.

When the ground surface has a density less than that specified for the particular area classification, the ground surface shall be broken up, pulverized, moisture-conditioned to near optimum moisture content of the soil material, and compacted to the required depth and percentage of maximum density.

Placement and Compaction

Backfill and fill materials shall be placed in layers not more than 150 milimeter in loose depth. Before compaction, each layer of backfill or fill material shall be moistened or aerated as necessary to provide the optimum moisture content of the soil material and shall then be compacted to the percentage of maximum density for each area classification as specified. Backfill or fill material shall not be placed on surfaces that are muddy, frozen, icy, or contain frost.

Backfill and fill materials adjacent to structures shall be brought up evenly around structures and

shall be carried up to the indicated elevations.

Compaction adjacent to structures, within a horizontal distance from the face of the structure equal to the depth of backfill or fill material (measured from the bottom of footing or bottom of foundation or retaining wall) to final grade, shall be done with power-driven hand tampers.

Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure in AASHTO T 180, Methods B or D.

Percentage of Maximum Density Requirements

Actual density of each layer of soil material-in-place shall be not less than the following percentages of the maximum density of the same soil material determined by the moisture-density test specified.

Table 2-6

Area Classification	Percent Maximum Density	
	Cohesionless Soil Material	Cohesive Soil Material
Structures		
Each layer of back-fill material	95%	98%
Building Slabs and Steps		
Top 300 millimeter of subgrade and each layer of backfill material	98%	98%

Moisture Control

Moisture content in soil material at time of compaction shall be within limits specified.

Where the moisture content of a layer of soil material is below optimum before compaction, the required amount of water shall be uniformly applied to the surface of the layer of soil material

and the layer of soil disked or otherwise mixed until uniform moisture content is reached.

Moisture of a layer of soil material that is above optimum shall be removed by drying.

Disposition of Surplus Material

Surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber shall be removed from Employer property as directed by the Engineer.

Testing

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Engineer. Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2167 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. ASTM D 2922results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017; the calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Engineer. ASTM D 2937, Drive Cylinder Method shall be used only for soft, fine-grained, cohesive soils. When test results indicate, as determined by the Engineer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements. Tests on recompacted areas shall be performed to determine conformance with specification requirements. Inspections and test results shall be certified by a registered professional civil engineer. These certifications shall state that the tests and observations were performed by or under the direct supervision of the Engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

Fill and Backfill Material Gradation

One test per 400 cubic meters stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with ASTM C 136 or ASTM D 422 or ASTM D 1140.

In-Place Densities

Table 2-5

Material Type	Location of Material	Test Frequency
Undisturbed native soil	Structures	Two random tests in building footings and two tests on subgrade within building line
Fills and backfills	Structures (adjacent to)	One test per structure per 200 sq. m taken 300 mm below finished grade.
Subgrades		One test per lift per 250 sq. m
Embankments or borrow	Any	One test per lift per 400 cubic m placed.
Native soil subgrade other than structures and parking	Any	One test or one test per 900 sq.m whichever is greater.
Borrow	Any	One test per lift per 400 cubic m placed.

Moisture Contents

In the stockpile, excavation, or borrow areas, a minimum of two tests per day per type of material or source of material being placed during stable weather conditions shall be performed. During unstable weather, tests shall be made as dictated by local conditions and approved by the Engineer.

Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 400 cubic meters of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

Tolerance Tests for Subgrades

Continuous checks on the degree of finish specified in Clause 5-3.15 - Subgrade Preparation shall be made during construction of the subgrades.

MEASUREMENT AND PAYMENT

Clearing

Measurement

Measurement for payment, of clearing of the dam site area of structures will be made of the horizontal projection of the areas actually cleared within the reservoir area below the pegged level and within 20m outside the limits of excavation for the permanent works but excluding clearing for temporary access or haul roads, construction facilities and other temporary works, quarries and borrow areas.

Payment

Payment for clearing of dam site and reservoir area will be made at the rate per hectare tendered therefore in the priced Bill of Quantities.

Payment will be made for costs associated with furnishing plant, labor, materials and equipments, and performing all operations necessary for clearing as specified.

The cost of clearing areas other than the dam site and area of structures shall be deemed to be included in the rates tendered in the priced Bill of Quantities for the various items of the Works. No separate payment shall be made for clearing areas other than dam site and reservoir area.

Unit of Measure

Unit of measure: Square meter

Stripping of Topsoil

Measurement

Measurement for stripping of topsoil will be made of horizontal projection of actual area stripped within 2m outside the limit of dam and dyke foundation.

Payment

Payment for stripping will be made at the rate per hectare tendered. No separate payment will be made for stripping of borrow areas.

Unit of Measure

Unit of measure: Square meter

Excavation

Measurement

Measurement, for payment, of surface excavation will be made of the volume of material excavated to the lines, grades and dimensions shown on the Drawings or directed and shall be taken only in the presence of the Engineer. The Engineer shall be notified at least 24 hours before such measurements are taken. Before commencing and immediately after completion of surface excavation, the Contractor shall take survey measurements sufficient to define the dimensions and elevations of the original and final surfaces. Measurement will be made separately for common and rock excavation as defined in **Clause 2-1.10 – Classification of Excavation**.

Also measurement will be made separately for building foundation. The measurement will not include the volume of subgrade material or other material that is scarified or plowed and reused in-place, and will not include the volume excavated without authorization or the volume of any material used for purposes other than directed. The measurement will not include the volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed grade.

Payment

Payment for the various items of surface excavation will be made at the applicable rates per cubic meter tendered therefore in the priced Bill of Quantities. These rates shall include the cost of all labour, materials, temporary construction, pumping, bailing, draining and all other work necessary to maintain the surface excavations in good order during construction, and of removing such temporary construction if so directed. These rates shall also include the entire cost of clearing and stripping of Soil provided in **Clauses 2-3.1 and 2-3.2** of excavating and transporting the materials from the excavation to the point of final use, or to disposal; and, where stockpiles are used. The cost of transporting the material to the stockpiles; of re-handling and of transporting such material to the point of final use; and the entire cost of cleaning up excavated surfaces.

Direct payment will not be made for work carried out in accordance with this Clause. The cost of all work in the quarries including clearing, excavation, separating, selecting, processing, hauling and dumping of unsuitable materials and of soil conservation measures shall be included in the rates tendered in the Bill of Quantities for the items for which the materials form the quarries are used.

Unit of Measure

Unit of measure: Cubic Meter

Subbase Material

Measurement

Measurement, for payment, of furnishing, placing and compacting subbase will be made of the volume of material in place to the lines grades and dimensions shown on the Drawings or directed.

Payment

Payment for furnishing, placing and compacting subbase will be made at the rate per cubic meter tendered therefor in the priced Bill of Quantities. Material from required excavation used for subbase will be paid for both as excavation when removed from required excavation and as fill when placed. Payment will not be made for excavating materials from stockpiles or sources other than required excavation.

Unit of Measure

Unit of measure: Cubic Meter

Embankment Fill

Measurement

Measurement, for payment, of furnishing, placing and compacting embankment fill will be made of the volume of material in place to the lines grades and dimensions shown on the Drawings or directed.

Payment

Payment for furnishing, placing and compacting embankment fill will be made at the rate per cubic meter tendered therefor in the priced Bill of Quantities. Material from required excavation used for embankment fill will be paid for both as excavation when removed from required excavation and as fill when placed. Payment will not be made for excavating materials from stockpiles or sources other than required excavation.

Unit of Measure

Unit of measure: Cubic Meter

Preparation of Subgrade

Measurement

Measurement for payment of preparation of subgrade will be made in square meter of the actual subgrade prepared.

Payment

Payment for preparation of subgrade will be made at the rate per square meter tendered therefore in the priced Bill of Quantities.

Unit of Measure

Unit of measure: Square meter

Road Shoulder Material

Measurement

Measurement, for payment, of furnishing, placing and compacting road shoulder will be made of the volume of material in place to the lines grades and dimensions shown on the Drawings or directed.

Payment

Payment for furnishing, placing and compacting road shoulder will be made at the rate per cubic meter tendered therefore in the priced Bill of Quantities. Material from required excavation used for road shoulder will be paid for both as excavation when removed from required excavation and as fill when placed. Payment will not be made for excavating materials from stockpiles or sources other than required excavation.

Unit of Measure

Unit of measure: Cubic Meter

Backfill

Measurement

Measurement, for payment, of furnishing, placing and compacting backfill will be made of the volume of material in place to the lines grades and dimensions shown on the Drawings or directed.

Payment

Payment for furnishing, placing and compacting backfill will be made at the rate per cubic meter tendered therefore in the priced Bill of Quantities. Material from required excavation or from the quarry used for backfill will be paid for both as excavation when removed and as backfill when

placed. Payment will not be made for excavating materials from stockpiles or sources other than required excavation.

Unit of Measure

Unit of measure: Cubic Meter

SECTION 3

QUALITY CONTROL

SECTION 3 QUALITY CONTROL ii

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QUALITY CONTROL

GENERAL

Scope

The Contractor shall institute a Quality Assurance System to demonstrate compliance with the requirement of the Contract. The requirements of this Section of the Specifications apply to, and are a component part of, each section of the Specifications.

References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 3740	(2001) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E 329	(2002) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 1110-1-12	(1993) Quality Management

Submittals

The followings shall be submitted for Engineer's review and approval in accordance with Clause1-1.4 - Submittal Procedures and in sufficient detail to show full compliance with the Specification:

1. Preconstruction Submittals

Contractor's Quality Assurance Plan

2. Test Reports

Contractor shall submit the following items in accordance with the Sub-Clause 2-1.6 – Records, of this section:

- Quality Control Data
- Quality Control Coordinating Actions
- Quality Control Training
- Inspection Records
- Letters of Authority or Delegation
- Field Tests
- Factory Tests

3. Certificates

a) Contractor shall submit a detailed written statement describing procedures that will be implemented to achieve quality on the project according to the Sub-Clause 2-1.5.1-Quality Assurance (QA) Plan of this Section.

b) Contractor shall submit the following in accordance with the Sub-Clause 2-1.7.1-Qualifications of this Section:

(i) Contractor's Quality Representative Qualifications

(ii) Special Certifications

General Requirements

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Conditions of Contract Sub-Clause 4.9 - Quality Assurance. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction, design and construction operations, both onsite and offsite, and shall be keyed to the proposed construction sequence. The Contractor’s site project superintendent (Engineer) will be held responsible for the quality of work on the job and is subject to removal by the Engineer for non-compliance with the quality requirements specified in the Contract. The site project superintendent in this context shall be the highest level manager responsible for the overall construction activities at the site, including quality and production. The site project superintendent shall maintain a physical presence at the site at all times, except as otherwise acceptable to the Engineer, and shall be responsible for all construction and construction related activities at the site.

Quality Control Plan

The Contractor shall furnish for review by the Engineer, not later than 60 days after receipt of notice to proceed, the Contractor's Quality Assurance (QA) Plan and a Design Quality control (DQC) Plan proposed to implement the requirements of the Conditions of Contract Sub-Clause - 4.9.

The QA plan shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. The Employer will consider an interim plan for the first 90 days of operation. Design and construction will be permitted to begin only after acceptance of the QA Plan and DQC Plan or acceptance of interim plans applicable to the particular feature of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a QA Plan and or DQC plan other interim plan containing the additional features of work to be started.

Quality Assurance (QA) Plan

The QA plan shall address the following:

a) Description of the authority, responsibilities and coordinating procedures, of on-site/off-site quality assurance personnel, including those QA personnel not under direct control of the Contractor.

b) Plan shall list personnel designated by the Contractor to accomplish the work required by the contract.

c) QA plan shall also contain an appendix with a copy of each form, report format, or similar record to be used in the QA program.

d) Contractor's organization that handles construction contract activities.

e) Contractor's operational plan for accomplishing and reviewing work controls, fabrication controls, certifications, and documentation of quality control operations, inspections, and test records, including those for subcontractors. These provisions shall include the methods to be used during the procurement cycle (order to delivery) for those materials or equipment that require source inspections, shop fabrications, or similar operations located separately from the work site.

f) Description of on-site personnel training.

g) Certification(s) of personnel, procedures, processes, and equipment.

h) Nondestructive testing requirements.

i) Identification of independent certifying and testing laboratories.

Design Quality Control (DQC) Plan

The following requirements apply to the Design Quality Control (DQC) plan for the works, which are to be designed by the Contractor.

(a) The Contractor's shall maintain a Design Quality Control (DQC) Plan as an effective quality control program which will assure that all services required by this Contract are performed and provided in a manner that meets professional engineering quality standards. The Contractor shall correct errors and deficiencies in the design documents prior to submitting them to the Engineer for review and approval.

(b) The Contractor shall include the design schedule in the master project schedule, showing the sequence of events involved in carrying out the project design tasks within the specific contract period. This should be at a detailed level of scheduling sufficient to identify all major design tasks, including those that control the flow of work. The schedule shall include review and correction periods associated with each item. This should be a forward planning as well as a project monitoring tool. If the schedule is changed, the Contractor shall submit a revised schedule reflecting the change within 7 calendar days. The Contractor shall include in the DQC Plan the discipline-specific checklists to be used during the design and quality control of each submittal. These completed checklists shall be submitted at each design phase as part of the project documentation.

(c) The DQC Plan shall be implemented by a Design Quality Control Manager who has the responsibility of being cognizant of and assuring that all documents on the project have been coordinated. This individual shall be a person who has verifiable engineering design experience and is a registered professional engineer. The Contractor shall notify the Engineer, in writing, of the name of the individual, and the name of an alternate person assigned to the position.

The Engineer will notify the Contractor in writing of the acceptance of the DQC Plan. After acceptance, any changes proposed by the Contractor are subject to the acceptance of the Engineer.

Records

Records shall include all quality control data; factory tests or manufacturer's certifications,

quality control coordinating actions; records of quality control training/certifications as well as routine hydrostatic, electrical continuity, grounding, welding, line cleaning, field tests and similar tests. Quality records shall be available for examination by the Engineer.

Legible copies of the test and inspection records shall be furnished to the Engineer. Records shall cover work placement traceable to the contract schedule, Specifications and drawings, and shall be verified by the Contractor.

Contractor shall submit for approval, the narrative description of an inspection system which provides for compliance with the quality requirements and technical criteria of the Contract within 30 calendar days after notice to proceed.

Contractor shall submit a monthly performance report that summarizes the quality operations. This report shall identify inspections made, tests performed, non-conformances, corrective actions taken, status of plans/procedures being developed, and status of open items/problems in work.

Contractor shall submit Letters of Authority or Delegation outlining the authority and responsibilities of quality control personnel along with a copy of the letter of delegation to the Engineer that defines delegated duties and responsibilities.

In-process inspection records and control away from the job site may be used as evidence of quality of materials/work and may reduce further inspection or testing after delivery to the job site.

Quality Assurance

Qualifications

Contractor's Quality Representative’s qualifications shall be submitted to the Engineer for approval.

When approval or certification of special processes, operating personnel, and special equipment or procedures is required by the Specifications, the Contractor shall obtain necessary approvals or special certifications prior to starting the work.

Quality Control Requirements

Contractor shall provide a quality control program encompassing: selection of construction materials and sources; suppliers; subcontractors; on-site and off-site fabrication of Contractor-furnished assemblies; on-site and off-site assembly; erection; work procedures; workmanship;

inspection; and testing.

Contractor's program shall provide document systems ensuring that quality provisions of contract schedule, Specifications, and drawings have been performed.

a. Management and Organization

Contractor shall designate an individual as Quality Program Manager within the on-site organization whose sole responsibility shall be the day-to-day on-site management and direction of the Quality Program.

The Quality Program Manager shall report to the Contractor's management and shall have the necessary authority to discharge contractual responsibilities.

b. CQC Personnel

The Contractor shall also provide specialized personnel to assist the Quality Program Manager for the following areas: civil, structural, electrical, mechanical, environmental, materials technician, engineering geology, submittals clerk. These individuals may be employees of the Contractor or Subcontractor; be responsible to the Quality Programme Manager; be physically present at the construction site during work on their areas of responsibility; have the necessary education and/or experience in accordance with the experience matrix listed herein. These individuals may perform other duties but must be allowed sufficient time to perform their assigned quality control duties as described in the Quality Control Plan.

Experience Matrix

Area	Qualifications
Civil	Graduate Civil Engineer with 5 years' experience in the type of work being performed on this project or technician with 10 yrs related experience
Structural	Graduate Structural Engineer with 5 yrs experience or person with 5 yrs related experience
Mechanical	Graduate Mechanical Engineer with 2 yrs experience or person with 5 yrs related experience
Electrical	Graduate Electrical Engineer with 2 yrs related experience or person with 5 yrs related experience
Engineering Geologist	Graduate Engineering Geologist with 2 yrs experience or person with 5 yrs related experience

Environmental	Graduate Environmental Engineer with 3 yrs experience
Concrete, Pavements and Soils	Materials Technician with 10 yrs experience for the appropriate area
Design Quality Control Manager	Registered Professional Engineer
Submittals	Submittal Clerk with 1 yr experience

c. Identification and Data Retrieval

Contractor shall have an identification and data retrieval system.

Referencing the Contract Number; Contract Specification Number; Contract Drawing Number; Submittal Document Number; Contract Change Number; and the Contractor's Drawing Number System shall identify records, drawings, submittals, and equipment.

d. Procurement

Contractor shall be responsible for controlling procurement sources and those of his subcontractors to ensure that each purchase meets quality requirements.

e. Receiving Inspection System

Contractor shall maintain a site receiving inspection system that ensures procured materials and equipment are inspected and tested.

Receiving inspection records shall accompany each procurement delivery to the construction site. Records of site receiving inspections shall be maintained by the Contractor.

Records shall show defects, discrepancies, dispositions, and waivers.

f. Nonconforming Articles and Material Control

The Contractor shall control non-conformances discovered by the Contractor, subcontractors, suppliers or Engineer quality representatives to prevent their use and to correct deficient operations.

(i) Contractor shall prepare a "non-conformance" report for each instance comprising:

(1) A unique and traceable number.

(2) Identification of the non-conforming article or material.

(3) A description of the non-conformance and the applicable requirement.

(4) Cause or reason for the non-conformance.

(5) Remedial actions taken or recommended.

(6) Disposition of the nonconforming article or material.

(ii) The Contractor shall identify and mark each nonconforming article for removal from the work area.

(iii) The Contractor shall monitor and correct deficient operations.

g. Fabrication Process and Work Control

Contractor's procedures and controls shall ensure compliance with requirements in contract Specifications and drawings.

Contractor shall establish in-process inspections, to ensure compliance with quality requirements.

Special processes may include, but are not limited to, plating, anodizing, nondestructive testing, welding, and soldering.

h. Quality Control Records

Quality control records shall be maintained at a central on-site location. Maintenance of quality control records shall not relieve the Contractor from submitting samples, test data, detail drawings, material certificates, or other information required by each section in the specification.

Contractor shall ensure each record is identified and traceable to specific requirements in the Specifications and drawings.

i. Drawings and Change Control

Drawing-control system shall be maintained to provide revised drawings and ensure continuous removal of obsolete drawings from work areas. Changes involving interface with other work areas, or affecting materials controlled by others shall be controlled by the Contractor. This system shall be integrated with the document requirements of the contract.

Drawing changes shall be clearly annotated. Implemented changes shall be clearly identified and associated drawings shall be revised accordingly. Drawings that have been approved, or approved as noted, by the Engineer shall be used for fabrication and inspection.

Quality Inspections

a. Engineer's Inspections

Work performed under this Contract will be subject to inspection by the Engineer.

When the Engineer determines that inspected work needs to be corrected, the Engineer will be allowed 24 hours to complete re-inspection of the corrected work.

Engineer shall also be notified in writing before backfilling or encasing any utility so that work may be inspected. Failure to notify the Engineer before backfill or encasement occurs shall require the work be uncovered at no additional cost to the Employer.

Contractor's program is subject to continuous evaluation, review, and verification by the Engineer. Contractor will be notified in writing of any noncompliance and will be given 15 calendar days to correct identified deficiencies.

b. Contractor's Quality Inspections

Contractor shall implement an inspection system. Documentation shall indicate quality control through records of inspections, tests, and procedures.

Contractor's quality assurance system shall include the following:

(i) Single Contractor's representative responsible for on-site communication and operation of the inspection program.

(ii) Purchasing control system documenting project procurement to drawings, Specifications, and approved submittals.

(iii) Receiving inspection system documenting inspections for each procurement.

(iv) Documentation for handling and disposing of nonconforming components and materials.

(v) Inspection records for each specific section of the Specification and drawings.

(vi) Identification of test(s) to be performed, test procedures, records, and independent organizations used.

(vii) Documenting and maintaining certification or re-certification of procedures.

(viii) Calibration of gages, tools, measuring instruments, and independent laboratories used.

Contractor shall establish a system of scheduled or random audits to ensure task completion.

Field Services

a. Responsibility for Inspection and Testing

Contractor shall be responsible for all inspections and tests, and the accompanying documentation for each inspection and test. Contractor shall establish his own laboratory at site or may utilize independent inspection and testing laboratories or services as approved by the Engineer. Contractor shall also be responsible for tests of construction materials utilizing the services of an approved independent testing laboratory.

b. Inspection and Test Records

Contractor shall provide on-site records of each inspection and test performed throughout the life of the contract. Records shall include, but not be limited to, factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, identification of operators and inspectors, result of inspections or tests, nature of defects, causes for rejection, proposed remedial action, and corrective actions taken.

Inspection records, test procedures, test results, and associated forms be verified by and provided to the Engineer. Final test data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data”.

Handling and Storage

Contractor shall provide controls, procedures and documentation with each shipment that meets requirements of each section of the Specifications.

The Contractor shall include documentation with each shipment. The data shall consist of documentation required by the Contract along with Specifications required to identify, store, preserve, operate, and maintain the items shipped.

Sequencing and Scheduling

Contractor shall notify the Engineer at least 24 hours prior to scheduled inspections and tests.

Contractor shall provide 24 hour notice to the Engineer of the date when any contract work will begin at the site.When Contractor suspends work for 7 calendar days or longer prior to completion; the Engineer shall be notified. Work shall not resume without notification of the Engineer.

Engineer shall be notified at least 24 hours in advance of backfilling or encasing any underground utility.

Tests

Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, the Contractor shall furnish to the Engineer duplicate samples of test specimens for possible testing by the Employer. Testing includes operation and/or acceptance tests when specified. The tests shall be conducted at the project site laboratory or any other laboratory approved by the Engineer. The Contractor shall perform the following activities and record and provide the following data:

(a) Verify that testing procedures comply with contract requirements.

(b) Verify that facilities and testing equipment are available and comply with testing standards.

(c) Check test instrument calibration data against certified standards.

(d) Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

(e) Results of all tests taken, both passing and failing tests, shall be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given. If approved by the Engineer, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility shall be provided directly to the Engineer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and

disapproval of the test facility for this Contract.

Testing Laboratories

a. Capability Check

The Employer reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract Specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

b. Onsite Laboratory

The Employer reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Employer.

Furnishing or Transportation of Samples for Testing

Costs incidental to the transportation of samples or materials shall be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Employer shall be delivered to the laboratory approved by the Engineer located in Pakistan.

Completion Inspection

Pre-Final Inspection

The Engineer will perform the pre-final inspection to verify that the project works are complete and ready to be occupied. A Pre-Final Punch List may be developed as a result of this inspection. The Contractor's Quality Program Manager shall ensure that all items on this list have been corrected before notifying the Engineer, so that a Final inspection with the Employer can be scheduled. Any items noted on the Pre-Final inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph shall be accomplished within the time stated for completion of the entire work or any particular increment of the work if the project is divided into increments by separate completion dates.

Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the superintendent or other primary management person, and the Engineer's Representative shall be in attendance at the final acceptance inspection. Additional Employer personnel including, may also be in attendance. The final acceptance inspection will be formally scheduled by the Engineer based upon results of the Pre-Final inspection. Notice shall be given to the Engineer at least 14 days prior to the final acceptance inspection and shall include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection.

Documentation

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:

(a) Contractor/subcontractor and their area of responsibility.

(b) Operating plant/equipment with hours worked, idle, or down for repair.

(c) Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.

(d) Test and/or control activities performed with results and references to Specifications/drawings requirements. The control phase shall be identified (Preparatory, Initial, and Follow-up). List of deficiencies noted, along with corrective action.

(e) Quantity of materials received at the site with statement as to acceptability, storage, and reference to Specifications/drawings requirements.

(f) Submittals and deliverables reviewed, with contract reference, by whom, and action taken.

(g) Offsite surveillance activities, including actions taken.

(h) Job safety evaluations stating what was checked, results, and instructions or corrective actions.

(i) Instructions given/received and conflicts in plans and/or Specifications.

(j) Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Engineer daily within 48 hours after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, one report shall be prepared and submitted for every 7 days of no work and on the last day of a no work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the Quality Program Manager. The report from the Quality Program Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

Notification of Noncompliance

The Engineer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

MEASUREMENT AND PAYMENT

Payment

No separate payment will be made for compliance of requirements of this Section. All costs associated with Quality Control are deemed to be covered in the rates tendered for the Bill of Quantities and as such indirectly included in the Contract Price.

SECTION 4

DIVERSION AND CARE OF WATER

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DIVERSION AND CARE OF WATER

GENERAL

Scope

This Section covers the technical requirements for the planning, design, testing, construction, maintenance and removal of the Temporary Works required for the diversion and care of water during the period of construction of the Permanent Works.

4-1.2 Reference

U.S. Army Crops of Engineers (USACE)

EM 1110-2-2300 (1994) Earth and Rockfill Dams-General Design and Construction Considerations

Definitions

The following terms shall have the meanings hereby assigned to them:

Flood Protection:	Provision of temporary works to protect the site from perennial and flood flows.
Maintenance of Irrigation Water supplies:	The Contractor shall maintain irrigation water supplies to the scheme throughout the contract period.

Submittals

The following shall be submitted for Engineer's review and approval in accordance with Sub-Clause 1-1.4 - Submittal Procedures.

8. Preconstruction Submittals

Proposal on Diversion and Care of water.

9. Shop Drawings

Drawings of Diversion Scheme

10. Design Data

Construction of diversion channels and appurtenant system for the diversion and care of water.

Initial Submission

The Contractor shall submit his proposed Diversion Scheme for the approval of the Engineer within 30 days of the Engineer's notice to commence work. This submission shall include all information necessary to understand fully the Contractor's Diversion Scheme and its interrelationship with the Contractor's Construction Schedule. The submission shall include the following:

- Descriptions and drawings of the various stages of the Diversion Scheme.
- Outline designs and construction methods of all the features of the Diversion Scheme.
- Descriptions of the methods, including the layout and capacity, of the drainage and dewatering systems proposed for the construction of all parts of the Permanent Works.
- Proposed outline specifications for any elements of the Temporary Works not covered by these Technical Specifications, or for which the Contractor wishes to propose alternative specifications.
- Description of any aspects of the Contractor's Diversion Scheme which may differ from that submitted with his Tender, giving the reasons for such differences.

After reviewing the initial submission, the Engineer may require the Contractor to submit further information or amended proposals until, in the Engineer's opinion, the proposals are satisfactory. The Engineer will then approve the Contractor's Diversion Scheme.

Detailed Submissions

Within 28 days after approval of the Contractor’s Diversion Scheme, the Contractor shall submit for the approval of the Engineer detailed designs of all the features forming part of the scheme, together with full technical specifications for any matters covered by Sub-Clause 4-1.4.1 hereof.

Measures Included

In accordance with the Specifications contained in this Section and or as directed, the Contractor shall:

- Divert and control the flows from the direct catchment of Yat-abad Weir, and

- Care for all surface water and groundwater from any source, as may be required, so that all the construction work can be performed in areas free from water.

The Contractor shall design, furnish, construct, operate, maintain, and remove the necessary facilities as may be required for diversion, for dewatering the construction areas, for caring for all surface water and groundwater from any source, and for general protection of the Works.

The design of all Temporary Works for the diversion and care of water shall be carried out by the Contractor and shall conform to accept and safe engineering practice. The Contractor shall include with his submissions copies of all design calculations relating thereto.

The Contractor's proposals for diversion and care of water shall not require any change to the location, dimensions, design or details of any part of the Permanent Works, unless approved by the Engineer pursuant to Sub-Clause 4-3.5.

Works used for diversion

With the approval of the Engineer, the Contractor may use parts of the Permanent Works, such as the sluices section where downstream stilling basin and downstream protection works have been completed to divert Nullah flows.

Data Supplied to Contractor

The limited hydrological data, its analysis for Weir works and the estimated hydrographs for Anambar River are available with the Employer for Contractor’s review. The Employer does not guarantee the reliability or accuracy of these data and will not be responsible for any deductions, conclusions or interpretations, which may be made by the Contractor from these data.

Works under construction.

The Engineer's Diversion Proposal is related primarily to the overall control

ion Proposal in the Contractor's Diversion Scheme shall not remove or diminish the Contractor's responsibility for the suitability and adequacy of his measures for the diversion of Nullah flows and care of water throughout the construction period.

The Engineer's Diversion Proposal is associated with a particular sequence of construction, and may not be appropriate for a different sequence of construction.

The Contractor has the right to modify the Nullah diversion scheme on his discretion provided that this modification:

(1) Has been made not to the detriment of the possibility to fill the reservoir as the Weir execution proceeds;

(2) Has been approved by the Engineer.

Schedule of Construction and Diversion Scheme

Contractor’s Diversion Scheme

General Requirements

The Contractor shall plan, design, construct, operate, maintain and remove, when required, all parts of his scheme for controlling and diverting the tributaries and for taking care of surface and ground water throughout the construction period.

The Contractor's Diversion Scheme shall be suitable and sufficient for the intended purpose and shall meet the specific design criteria given hereunder.

Criteria

The Contractor's Diversion Scheme shall be based on the general guidelines on design of diversion works as provided in USACE – EM 1110-2-2300: “Concrete Weirs– General Design and Construction Considerations”, or any other criteria approved by the Engineer.

Any diversion channel included in the Contractor's Diversion Scheme other than that mentioned in Engineer’s Diversion Plan shall be designed by the Contractor. The Contractor shall carry out sufficient surveys as may be needed to establish the required extent of the diversion channel and demonstrate to the satisfaction of the Engineer that the channel will perform as intended.

Use of Permanent Works

The proposed use of any part of the Permanent Works as part of the Contractor's Diversion Scheme shall be such that the Permanent Works are not subjected to any greater loads or any other more adverse conditions, such as erosion, than would occur after that part of the Permanent Works has been put into service during impounding or after completion of the construction.

Contractor's acknowledgement and responsibility

The Contractor shall be solely and fully responsible for the diversion and care of water throughout the period of construction and for any damage to persons and property, as provided in **Clauses 17 and 18 of the Conditions of Contract**.

The Contractor shall be responsible for any damage or detriment to the Permanent Works which may result from any overtopping, breach, breakdown or other failure of his measures for the diversion and care of water, and shall make good such damage to the satisfaction of the Engineer, at no additional cost to the Employer.

PRODUCTS

Materials

The materials used for all diversion features shall conform to the requirements of the appropriate sections of these Specifications.

EXECUTION

General

In addition to the specific requirements of this Section, the construction of all Temporary Works for the diversion and care of water shall conform to the requirements of the appropriate sections of these Specifications.

Closure of Diversion Channels

No diversion channel shall be closed unless the Engineer is satisfied that its closure can be undertaken without detriment to the safe conveyance of water through and/or past the site of the Permanent Works, and that those parts of the arrangements for the diversion and care of the water remaining after its closure will meet the requirements of this Section of the Specifications. Nor shall it be closed until the Engineer is satisfied that the Contractor has made adequate preparations and secured sufficient resources for the proper and timely execution of any subsequent parts of the Diversion Scheme as the Engineer may consider necessary to allow the safe discharge of Nullah flows.

Closure of a diversion channel shall not be commenced without the written permission of the Engineer.

Incorporation in Permanent Works

Subject to the approval of the Engineer, any suitable part of the Temporary Works which is located within the limits of Permanent Works may be incorporated therein, provided that its construction standard has been shown to meet the specified requirements, and the construction details are compatible with the design of the Permanent Works.

Subject to the approval of the Engineer, parts of the Permanent Works may be constructed

with additional features required to enable them to function as part of the diversion arrangements. Such features may be retained within the Permanent Works, subject to the approval of the Engineer, provided that their construction standard has been shown to meet the specified requirements and the construction details are compatible with the design of the Permanent Works.

Dewatering

General

Except where otherwise specified, shown on the Drawings or approved by the Engineer, the Contractor shall maintain all foundations and other Permanent Works areas well drained and free of water of any origin, including groundwater, seepage, precipitation, runoff or from construction uses.

Except where otherwise approved by the Engineer, the Contractor shall drain, dewater and keep dry all areas of construction that are below the Nullah or the groundwater elevation, and shall ensure that all excavated surfaces are maintained in a safe and stable condition.

All embankments whether Permanent Works or Temporary Works, shall be placed in the dry, with the exception of such parts of the Contractor's Diversion Scheme as are designed to be placed in water and have received the Engineer's approval for that method of placing.

The work to be performed by the Contractor in connection with dewatering shall include, but not necessarily be limited to, the following:

- The supply, installation, operation, maintenance and subsequent removal of all pumps, pumping stations, pipework and other equipment, including sufficient standby equipment, for the dewatering of the works areas and maintaining those areas free of water as required. Should deep well pumps be deployed, they shall be placed at least 30 m beyond the limits of any completed Permanent Works, except flexible aprons.

- The construction, maintenance and subsequent removal of any temporary sumps, lagoons, chambers, flumes, cofferdams, protective bunds or dykes and the like. All temporary sumps and lagoons shall be placed at least 20 m beyond the limits of any Permanent Works.

- The construction, maintenance and subsequent backfilling of such temporary drains or ditches as are required to efficiently carry all water to sumps or other collection or disposal locations.

- The supply, installation, maintenance, operation and subsequent removal of dewatering wells and/or well points.

Subject to the Engineer's approval, which shall not be unreasonably withheld, the Contractor may deploy any other appropriate part of the Permanent Works as part of his drainage and dewatering arrangements.

Groundwater Pressure Relief

The Contractor shall evaluate all groundwater information and take whatever measures are necessary to ensure the stability of all structures and ground surfaces during construction. The measures needed may depend on the precise sequence of such matters as excavation, construction and the installation of permanent drainage wells and blankets.

The Contractor's dewatering arrangements may require the drilling of drainage wells from the ground surface, together with the installation of piezometers to monitor groundwater levels and the performance of the dewatering arrangements.

If, in the opinion of the Engineer, the foundation is damaged due to any inadequacy or failure of the Contractor's system for groundwater pressure relief, then the Contractor shall take all corrective measures necessary, as directed by the Engineer, at no additional cost to the Employer.

Excavations for Concrete Structures

At all excavations where concrete is to be placed, the water level within and adjacent to the excavation shall be maintained a minimum of 300 mm below the finished excavation for at least 24 hours after the completion of the structure to an elevation above the natural water-table, or for such additional time as the Engineer may require to preclude injury to the foundation or structure.

Maintenance of Temporary Works

The Contractor shall maintain all Temporary Works required for the diversion and care of water, shall carry out any repairs promptly and shall ensure that each part of the Temporary Works functions properly throughout the period during which it is required.

Removal of Temporary Works

Subject to the requirements for the diversion and care of water shall be removed promptly after they have served their intended purpose. The Engineer may, however, permit the removal of certain Temporary Works to be delayed, if he is satisfied that this will cause no detriment to the Permanent Works or to the safe conveyance of water through and/or past the site of the Permanent Works, and that the Contractor has made adequate provision for their subsequent timely removal.

Removal of all Temporary Works for the diversion and care of water shall be carried out in a

workmanlike manner and to the approval of the Engineer, leaving a clean appearance to the remaining surfaces, and so as not to interfere with the proper completion or future functioning of the Project. Waste material shall be properly disposed of, to the approval of the Engineer.

The site of any diversion channel shall be backfilled and reinstated to such levels and in such a manner as the Engineer may direct, having regard to the subsequent construction of Permanent Works on or near the site of the diversion channel and the safe conveyance of water through and/or past the Works.

Reinstatement

Any surfaces which are affected by erosion or deposition due to the flow of water shall be reinstated in such a manner and at such a time as the Engineer may direct, having regard to the construction, safety, stability and proper functioning of the Permanent Works.

MEASUREMENT AND PAYMENT

General

No measurement or payment shall be made for diversion, drainage, dewatering or care of water, except as specified herein and included in the Bill of Quantities.

The lump sum price included in the priced Bill of Quantities shall be deemed to cover all costs of diverting the flows, conveying flows through and/or past the site of the Permanent Works, keeping each part of the Works protected against inundation, well drained and properly dewatered during construction; and of constructing, maintaining, operating and removing all Temporary Works in connection therewith. Any costs resulting from accidental inundation of any working areas, whether due to breakdown, failure or overtopping of the Temporary Works, shall be to the account of the Contractor.

The lump sum price shall be deemed to include all measures for the diversion and care of water including dewatering of foundations, required for the proper completion of the Permanent Works, whether or not they are specifically mentioned in the Contract.

The lump sum price shall be deemed to take account of any effects of the measures for the diversion and care of water on any surfaces, including such effects as erosion and deposition due to the flow of water. The lump sum price shall be deemed to include all costs resulting from the reinstatement of such surfaces.

Progress payments for diversion and care of water shall be made according to such schedule as the Engineer approves as reasonable, having regard to the construction schedule of each feature of the Works.

Diversion and Care of Water

Measurement

Diversion and care of water will be measured on the basis of break down of the Lump sum Price showing cost of all items for water control works of listed in the Water Control Plan proposed by him and submitted with the Tender.

Payment

Payment will be made as per the breakdown of the lump sum price tendered and submitted by the Contractor as stated under Measurement.

The lump sum price shall be deemed to cover all costs of diversion and controlling water, maintaining all work areas free of water regardless of source; constructing, maintaining, breaching, and removing cofferdams, and all other work related to the item.

Payment shall include all costs of designing and furnishing all sumps, ditches, pumps, motors, pipes, valves, etc., for care of water and performing all pumping and drainage operations including the furnishing of all power and energy etc necessary to comply with the requirements under the Sub-Clause. The Employer shall not pay any additional amount in full compliance to the requirements of this Sub-Clause.

Incorporation in Permanent Works

Any parts of the Temporary Works which become incorporated within the Permanent Works shall, at the time of incorporation, be measured for payment to such limits and under such bill items as would have applied to the relevant part of the Permanent Works, as if that part of the Temporary Works had not previously existed.

SECTION 5

CONCRETE WORKS

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CONCRETE WORKS

Scopes

This Section contains requirements for the manufacture, transportation, placement, finishing, repair and curing of concrete; for the detailing, supply and placing of reinforcement; for formwork; for joints, joint materials, joint treatment and bearing pads; and for all other works associated with cast-in-place and precast concrete.

Reference Standards

Reference Standards are referred to in the text of the Specifications in abbreviated form (e.g. BS 12).The numbers and subjects of standard are given below for convenience:-

STANDARD	SUBJECT
American Concrete Institute (ACI)	
ACI 211.1-91	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 305R-99	Hot Weather Concreting
ACI 306R-88	Cold Weather Concreting
ACI S15-99	Details and Detailing of Concrete Reinforcement
ACI 318-11	Building Code Requirements for Structural Concrete and Commentary
American Society for Testing and Materials (ASTM)	
ASTM C33	Specification for concrete aggregates
ASTM C39	Test method for compressive strength of cylindrical concrete specimens
ASTM C40	Test method for organic impurities in fine aggregates for concrete
ASTM C42	Methods of obtaining and testing drilled cores and sawed beams of concrete
ASTM C88	Test method for soundness of aggregates by use of sodium sulphate or magnesium sulphate
ASTM C94	Specification for ready-mixed concrete
ASTM C117	Test method for materials finer than 75 pm (No. 200) sieve in mineral admixtures by washing

STANDARD	SUBJECT
ASTM C127	Test method for specific gravity and absorption of coarse aggregate
ASTM C 131	Test method for resistance to degradation of small-size coarse aggregate by abrasion and impact in the Los Angeles machine
ASTM C136	Method for sieve analysis of fine and coarse aggregates
ASTM C 142	Test method for clay lumps & friable particles in aggregates
ASTM C143	Test method for slump of Portland cement concrete
ASTM C151	Test method for autoclave expansion of Portland cement
ASTM C186	Test method for heat of hydration of hydraulic cement
ASTM C231	Test method for air content of freshly mixed concrete by the pressure method
ASTM C260	Specification for air-entraining admixtures for concrete
ASTM C309	Specification for liquid membrane-forming compounds for curing concrete
ASTM C311	Method for sampling and testing fly ash or natural pozzolan for use as a mineral admixture in Portland cement concrete
ASTM 0404	Specifications for aggregate for masonry grout
ASTM 0441	Test method for effectiveness of mineral admixtures in preventing excessive expansion of concrete due to the alkali-aggregate reaction
ASTM 0451	Test method for early stiffening of Portland cement (Paste method)
ASTM 0494	Specification for chemical admixtures for concrete
ASTM C618	Specification for fly ash and raw or calcined natural pozzolan for use as a mineral admixture in Portland cement concrete
ASTM C989	Specification for ground iron blast-furnace slag for use in concrete and mortars
ASTM D1190	Specification for concrete joint sealer, hot-poured elastic type
ASTM D1751	Preformed expansion joint fillers for concrete paving and structural construction (Non-extruding and resilient bituminous types)
ASTM D 1752	Specification for preformed sponge rubber and cork expansion joint fillers for concrete paying and structural construction.
ASTM D1850	Specification for concrete joint sealer, cold-application type

STANDARD	SUBJECT
ASTM D2419	Test method for sand equivalent value of soils and fine aggregate
British Standards (BS)	
B6 12	Specification for ordinary and rapid hardening Portland cement
BS 146:Part 2	Specification for Portland blast-furnace cement (Metric units)
BS 340	Specification for precast concrete kerbs, channels, edgings and quadrants
BS 368	Precast concrete flags
BS 1200	Building sands from natural sources
BS 3148	Methods of tests for water for making concrete
BS 4246	Low heat Portland blast-furnace cement
BS 6073	Specification for precast concrete masonry units
U.S. Army Corps of Engineers (US COE)	
CRD C568	Rubber - preparation of pieces for test from other than standard vulcanized sheets
CRD C570	Test for brittleness temperature of plastics and elastomers by impact
CRD C571	Test for stiffness of plastics by means of a cantilever beam
CRD C572	Specifications for polyvinyl chloride water-stop
CRD C573	Test for rubber properties in tension
US Federal Specifications (US)	
SS S1614	Scaling compound, jet-fuel resistant, hot-applied, one-component, for Portland cement and tar concrete pavements
TT C598C	Caulking compound oil and resin base type (for building Construction)
TT S00227E	Sealing compound elastomeric type, multi-component (for cement Pozzolanic materials admixtures caulking, sealing, and glazing in buildings and other structures)

Submission by the contractor

General

The contractor shall submit the following to the Engineer for record or approval

Certificates and Mill Test Data

Manufacturers or suppliers certificates of compliance with relevant standards for each shipment of all materials and accessories used in the Permanent Works, including

- ► Cement
- ► Pozzolanic materials
- ► Admixtures
- ► Curing compound
- ► Jointing materials, including Waterstops

Appropriate mill analysis and laboratory test data of samples tested by the supplier. Mill analysis and test data shall be representative of materials furnished for the Permanent Works. The frequency of sampling and testing by the supplier shall conform to applicable standards.

Results of Tests Performed by the Contractor

- ► Daily reports and monthly summaries of aggregate plant gradation test results on aggregate produced.
- ► Monthly calibration certificates for the weighing and dispensing devices on batching and mixing plants.

Samples

Samples of all materials, together with manufacturers' technical information, to be used in the Permanent Works as may be required by the Engineer. Reference samples shall be kept in suitable containers, properly labeled, and stored on site.

Construction Plants

Location plans, layout drawings, flow-.diagrams and equipment list for the aggregate plant(s), refrigeration plant(s) and concrete batching and mixing plant(s) prior to ordering or erecting these plants. The submittal for each plant shall be accompanied by the Contractor's detailed written proposal for quality control of the product at the Site. The proposals for the plant and quality control will be reviewed 'and commented on by the Engineer with regard to compliance with Specifications and the Contractor shall modify his proposals to the satisfaction of the Engineer. The Engineer will require one month for review of the proposals.

Shop Drawings

Shop drawings for execution of work explaining layout of lifts, techniques to install water stops, details of construction joints, sequence of pouring of concrete, formwork details, bar bending schedule and any special unforeseen feature during the concreting work. Engineer will review it and the Contractor will incorporate those changes in the Drawings and accordingly execute the work.

Construction Details

Detailed proposals for the following for advance approval by the Engineer

► Construction joints where they are not shown on the Drawings

► Grouting of construction joints

► Layout of lifts

► Installation of Waterstops

► Concrete placement sequences including special measures for dealing with concreting in hot and cold weather and during nights. .

► Precast concrete works.

► Reinforcing bar details showing bar shapes, embedment and splice lengths.

Work shall not commence before such approval is received by the Contractor.

Concreting Records

Daily returns in respect of all concrete placed during the previous day, in a form as agreed with the Engineer.

The returns shall include but not necessarily be restricted to:

► In respect of each concrete mix design.

- the number of batches mixed,
- the number of batches and the total volume of concrete placed,
- the number of batches wasted or rejected, and
    - the weights of all cement, aggregates, water, Pozzolanic materials and additives used;
- in respect of each location in the Permanent Works
- the position of the placement (e.g. structure, bay or lift reference number),
- the concrete mixes placed, and

- the total volume of concrete placed and the number of batches of each mix used.

► An accurate and up-to-date record showing dates, times, weather and temperature conditions when each part of the Permanent Works was concreted the record shall be available for inspection by the Engineer at all times.

Materials and Equipment

Cementitious Materials

General

Cementitious materials shall normally consist of ordinary Portland cement (OPC) and Pozzolanic material (either raw or calcined natural Pozzolanic, fly ash or blast-furnace slag). The sources of Pozzolanic material shall be proposed by the Contractor and shall be subject to approval by the Engineer

The proportions of OPC and Pozzolanic material will be determined by the Engineer for each mix. The mix will normally be designed by the Engineer to have:

► a mortar bar expansion of (less than 0.02% at 14 days when tested in accordance with ASTM C441, and

► a heat of hydration of less than 70 calories per gram of cementitious materials at 7 days when tested in accordance with ASTM C176

The Contractor may propose the use of Portland blast-furnace cement, subject to the Provisions as per specifications.

Cement

Cement used in the Permanent Works shall be OPC conforming to BS 12 except where Portland blast-furnace cement is permitted.

Cement shall be non-false setting, defined as having a minimum final penetration of 50% of initial penetration when tested in accordance with ASTM C451.

In addition to the requirements for soundness of cement given in BS 12, cement shall also be tested for soundness in accordance with ASTM C151. The expansion or contraction of the tested bar resulting from this test shall not exceed 0.70%.

The Contractor shall arrange with the suppliers to have silos set aside for exclusive use in this Contract. Samples of cement shall be taken at regular intervals during the filling of each silo from, which shipment to the Site is to be made. A composite sample of each silo shall be tested for fineness, soundness, time of set, loss on ignition, compressive strength, false set and chemical analysis including alkali and compound composition. Each silo of cement will be

released by the Engineer for shipment to the Site upon completion of the 3-day comprehensive strength test provided that the test results are satisfactory. No cement shall be shipped from a silo to the Site until that silo is released for shipment. Once a silo has been released for shipment, there shall be no further additions of cement to that silo until the cement contained therein has been exhausted.

Each shipment of cement shall be accompanied with a certificate stating the silo number from which the cement was taken, transporting unit number, time of loadout, date shipped and amount transported. The Contractor shall undertake each month two tests for heat of hydration of cement from each source in use. The tests shall be in accordance with ASTM C176. The Engineer may order further heat of hydration tests, in which case the cost of additional tests shall be reimbursed to the Contractor. Before the 14th day of each month, the Contractor shall submit an updated summary of all tests made on cement supplied to the Permanent Works including 7 and 27 day compressive strength and heat of hydration. The Engineer shall have the right to sample and test cement at any time, to confirm compliance.

Immediately upon arrival at the site, cement shall be stored in silos designed for the purpose or in dry, weather tight and properly ventilated structures with floors raised 20" above ground level and having adequate provision to prevent absorption of moisture. All storage facilities shall be subject to approval by the Engineer and shall be such as to permit easy access for inspection and identification. Each shipment of cement shall be kept separately and the Contractor shall use the shipments in the order in which they are received. Sufficient cement from a single source shall be in storage at the Site to complete any lift of concrete started. Adequate storage capacity shall be furnished to provide sufficient cement to meet the Peak needs of the approved construction schedule.

Cement of different types and from different sources shall be kept in clearly marked separate storage facilities. Cement delivered to the Site in drums or bags provided by the supplier or manufacturer shall be stored in the unopened drums or bags until used in the Permanent Works. Any cement in drums or bags which have been opened on the Site shall be used immediately, or shall be disposed off. Unless otherwise permitted, cement from not more than three plants shall be used and, in general, only the product of one plant shall be used in any particular section of the Permanent Works.

Any cement which is, in the opinion of the Engineer, lumpy or partially set shall be rejected and the Contractor shall promptly remove such cement from the Site. Cement which has been stored on the Site for more than 90 days and cement which, in the opinion of the Engineer, is of doubtful quality shall not be used in the Permanent Works unless it is retested and the test results show that it complies in all respects with these Specifications.

Accurate records of deliveries of cement and its use in the Permanent Works shall be kept by the Contractor. Copies of these records shall be supplied to the Engineer in such form as he may require.

Aggregates

General

Aggregates for concrete shall be processed and shall consist of natural particles or a blend of natural and manufactured particles. Aggregates shall be produced from suitable material from required excavations or borrow areas as approved by the Engineer. The approval of any source from which aggregates are to be produced by the Contractor shall not be construed as constituting approval or acceptance of all materials taken from the source.

The Contractor shall provide all labour and equipment and shall maintain a testing laboratory for the quality control of aggregates produced for the Permanent Works. At least once per shift, the Contractor shall sample and test for grading each coarse aggregate produced during that shift. The gradation of fine aggregate shall be determined at a minimum frequency of one test per hour of production unless, in the opinion of the Engineer, the test results show the aggregate grading to be sufficiently consistent to allow less frequent testing. The Contractor shall also sample and test aggregates for gradation at various stages in the processing, transporting, stockpiling and reclaiming as may be required by the Engineer. The Contractor shall submit a daily report to the Engineer, which shall include production quantities and gradation test results.

The Contractor shall promptly correct any excesses or deficiencies in gradation of coarse and fine aggregates during processing. Rejected or waste material shall be disposed off in approved areas.

Aggregate Quality and Grading for Concrete

Fine Aggregate

Fine aggregate for concrete shall conform to the quality requirements of ASTM C33 and shall consist of natural and/or crushed sand. Fine aggregate shall be washed.

In addition to the above, fine aggregate for concrete shall meet the following physical requirements

- ► Fineness modulus (ASTM C33) 2.50 to 3.0
- ► Sodium sulphate soundness (ASTM C88) 5 maximum 10% loss cycles
- ► Sand equivalent (ASTM D2419) minimum 80%

In addition to compliance with grading requirements, the fine aggregate grading shall be controlled such that the fineness moduli of at least 9 out of every 10 consecutive test samples do not vary by more than 0.20 from the average fineness modulus of the 10 test samples.-

The maximum percentages of deleterious substances in the fine aggregate, as delivered to the mixer, shall not exceed the following values

- ► Clay lumps and friable particles (ASTM C33) 3% by weight

- ► Material passing 0.075 mm sieve 3% by weight
- ► Shale 1% by weight
- ► Total of other deleterious substances (such as mica, chlorite, coated grains and soft flaky particles) 3% by weight

The sum of the percentages of all deleterious substances shall not exceed 5% by weight.

The amount of hollow shells likely to form voids and present in the material retained on a 0.1 inch 2.36 mm (No. 8) sieve, determined by direct visual separation, shall not exceed 3.0% by weight of the entire sample.

Aggregates shall be tested in accordance with ASTM C40 for content of organic impurities. Any aggregate producing a colour darker than the standard shall be rejected.

When tested in accordance with ASTM C136, fine aggregate shall be uniformly graded within the following graduation requirements:-

US Standard Sieve Size	% Passing By Weight
0.375 in.	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10
No. 200	0-3

Coarse Aggregate

Coarse aggregate for concrete shall conform to the quality requirements of ASTM C33, and shall consist of gravel, crushed gravel or crushed stone. Coarse aggregate shall be washed and shall be separated into nominal size ranges. The specific gravity and absorption of coarse aggregates shall be determined in accordance with ASTM C126.

In addition, coarse aggregate for concrete shall meet the following physical requirements

- ► Sodium sulphate soundness 5 cycles (ASTM C88) maximum 12% loss
- ► Los Angeles abrasion value (ASTM C131) maximum 40% loss

The Maximum percentages of deleterious substances in any size of coarse aggregate as delivered to the mixer, shall not exceed the following values: -

- ► Material passing No. 200 sieve (ASTM C117)

- 3/4" to No. 4 size range — 0.50 % by weight
- 1 1/2" to 3/4“ size range — 0.25% by weight
- 3" to 1 %" size range — 0.25% by weight
- Shale — 1 % by weight
- Clay lumps and friable particles (ASTM C142) — 2 % by weight
- Other deleterious substances — 1 % by weight

The sum of the percentages of all deleterious substances in any size, as delivered to the mixer, shall not exceed 3% by weight.

When tested in accordance with ASTM C136, the coarse aggregate nominal size ranges shall meet the following graduation requirements when delivered to the mixer and shall be uniformly graded within the limits stated:-

Sr.#	Nominal Size Ranges	%age Passing by Weight		
	Sieve Size	3/4”to No. 4	$1^{1/2}$ ” to $^{3/4}$”	3” to $1^{1/2}$”
1	4 in			100
2	3 in			90-100
3	2 in		100	20-55
4	1.2 in		90-100	0-15
5	1 in	100	20-55	0-2
6	¾ in	90-100	0-15	
7	3/7 in	10-40	0-2	
7	No. 4	0-5		
9	No. 7	0-2		

Second Stage Concrete

Second stage concrete will be designed by the Contractor and submitted to Engineer for

approval. It will be placed as shown on the drawings. All other details for cement, aggregate etc. will be same as for the other structure concrete.

Sampling and Testing of Aggregates

Aggregate for Concrete

During concrete production, aggregates, as delivered to the mixer, will be sampled and tested in accordance with BS812 by the Engineer to determine compliance with the provisions of these Specifications. The Contractor shall provide samples and such facilities as may be necessary for the ready procurement of representative test samples. Testing of concrete aggregates by the Engineer shall not relieve the Contractor of his responsibility to maintain control on production, stockpiling and handling of both fine and coarse aggregates in accordance with the Specifications.

Storage of Aggregates

The Contractor shall provide means of storing the aggregates such that:-

► Each nominal size range of coarse aggregate and the fine aggregate shall be kept separated at all times,

► Contamination of the aggregates by the ground or foreign matter shall be effectively prevented at all times, and

► Each heap of aggregate shall be capable of draining freely.

Rock ladders of satisfactory design shall be used with conveyor systems for stockpiling aggregate larger than 1 $^{1/2}$" in size to prevent segregation and excessive breakage.

The Contractor shall ensure that graded coarse aggregates are tipped, stored and removed from store in a manner that does not cause segregation. No equipment shall be permitted to operate on storage piles.

Fine aggregate, as delivered to the batching and mixing plant storage bin, shall have a uniform and stable free-moisture content, which shall not exceed 7%. Excessive moisture shall be removed mechanically or by the 3-pile drainage method.

The Contractor shall protect the heaps of fine aggregate against inclement weather.

Windbreaks shall be provided where aggregates might suffer contamination by wind-blown materials.

Water

Water for washing aggregates, mixing concrete and curing shall be clean and free from harmful matter and shall comply with the recommendations contained in the Appendix to BS3148. The concentration of sulphate and chlorides shall be such that the concrete mix as a whole complies

with the limits of salts content also recommended in BS3148. The Contractor shall make arrangements to protect water from direct sun and contamination by wind-blown materials. The Engineer shall order retesting of water whenever deemed necessary.

Admixtures

Admixtures shall mean materials added to the concrete materials during mixing for the purpose of altering the properties of the concrete mix. They shall not contain calcium chloride.

The Contractor shall furnish and use a water-reducing set-retarding admixture in all concrete unless otherwise approved by the Engineer. The water-reducing set-retarding admixture shall conform to ASTM C494, Type D. The amount of admixture used per batch shall be determined by the Engineer but, in general, will be in accordance with the manufacturer's instructions. No water-reducing set-retarding admixture shall be considered for approval that has not been used with satisfactory service in works of similar nature. A manufacturer's technical data sheet and certification of compliance with ASTM C494, Type D, shall be submitted at the time of request for approval. After approval is granted, a manufacturer's certificate of compliance shall be furnished with each shipment to the Site. Water-reducing set-retarding admixture may be sampled and tested by the Engineer for compliance with ASTM C494. If tests prove that any admixture, which has been delivered, is unsatisfactory, it shall be promptly removed from the Site.

The Contractor shall furnish and use an approved air-entraining admixture in all concrete except in high strength concrete. The air-entraining admixture shall be a neutralized vinyl resin and shall conform to the requirements of ASTM C260.

The admixtures shall be accurately batched by mechanical batcher and shall be added in a manner, which ensures uniform distribution throughout the batch.

The compatibility of different admixtures used in the same batch shall be established to the satisfaction of the Engineer.

The amount of air-entraining admixture used in each concrete mix shall be just enough to cause entrainment of air in the following percentages when concrete is discharged from the mixer:

Sr. #	Nominal Maximum Size of Coarse Aggregate	Total Percent of Air by Volume
1	3”	4 to 5*
2	1 1/2	4 to 6
3	3/4"	5 to 7

* based on the minus ½” portion of a sample after sieving on 1 ½” sieve.

Field tests on air-entrained mixes shall be made in accordance with ASTM C231. Concrete produced with air contents exceeding the above limits may be rejected by the Engineer.

Admixtures shall be stored in suitable containers, which will maintain them in uniform solution and will protect them from weather and contamination.

Admixtures, which have been in storage for more than 6 months, shall not be used unless retest proves them to be satisfactory. Costs of all such retests shall be borne by the Contractor. Rejected Materials shall be removed immediately from the Site.

Jointing Materials and Waterstops

Jointing materials include fillers, paints, caulking compounds, sealants, adhesives, Waterstops and other such materials required for the making of joints in concrete.

Jointing materials shall be proposed by the Contractor and approved by the Engineer. They shall be handled, used and stored in accordance with the manufacturer's recommendations.

Where there is no appropriate standard to which reference may be made in respect of any proprietary jointing material, the Contractor shall prove by demonstration, tests or otherwise the suitability, adequacy and performance of the material under Site conditions. In other instances the Contractor shall supply manufacturer's test sheets to certify compliance with relevant quality standards. Only such materials as have -been approved by the Engineer shall be used in the Permanent Works.

Bond-breaking coating for application to concrete surfaces to prevent bonding of fresh concrete to concrete previously placed shall be of a type that will adhere to damp surfaces of concrete and perform its function of breaking bond without any damage to the new concrete. The Contractor shall furnish detailed specifications and samples of the material he proposes to use for the approval by the Engineer.

Jointing materials used in the work shall conform to the following standards:-

Sr.#’	Material	Standard
1	Hot-poured joint sealing compound	ASTM D1190 or US SS S1614 Sealer; Hot-poured type for joints in concrete
2	Cold application type	ASTM D1750
3	polysulfide-base or polyurethane-base joint sealant	US TTS00227E
4	Performed expansion	ASTM D1851
5	Joint filler	ASTM D1752 Type II
6	Caulking compound	US TT C598C, Grade 1 or 2, colour as shown on the Drawings or as approved
7	Extruded plasticized polyvinyl chloride resin. (PVC) waterstop	US COE Specification CRD C572 for polyvinyl chloride water stop

Waterstops

General

a) PVC, Hypalon or copper water stops shall be placed in joints of concrete structures as shown on the Drawings or as directed.

b) The Contractor shall store the waterstops in such a way that the material does not deteriorate during storage.

c) Adequate provision shall be made to support and protect the waterstops during the progress of the Works. Flexible waterstops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixture.

d) The Contractor shall replace or repair any waterstops punctured or damaged before final acceptance of the Works.

e) Placing and compacting of concrete in the vicinity of waterstops shall be carried out with particular care to ensure any damage or displacement is avoided and that the waterstops do not bend or distort, and that no voids are left below the waterstop.

f) As far as possible, jointing of waterstops on Site shall be confined to the making of butt joints in straight runs. Where it is necessary for an intersection, or change of direction, or any joint other than a butt joint in a straight run, to be made on Site, a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer may require.

PVC Waterstops

a) Size and Material

i) PVC waterstops shall be nominally 10 inches (250 mm) wide. The waterstops shall be of polyvinyl chloride extruded from an electrometric plastic compound, the basic resin of which shall be PVC. The compound shall contain such additional resins, plasticizers, stabilizers or other materials needed to ensure that when the compound is extruded to the shapes and dimensions shown, it will have the following physical characteristics when tested by the US Army Corps of Engineers test method specified below:

Sr. #	Physical Characteristics	Requirement	Test Method
1	Tensile strength not less than	15 MPa (2175 psi)	C568
2	Ultimate elongation not less than	350 %	C573
3	Low temperature brittleness, no sign of failure such as cracking or chipping at	2°C (35°F)	C570
4	Stiffness in flexure, 0.5" span, not less than	2.75 MPa (400 psi)	C571

ii) The Waterstops shall be of sufficient stiffness so that they remain in their correct position during concreting. The type shall suit the particular location in the structure in which the waterstop is to be placed and the pattern shall be such that concrete can be placed all around it with complete consolidation and no voids or crevices.

Waterstops used in each location shall include at least one approved nailing strip so located that the efficiency of the waterstop is not impaired, shall have a minimum thickness of 0.20 inch (4.5

mm). The width of the waterstop shall be within a tolerance of 0.40 inch (10 mm) of the nominal width exclusive of the nailing strip.

b) Joints

i) The number of joints in the waterstops shall be the minimum practicable and ail joints and bends shall be made as approved. The number of straight field joints shall be kept to a minimum and all Tee and Cross joints shall be factory produced. The equipment used for making field joints shall be furnished by the Contractor and shall be as approved. The Contractor shall protect the waterstops against perforation or damage during the progress of the work.

ii) Ali joints shall be made with a temperature controlled apparatus and in such a manner as to ensure:-

► that the material is not damaged by heat, searing or by the application of cementing materials;

► that the splices have a tensile strength not less than 80 percent of that required of the specified material (tested as per ASTM D412);

► that the splice is watertight and free of air bubbles;-and

► that the ribs and central bulb, where applicable match up exactly and are continuous.

Joint Fillers / Placing of Jointing Materials

General

a) Joint fillers shall be placed in joints as shown on the Drawings or as directed. Joint filler shall be cut from the least practicable number of pieces to fit exactly and completely cover the areas shown on the Drawings. Loose fitting or open joints between sections of filler or between filler and forms will not be permitted.

b) When required by the Drawings or directed by the Engineer, a space adjacent to the preformed expansion joint filler shall be filled with a joint sealant. Joint sealant shall be as specified and shall be placed in strict accordance with the manufacturer's recommendations.

c) The Contractor shall submit a sample of all proposed fillers and the details of the proposed method of application for approval at least 60 days before their intended use.

d) The surface of set concrete in a joint shall, where a bond breaker ig-specified on the Drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when tl'.c paint is dry.

e) Caulking grooves shall be provided as shown on the Drawings. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be sand-lasted and loose material removed and blown out by compressed air. After the groove

has dried, it shall be primed and caulked with approved caulking compound in strict accordance with the manufacturer's recommendations.

Polysulphide Mastic Joint Fillers

Polysulphide mastic joint filler shall be placed in joints in the' wall where shown on the drawings and elsewhere as directed. The joint filler shall be an approved two-part Polysulphide liquid polymer.

Bitumen-Rubber Mastic Joint Filler

a) Bitumen-rubber mastic joint filler shall be placed in the perimetric and vertical joints of the embankment where shown on the Drawings or as directed. .

b) The bitumen-rubber based mastic shall be 'Igas' made by the Sika Chemical Company, USA, or approved equivalent.

c) The mastic shall have a medium-stiff consistency suitable for flowing into the perimetric joint and vertical joints as shown on the Drawings.

d) Where shown on the Drawings, or as directed, the joint filler shall be protected with a 0.12 inch (3 mm) thick Hypalon or an approved equivalent membrane. The Hypalon strip shall have the same properties as specified for Hypalon waterstop in Sub-clause 6.12.3. The membrane shall be held in position using 2.52 inchx2.52inch (64 mm x64 mm) galvanized steel angles 0.20 inch (5 mm) thick placed on either side of the joint and attached to the concrete at intervals of not greater than 0.5m using approved power driven fasteners.

e) Perimetric and vertical joint slots must be clean and dry and concrete surface primed with gas primer equivalent. The area of mastic shown on the Drawings shall be* applied to the joint and the protective membrane drawn tightly over the mastic.

f) The mastic and membrane shall be protected against damage. During placement of the impervious fill in Zone 1, rock free material shall be hand placed directly against the membrane.

Expanded Polystyrene Joint Filler

a) Expanded polystyrene joint filler shall be placed in expansion joints where shown on the Drawings or as directed. Expanded polystyrene shall meet the requirements of BS 3837 for Type N material of density 1.05 gm/cm3.

b) Expanded polystyrene shall be 0.80 inches (20 mm) thick and shall be installed in as large a size sheet as possible.

c) The Contractor shall cut the joint filler to cover the required surface of the concrete at

expansion joints and to fit around all openings.

d) Where placed against vertical surfaces, the joint filler shall be held in place against the completed side of an expansion joint by water proof cement, applied to the face of each piece of joint filler as a marginal strip coating approximately 50 mm wide.

e) Joints in the joint filler shall be scared, made tight and filled with a suitable material so that mortar from the concrete will not seep through to the opposite concrete surface. The number of field joints shall be kept to a minimum.

f) Where shown on the Drawings or directed, the joint filler, shall be raked out after the concrete has set.

Bituminous Fiber Sheet

a) Bituminous fiber sheet Joint filler shall be placed in expansion joints where shown on the Drawing or as directed.

b) The bituminous fiber sheet shall be 0.5 inches (12 mm) thick and shall conform to ASTMD 1751 - 60T for preformed expansion joint filler for concrete paving and structural construction. Furthermore, the Contractor shall demonstrate to the satisfaction of the Engineer that the installed and expanded material will be capable of additional expansion, upon appropriate post construction treatment, of not less than 20 percent of its original thickness. The material shall be installed in as wide and as long a strip as possible.

c) The exposed edges of the bituminous fiber sheet shall be installed flush with either the back of the recess formed by chamfers on the corners of the concrete or the finished concrete surface as shown on the Drawings or as directed.

d) Joints in the bituminous fiber strips shall be scared. The number of field joints shall be kept to a minimum and where possible joints shall be factory produced.

Cement Sand Mortar Joint Pads

e) Joint pads shall be constructed under copper water stops to provide an even bedding surface for the copper waterstop and joint form work. The pads shall be S in. wider than the copper waterstop, and shall be of such thickness and constructed to such tolerances that the departure from a straight line 9m long touching the pad at each end shall not exceed 0.8 inches (20 mm). Abrupt steps shall not exceed 0.12 inch (3 mm). The pad shall not in trude in to the design thickness of the concrete face by more than 2.0 inches (50 mm).

f) Under face joints, medium and any fine transition material forming the embankment face shall be trimmed as necessary to enable the joint pad to be placed The excavation shall be of sufficient size to ensure that the joint pad mciterial can be placed without voids and

without damage to, or displacement of, the waterstop.

g) The cement sand mortar joint pads shall consist of 1:3 (by volume) cement-sand * moTtar in accordance with this section.

Sand Asphalt Joint Pad

a) The sand-asphalt joint pads shall be constructed at perimetric joint under copper waterstops to provide an even bedding surface for the copper waterstop and joint formwork. The sand asphalt joint shall be constructed to the line and grade shown on the Drawings and shall be to such tolerances that the departure from a straight line 9 m long 'touching the pad at each end shall not exceed 0.8 inches (20 mm). Abrupt steps shall not exceed 0.12 (3 mm). The pad shall not intrude in to the design thickness of the concrete face by more than 2in (50 mm).

b) Under the perimetric joint the zone 1 material forming the embankment face shall be excavated as necessary to enable the joint pad to be placed to. the required dimensions.

c) The sand asphalt shall consist of sand mixed with bitumen and filler all meeting the following requirements:

i) The sand shall consist of crushed rock or clean river sand having particle size not greater than 0.1S inch (4 mm). The content of silt, loam and clay shall not exceed 3 percent oy mass of the sand, determined in accordance with BS 812, method A or B.

ii) The filler should conform to the requirements of Clause 12.6.6 (b) (iii).

iii) The bitumen shall be petroleum bitumen complying with BS 3690.lt shall have a penetration grade of 100.

d) The composition of freshly placed sand asphalt mix shall be selected to meet the requirements of paragraph (e) of this Sub-clause. The bitumen content found by analysis should not be less than 4% of mix by weight.

e) The placed sand asphalt shall have the following characteristics after placement:

i) Bulk density 2.2 to 2.7 gm/mm.

ii) Void Less than 6%

iii) Permeability Less than 1x10’5cm/sec

f) The mixing, transporting, testing and treatment of 'joint shall be in, accordance with the procedures for coated macadam for roads as specified in Clause 10.6

Formwork

Formwork shall be constructed of timber, sheet metal or other approved material depending on the class of finish to be obtained since different materials have different textures and absorptions, the Contractor shall use only approved material for exposed surfaces of the same class of finish. Ties shall be of the rod and cone or other approved proprietary type. Embedded material rods shall terminate not less than 2 inch inside the formed faces of the concrete. Wire ties shall not be permitted.

Ties for use in water-retaining structures, which are continuous through the section, shall incorporate a diaphragm, not less than 2 inch diameter, welded to the midpoint of the tie, designed to prevent water passing along the tie.

Accessories

Spacer blocks for maintaining concrete cover to reinforcement shall be of concrete of the same texture, colour and composition as the in situ concrete. They shall be cast in the form of a truncated cone or pyramid with the smaller face having a minimum dimension of 2 in PVC spacer blocks of colour matching with the concrete shall be used where formed surfaces are designated. The Contractor shall submit samples and manufacturer's technical data to the Engineer for his approval. They shall not be used for any surface that may be in contact with water.

Chairs and other accessories for maintaining reinforcement in position shall be of steel and shall not be placed within the specified minimum cover to steel. Binding wire shall be 1/7" soft iron wire.

Equipment

General

Plant and equipment shall be sufficient to meet the requirements of both the specifications and the construction program. Special requirements for plant and equipment for concrete production are described below.

Communication System

The Contractor shall install, maintain and operate at his own cost a communication-system linking the points of placing concrete with the concrete batching and mixing plant and such facilities shall be available to the Engineer at all times.

Aggregate Production Plant

The Contractor shall submit the following information before delivery of his plant on site.

► Scheme for developing aggregate sources

► Plant flow diagram and list of major pieces of equipment

► Plan showing proposed layout of the plant, including waste disposal areas and facilities

► Method of transporting raw materials to the aggregate plant Production capacity per hour of each section of the plant

► Method and provisions for dust control

► Method and provision for drainage of the plant area

► Proposals for quality control at each stage of the process to ensure satisfactory and uniform products.

The plant shall be capable of stocking the screened aggregate into allocated bins in the stockpile. The plant shall have means for quick adjustments of the crusher and/or of the screening equipment operations, as may be necessary, to maintain consistent grading the aggregate.

Ail milling to manufacture fine aggregate shall be done in equipment normally used produce manufactured sand for concrete. Crushing plant screenings smaller than 3/8 sieve size will not be accepted for any part of the fine aggregate unless the screenings first pass through the fine aggregate processing equipment. Both fine and coarse aggregates shall be washed.

Batching and Mixing Plant for Concrete

The Contractor shall provide and maintain a modern and dependable, automatic (automatic means (a) batch weights set manually as mix selector, (b) mixes changed automatically by mix selector and (c) materials batch automatically), interlocked, computer-controlled batching and mixing plant / plants. All solid materials entering the plant shall be measured and batched by weight. Liquid materials may be measured and batched by weight or by volume. All concrete shall be centrally mixed in stationary mixers located with the batching equipment. The total production capacity of the plant shall be enough to meet the peak- period concrete demands. Each plant shall be of heavy duty construction that is capable of withstanding continuous day to day production of 3 inch nominal maximum size aggregate android-slump concrete mixtures

The equipment shall provide facilities for the separate measurement and batching of cement, pozzolan, water, ice, and fine aggregate, three size- ranges of coarse aggregate, air-entraining and water-reducing set-retarding admixtures. The handling and batching system for cement and for pozzolan, including storage, screws, elevators, and chutes and weighing hoppers shall be completely independent and separate from each other.

In case the Contractor elects to blend natural sand with manufactured sand in the batching plant, he shall provide separate batching bins and weighing systems for each type of sand.

The Contractor shall submit, for approval by the Engineer, drawings showing the general plant

arrangement and general descriptions of the equipment proposed for use prior to the ordering of the batching and mixing plant. At the same time he shall submit written proposals as to how he will control and check the operation of the plant to ensure that each batch of concrete produced will satisfy the mix design requirements and that there will be no significant variation between different batches made to the same mix design. After completion of the installation, the operation and performance of the plant equipment shall not, however, waive or modify any provision or requirement contained in these Specifications. .

Each plant shall be equipped with separate screen decks for rewashing and finish screening of coarse aggregate. All coarse aggregate shall be rewashed on a rinsing screen with spray bars immediately prior to elevating to the batch plant. The rinsing screens shall be of sufficient length to remove excess moisture from the coarse aggregate. Coarse aggregate shall be finish screened on horizontal vibrating screens. The finish screens shall be so mounted that the vibration of the screens will not be transmitted to, or affect the accuracy of the batching scales. The method and rate of feed shall be' such that the screens will not be overloaded and will operate properly in a manner that will result in a' finished product which consistently meet the grading requirements of the Specification. Feed to the finish screens shall be a combination or alternation of aggregate size ranges such that there will be no noticeable accumulation in any bin of material not having the full range of sizes specified. Aggregates larger than 11/2 inch shall be lowered into the bins by means of rock ladders, which shall operate effectively to keep breakage at a minimum. Material that is removed from the coarse aggregate and passes the No. 4 sieve as a result of the finish screening operation shall be wasted.

Aggregates shall be weighed in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Weighing hoppers shall be arranged to permit the convenient addition or removal of material. Aggregate batching equipment shall be constructed and arranged so that the sequence and time of discharge can be controlled to produce a rib boning and mixing of the aggregate with the cement and pozzolanic material as the materials are charged into the mixer. This shall be accomplished by control of the batcher discharge gates.

An approved electric resistance device shall be provided in the sand batcher for indicating moisture content. The electrode shall extend to within 1 foot of the batcher discharge gates. The monitoring instrument shall be located in plain view of the plant operator. Plant controls shall be capable of ready adjustment to compensate for varying moisture contents of aggregate and for affecting changes in the concrete mix proportions.

Scales shall be in full view of the operator. The scales shall be independently supported by a structure separate from that supporting the related equipment if vibrations are of such intensity that they can affect the scales during batching.

Scales may be either the springless dial type or the multiple beam type. If the dial type is used, the dial shall be of such size and so arranged that it may be easily read from the operating platform. If the multiple beam type is used, the scales shall be provided with an indicator which will give positive evidence of over or under weight easily visible to the operator. The indicator shall be so designed that it will operate during addition of the last 330 lbs weighed by each beam. The over-travel of the indicator hand shall operate during overload up to 155 pounds. Scales and indicators shall be protected against moisture and dust. Graduation interval of each

scale shall be not larger than 1/500 of the total capacity of the scale.

The plant shall include suitable devices for the batching of each admixture. Admixtures may be discharged with the fine aggregate, ice or water but in no case shall admixtures be permitted to intermix until they enter the mixer. Equipment for admixture batching shall be designed for visual confirmation of the accuracy of the measurement through a vertical glass cylinder. The filling mechanism of the device shall be capable of ready adjustment to permit varying the quantity of admixture. Equipment for admixture batching shall be within full view of the operator and shall be interlocked with the other measuring mechanisms.

All batching equipment shall.be interlocked so that a new weighing cycle cannot be started. until all batchers are completely emptied and the batcher discharge gates and valves are closed; the batcher discharge gates cannot be opened until the correct weights of materials are in the batching hoppers and the scales in balance; and the discharge gates cannot be closed until all the materials are entirely discharged from the hopper and the scales return to zero. The filling and discharge valves for the water batcher shall be interlocked with the other weighing mechanism. The pipe for delivering water to the mixer shall be such that leakage will not occur when the valve is closed and the pipe will quickly drain without water trail.

The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale and other measuring device from zero to full capacity of the scale or device within an accuracy of 0.2%. The accuracy of the batching equipment in delivery of materials shall be as follows:

Pozzolanic Material	± 1 % of the required weight of material being weighed or ± 0.3 % of scale capacity, whichever is greater. Same as cement.
Water (ice)	± 1 % of the required weight of material being weighed or ± 0.3 % of scale capacity, whichever is greater, or
Aggregates	+ 1 % of the required volume of material being batched or ± 5 liters (1 gallon), whichever is greater,
Admixture	For each aggregate size, ± 2 % of the required weight of material being weighed or + 0.3 % of the scale capacity, whichever is greater + 0.3 % of the required weight or volume of material being batched.

The plant computer control system shall have a capacity to input and store no less than 20 different mix designs. The proportions for each mix design shall be easily adjustable and shall be based on aggregate weights in surface dry condition. Actual batch weights shall be automatically adjusted by input of aggregate moisture contents and shall be readily changed within the system as the aggregate moisture content changes. The system shall store and output the number and size of batches of each mix design batched and the cumulative quantity of each material used during each shift of operation.

All batching and mixing operations shall be automatically operated by the computer on command. An accurate display shall be in full view of the operator, which shall display the target batch weights based on mix design used and when batching is completed, the actual batch weights of each material. The system shall not discharge materials from the batchers until all

materials are within tolerance. A printed record shall be made showing the mix design, target batch weights, actual batch weights, moisture content of each aggregate, mixing time, placement to which the batch is designated, date and time of day for each batch. The printed sheet shall be made in triplicate and the original shall become the property of the Engineer upon completion of each shift. The print-out shall be readily and conveniently available for review by the Engineer at any time during concrete production and a copy of the print-out for each batch shall travel with the concrete to the placement area.

The plant operator's platform shall be closed, air-conditioned, completely protected from dust and sound proof and shall be positioned where the operator can readily observe the mixing action of concrete in at least one mixer and the discharge of ail mixers. Suitable location of the operator will, be required for adequate control of concrete consistency. In addition, the plant-shall include facilities for sampling each aggregate size from under the storage bin gates.

The plant shall be equipped with one or more batch type tilting drum mixer, vertical shaft pan mixer, or horizontal shaft pan mixer and a discharge hopper. Each mixer shall be capable of combining the aggregates, cement, pozzolan, admixtures and water (including) into a uniform mixture, in colour and consistency, and of discharging the mixture without segregation. The mixers shall be interlocked with the batching plant such that they cannot be charged until empty or discharged until the required mixing time has elapsed.

The minimum mixing time shall be 2 minutes for the first three cubic feet plus 20 seconds for each additional cubic feet up to mixer capacity. Mixing time shall start when all solid materials are in the mixer. The timing device for mixing time on each mixer shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal to the plant operator each time mixing is completed. The mixing plant shall have means for readily wasting material or concrete that is improperly batched, mixed, or held in the mixer too long.

The discharge hopper shall be fitted with a suitable device to facilitate obtaining of representative samples of concrete and delivering them to the ground for slump, unit weight and consistency tests. The Contractor shall furnish all necessary platforms, tools, equipment and personnel to assist the Engineer in obtaining samples.

The Engineer will conduct mixer performance tests in accordance with ASTM C94 to determine the uniformity of the mix when mixed to the specified or approved mixing time.

Should the mixer performance tests show that operations fail to result in the required uniformity of composition and consistency of concrete within the mixed batch, the Engineer may require repairs to the mixing plant or increase in mixing time until satisfactory results are achieved. If the repairs do not remove the defects from the mixing plant and the necessary increase in the mixing time could affect the production progress, the Engineer may order immediate removal of the defective mixing plant or provision of additional mixer capacity.

The mixer shall revolve at a uniform speed and shall not be charged in excess of the capacity recommended by the manufacturer. Excessive over-mixing, requiring addition of water to preserve the required consistency, will not be permitted.

Should any mixer at any time produce unsatisfactory results, its use shall be promptly

discontinued until it is repaired or replaced. Mixers shall be maintained in clean and good working condition at all times.

Each mixer shall have attached in a prominent place a. manufacturer's plate showing the capacity of a drum or pan in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

The batching and mixing plant shad be maintained free-of set concrete or cement and shall be clean before commencing mixing. The accuracy of calibration of every weighing device, water measuring device and admixture dispenser, shall be checked by the Contractor in the presence of the Engineer before carrying out 1) trial mixes, 2) before the first mixing of concrete for inclusion in the Works, 3) after each service or adjustment to the mixing plant and 4) in any case at least once per month.

Transit Mixers

Transit mixers may be used for transporting mixed concrete, subject to the requirements of the Specifications-and subject to approved measures to ensure that no water is added to the concrete in the transit mixers. Transit mixers shall not be charged in excess of capacity “recommended by the manufacturer on the name piate. Excessive over mixing requiring addition to water will not be permitted. The transit mixers shall be maintained in satisfactory operating condition and mixer drums shall be kept free of hardened concrete. Transit mixer blades shall be replaced when work down is more than 10% of their depth.

Vibrators for Concrete Compaction

Vibrators for vibrating concrete in structures shall be heavy duty, immersion type vibrators. They shall operate at frequencies and amplitudes of vibration of not less than six thousand impulses per minute and 1/32 inch respectively. For vibrator beads with a diameter greater than 5 inches, seven thousand impulses per minute and 1/64 inch amplitude for smaller vibrator heads. Vibrating equipment shall be fully capable-of obtaining satisfactory results and operating reliably and effectively with all types of specified concrete mixers. The Engineer will test vibrator frequency and amplitude from time to time for compliance with manufacturer's specifications. Prompt modification or replacement of vibration equipment will be required if it does not perform satisfactorily under all operating conditions. The use of surface vibration equipment or form vibration equipment will not be permitted unless specified or approved in each case-by the Engineer.

Refrigeration Heating Plant

Adequate refrigeration facilities shall be provided to ensure that the temperature of concrete when discharged from the mixers is sufficiently low to meet the temperature requirements.

Refrigerated mixing water, ice, precooled aggregate, air conditioned housing of the batching and mixing equipment, or any combination of these methods may be used to accomplish the precooling of the concrete subject to the approval of the Engineer. The design, type, size and

layout of all refrigeration equipment shall be subject to the approval of the Engineer but approval shall not in any way relieve the Contractor of the responsibility of placing concrete at temperatures at or below the specified limits.

WORKMANSHIP

Proportioning of Concrete

The proportions of all materials, except water to be used in each concrete placement, will be approved by the Engineer.

Concrete mixtures shall be composed of cementitious materials, water, fine and coarse aggregate, and water reducing set-retarding and air-entraining admixtures unless otherwise specified. Cementitious materials may consist of cement alone or cement and pozzolanic material. Epoxy resin shall be used to produce epoxy concrete/mortar when so ordered by the Engineer.

The design of the mixtures will be based on securing a plastic workable mixture both suitable for the specific conditions at placement and, when properly cured a product having durability, impermeability ’and strength in accordance with the requirements of the structures covered by these Specifications. For all concrete placements, the Contractor will be required to, handle and place low-slump mixtures in order to achieve high-quality concrete. In the placement of any single concrete lift, the Contractor may be required to handle and place several different concrete mixtures containing different maximum size coarse aggregate for producing higher quality, more durable exterior' concrete and for placement in highly reinforced and congested areas. The mixtures will contain no more cementitious material than needed to meet the structural design requirement. The use of pozzolanic material with OPC will result in a slow early rate of gain in concrete strength, and the Contractor shall have due regard for this when designing his formwork and planning his programme for formwork removal.

In general, ACI 211.1 will be followed for proportioning of concrete materials, except that the fine aggregate content may be reduced to avoid over-sanded mixtures. The Contractor shall provide all necessary equipment and plant to determine and control the amount of each material entering each batch. The proportions will be changed for varying conditions and the Engineer will instruct the Contractor whenever such a change is necessary. The Contractor will not be entitled to any additional payment for such changes.

The content of cementitious material will be total weight of cement plus pozzolanic material per cubic feet of concrete in the various concrete mixes and will be in the range from 13 lb to 35 lb, depending on the size and type of structure, durability requirements, and gradation of aggregate and on structural requirements. Pozzolanic material will be used as a cement replacement of up to 40% by weight of total cementitious material. The Engineer will order the quantity of pozzolanic material to be used. The Contractor shall provide mix design keeping in view the ranges of cement material and strength of concrete given on Drawings. The Engineer will review it and give approval on the basis of trial test results.

Aggregate shall be a mixture of coarse and fine aggregate. Coarse aggregate shall consist of one or more of the specified size ranges to produce a well graded aggregate mixture with the required nominal maximum size aggregate. The nominal maximum size aggregate to be used in the various parts of the Permanent Works shall be in accordance with the following unless otherwise directed or approved:

Sr.#	Nominal Maximum Aggregate Size	General Use
1	3 inches	Mass concrete and reinforced walls, slabs and piers -3 ft thick and more
2	1 1/2 inches	Walls, columns and slabs - 1.0 to 3 ft thick
3	3/4 inch	Thin walls, slabs, and beams - less than 1.0 ft thick; heavily reinforced concrete, and blinding layer concrete.

In no event will the nominal maximum size aggregate exceed one-fifth of the narrowest dimension between sides of forms; one-third the depth of slabs; nor three-fourths of the minimum clear spacing between, individual reinforcing bars or bundles of bars or post tensioned cable conduit.

The Contractor shall provide effective means such as pre-cooling of aggregates, refrigerating the mixing water, adding ice up to the full amount of added mixing water, or a combination of these or other methods, as necessary to maintain the temperature of concrete at or below the specified temperature as it is placed. The size of the ice particles shall be such that the ice is completely melted before the end of the mixing time for each batch.

Concrete Consistency

This Clause applies to concrete other than epoxy concrete. The quantity of mixing water, including ice, used in all concrete mixtures shall be determined by the Contractor. The quantity of mixing water, including ice, added by the Contractor shall produce concrete which has a consistency, as measured by the slump method (ASTM C143), conforming to the various limits specified below:

Sr. #	Specified Concrete Work	Slump (inch)			
		Specified Working Limit (inch)	Working Range (inch)	Margin for Occasional Inadvertent High Slump (inch)	Specified Rejection Limit (inch)
1	Mass concrete and reinforced concrete walls, slabs and piers more than 3 ft. thick	2”	1.0"to 2"	2"to 3”	3”
2	Walls, slabs and columns less than 3 ft. thick	3"	2" to 3”	3" to 4”	4”
3	Blinding Concrete	4"	3” to 4"	4”to 5"	5"
4	Concrete in underground	5"	4”to 5”	5" to 6”	6"

The Engineer will reject concrete with a slump equal to or greater than the rejection limit as measured by the Engineer at the point of placement. Concrete consistency shall be uniform from batch to batch. The Contractor shall vary the quantity of mixing water from batch to batch if necessary to offset variation in free moisture content or grading of the aggregates Water shall not be added to compensate for stiffening of concrete held in the mixer too long or for delays in placement.

The specified working limit is the permitted upper limit of a range of slumps selected to provide the required concrete properties including the ability to be readily compacted by the specified vibration equipment during concrete placement. The slump of concrete as placed shall average approximately 3/8 inches less than the specified working limit. The 1 inch margin between the working limit and the rejection limit is provided for occasional inadvertent batches, which may exceed the working range. Batches of concrete with slumps exceeding the working limit, but within the inadvertency margin, will be rejected if the frequency of their occurrence is such that the average of three successive rests exceeds the working limit by more than 0.5".

Concrete that has been rejected for failure to meet slump limits shall not be used in the Permanent Works.

Sampling and Testing of Concrete

During concrete production, the Engineer will routinely test the concrete for compliance with specified requirements In general, one set of four cylinders will be made for each 1000 cubic feet, or a fraction thereof, of each class of concrete placed in a shift or from each day's placement as appropriate. The Contractor shall provide a suitable device to sample the discharge from each mixer and shall provide all help that may be required by the Engineer to carry the samples to the laboratory.

Test, specimens will be made by the Engineer in accordance with the requirements of ASTM C31.

Test specimens will be tested by the Engineer in accordance with the requirements of ASTM C39 for compressive strength, to develop a comprehensive and historical record of mixtures, strength development and the degree of quality control achieved. In addition, the Engineer shall also determine the air content and density of the fresh concrete samples from which a set of specimens are cast.

Where there is evidence that concrete production and placement has resulted in work that .does not meet the quality requirements of these Specifications, core boring will be ordered by the Engineer in accordance with ASTM C42. In the event that examination and tests on samples removed from the structure show that the concrete does not conform to these Specifications, measures as prescribed by the Engineer shall be taken by the Contractor to correct the deficiency. The entire cost of testing and corrective action shall be borne by the Contractor.

Concrete samples containing aggregate particles larger than 1.5" will be wet-screened to remove

such particles before making the slump test or casting 6 inch by 12 inch cylindrical compression test specimens.

Preparing for Concreting

Before placing concrete, the Contractor shall ensure that:

► The surface of the previously placed concrete or the foundation is clear of ail oil, loose fragments of rock, earth, mud, timber, pieces of tie-wire or any other foreign material, running or standing water, dust, etc.

► Excavated surfaces on which concrete is to be placed shall consist of undisturbed in- situ material. They shall be compacted if so directed by the Engineer.

► Where concrete is to be placed on compacted fill, the compacted fill shall be extended beyond the foundation line by a distance sufficient to ensure that all fill below the foundation surface is compacted to the specified degree. The fill shall then be trimmed to the foundation level shown on the Drawings. The surfaces shall be re-compacted if so directed by the Engineer.

► All reinforcement is in its correct place, well tied and fitted with spacer blocks to maintain correct cover, and is clean.

► All formwork is well supported, made to dimensions shown on the Drawings, erected to the specified tolerances, cleaned, oiled, inspected and accepted by the Engineer.

► All necessary tools and plant, e.g. vibrators, and all necessary materials for protection and curing of concrete are available and in working order.

► All surfaces against which concrete is to be placed are wet.

► Concrete materials are within specified temperatures.

Embedded Pipes and Other Items

Pipes and other items designed to be embedded in concrete structures shall, wherever practicable, be built into the structure as indicated on the Drawings or as directed by the Engineer as work proceeds, having been installed and connected to the remainder of the system to ensure proper fit prior to the start of any concreting.

When that procedure cannot be adopted, holes shall be formed or conduits built-in for such items to allow them to be installed later. Such holes shall be of size and shape sufficient to' permit proper placing and compacting of concrete or grout. The surfaces of the holes shall be treated to produce a bonded surface where so directed by the Engineer.

All items to be built-in shall be securely supported in their correct position to prevent movement or damage during building-in. in particular, any pipe with flanged joints shall not the concreted-in until its accurate fit with other pipe-work has been checked and it has been secured in position.

Concrete used for building-in shall be of the same grade, as the surrounding concrete, except that the mix shall also incorporate an approved expanding additive used with due regard to the manufacturer's instructions. Cement/sand mortar or cement grout, if used, shall also incorporate an approved expanding additive. Concrete, mortar and grout shall be placed and compacted by the methods to be approved by the Engineer.

Any air or water lines or other materials to be embedded in structures, shall be firmly and securely fastened in place and thoroughly clean and free of oil and other foreign matter such as loose coatings of rust, paint, scale or mortar prior to embedment. After embedment and upon completion of their use, they shall be backfilled with concrete or grouted as directed by the Engineer.

Fixing and Cover to Reinforcement

All reinforcement shall be securely and accurately fixed in the positions as shown on the drawings using approved spacer blocks or chairs. All intersections of bars shall be secured with soft iron wire, the ends ’turned into the body of the-concrete. The Contractor shall ensure that all reinforcement is maintained in correct position at all times, particular care being taken during placing of the concrete.

Concrete cover to reinforcement, unless shown on the Drawings, shall be maintained in accordance with the following:

Sr.#	Type	Cover
1	Bottom of foundations and footings	4"
2	Backfilled surfaces, water-retaining surfaces and surfaces subjected to submergence or rapid flow	4“
3	Other exterior walls, beams, slabs and columns:	
	Elements greater than 3 ft thick	3”
	Elements 2 to 3 ft thick	2”
	Elements less than 2 ft thick	1 ¼
4	Interior beams, girders and columns	$1^1/_2$"
5	Interior walls and slabs	1"

Top reinforcement in slabs shall be maintained in position with the use of chairs, sized and spaced to provide adequate support, and fixity for the reinforcement. The reinforcement closest to the form shall be positioned parallel to the direction of flow in water passages.

No part of the reinforcement shall be used to support formwork, access ways, working platforms, or the placing equipment or for the conducting of an electric current.

Design and Layout of Formwork

The Contractor shall be responsible for the adequacy of the design and safety of formwork. The type, size, shape, quality and strength of all materials shall be subject to approval by the Engineer.

On formwork for external faces which will be permanently exposed and where finish F2 or F3 is designated, care shall be taken to construct the form in such a manner that horizontal and vertical joints are well matched and are continuous across the entire surface of the structure. Special attention shall be paid to such places as points of bifurcation in a structure, widening or narrowing of a structure, where horizontal members meet with vertical members and where the shape of a structure changes. Joints in formwork shall be sanded or ground to remove imperfections if necessary. Joints shall be mortar-tight and sufficiently strong to withstand loads of concrete and equipment. Headed nails shall not be used.

Curved surfaces shall be smooth and construction in chorded lengths shall not be allowed except when permitted by the Engineer. Forms for warped surfaces shall conform accurately to the specified curved surfaces, which shall have been dimensioned at several sections. Intermediate sections shall be interpolated as necessary and the forms shall be constructed so that the curvature will be continuous between sections. Where necessary to meet requirements for curvature, the form lumber or plywood shall be built up of laminated splints cut to make tight, smooth form surfaces.

All exposed joints, edges and external corners shall be chamfered $^{3/4}$" x $^{3/4}$" except when shown otherwise on the Drawings. Internal corners shall be filleted as indicated on the Drawings or as directed by the Engineer.

Forms for external concrete surfaces shall not be constructed continuous but shall be removed and reset for each placement. Form sheathing shall not overlap previously placed hardened concrete by more than 1 inch and shall be drawn tight against the hardened concrete so that an offset at the construction joint and loss of mortar are avoided.

Erection of Formwork

All formwork shall be soundly constructed, true to grade and line, firmly supported, adequately strutted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather.

Faces of formwork in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from standing water, dirt, shavings, and chippings, tying wire or other foreign matter. Joints shall be sufficiently watertight to prevent the escape of mortar or the formation of fans or other blemishes on the face of the concrete.

Except where the surface is subsequently to be rendered, formwork in contact with the concrete shall be treated with an approved non-staining form mould oil to prevent adherence of the concrete. Care shall be taken to prevent the oil from coming in contact with reinforcement or with concrete at construction joints. Surface retarding agents shall not be used unless specified.

Openings for inspection of the inside of the formwork, for the removal of water used for washing down and for placing concrete shall be provided and so formed as to be easily closed before or during placing concrete. Before placing concrete, all bolts, pipes or conduits or any other fixtures which are to be built-in shall be fixed in their correct positions, and cores and other devices for

forming holes shall be held fast by fixing to the formwork or otherwise.

For all surfaces where quality of finish is of paramount importance, the Contractor shall cast samples, to actual scale and dimensions or a part thereof as may be decided by the Engineer, to ensure that the desired quality of finished surface has been achieved. Concreting shall not commence before approval of the specimen sample.

Removal of Formwork

Formwork shall be so designed as to permit easy removal without resorting to hammering or levering against the surface of the concrete.

The periods of time elapsing between the placing of the concrete and the striking of the formwork shall be as approved by the Engineer after consideration of the loads likely to be imposed on the concrete and shall in any case be not less than the periods shown in the following table:

Minimum Time for Removal (for Concrete using Ordinary Portland Cement)

Sr.#	Position	Normal Weather (Days)	Cold Weather (Days)
1	Beam Sides, Walls and Columns	1	2
2	Slab and Beam Soffits	14	21

Minimum times shall be determined by the Engineer when pozzolanic materials are used.

Cold weather is defined as the situation where either or both of the following conditions exist at the Site:

► The air temperature at the time considered is below 2°C (35°F).

► The mean daily air temperature over three or more' successive days has dropped below 5°C (40’F).

► Normal weather is at all other times.

Where soffit formwork is constructed in a manner-that allows the removal of the majority of the formwork' and. the retention, during and after such removal, of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may, with the agreement of the Engineer, remove the formwork at the earlier times listed above provided that the props are left in position and are not disturbed during removal of the majority of the formwork.

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

Transporting Concrete

Concrete shall be conveyed from mixer to its place on the Permanent Works as speedily as possible by ways and means, which will prevent segregation or drying out and ensure that the concrete is of the required consistency at the time of placing.

Buckets, belt conveyors, chutes or other similar equipment will be permitted for conveying concrete subject to approval of the proposed system by the Engineer.

All conveying equipment and methods shall be designed for and capable of handling concrete of all specified aggregate sizes and slumps, including low-slump concrete.

Clear indication shall be provided for the identification of different mixes of concrete and their destination, and each consignment shall be accompanied by a copy of the batching plant printed record as specified as per specification. '

Placing Concrete

All concrete shall be placed so as to produce a set concrete that is hard, durable, dense, free from honeycombing, formwork irregularities and other surface blemishes.

At least sixty calendar days before placing concrete in any major structure, the Contractor shall submit to the Engineer for his approval details of his proposed construction procedures including a description of the methods of concrete placement. .Approval of construction procedures and methods of placement will not relieve the Contractor of his responsibility for their adequacy and he shall remain solely responsible for satisfactory construction of the Permanent Works.

For each concrete placement, the Contractor shall provide the Engineer with written notice, a drawing and a pre-placement checkout sheet signed by the Contractor's appropriate supervisory personnel that demonstrate that foundation preparation, construction joint cleanup, formwork, installation of reinforcing steel, blockouts and all embedded items for the placement have been completed according to the Drawings or as specified. Before Concrete placement is permitted, each item on the checkout sheet shall be initialed by the Engineer showing that the item has been inspected and is ready to receive concrete. Concrete placement will not be permitted when, in the opinion of the Engineer, conditions prevent proper placement consolidation, finishing and curing.

Concrete mixed in stationary mixers and transported by non-agitating equipment shall be placed within thirty minutes of mixing. When an agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within 1% hours after introduction of cement to the aggregates except that, when the temperature of the concrete exceeds 21°C (70°F), the time shall be reduced to 45 minutes. The concrete shall be placed within 20 minutes after it has been discharged.

Concrete shall be carefully placed in horizontal layers not exceeding 17 ft thick. Concrete shall not be allowed to slide or flow down sloping surfaces, except in underground galleries, but shall be placed in its final position from skips, trucks, barrows, down pipes or other placing machine or

device or, if this is impossible, it shall be shoveled into position with care being taken to avoid separation of the constituent materials. Concrete placed in horizontal slabs from barrows or other tipping vehicles shall be tipped into the face of the previously placed concrete.

Concrete dropped into place shall be dropped vertically. It shall not strike the formwork between the point of its discharge and its final place. Concrete shall not be dropped freely through a height greater than 5 ft. Chutes and conveyor belts shall be so designed that there is no segregation or loss of mortar and shall be provided with a vertical tapered down pipe, or other device, to ensure that concrete is discharged vertically into place.

Where a lift of concrete is built up in a series of layers, each layer shall be properly merged into the preceding layer before initial set takes place.

When pumps are used, the end of the supply pipe shall be arranged so as to avoid segregation. Mortar or water used at the beginning or end of a run shall be discharged outside the formwork concrete abuts against earth or other materials liable to become loose or to slip, the Contractor shall take steps to prevent any such loose material falling onto the surface of the ' concrete.

Lift Height and Time between Placement

The permissible depth of concrete, placed in one lift and the minimum time elapsing between the placing of successive lifts shall be as follows unless otherwise shown on the Drawings or directed by the Engineer.

Sr. #	Location	Maximum Depth of Concrete Placed in One Lift	Minimum Time Elapsing between Placing of Successive Lifts
1	Concrete in base slabs and in walls, columns and piers whose thickness does not exceed 3 m (10 ft)	3.0 m (10 ft)	120 hr
2	Gate guide blackouts	4.5 m (15 ft)	7 *hr*
3	All other concrete	1.5 m (5 ft)	120 hr

Elapsed Time between Adjacent Pours

The elapsed time between adjacent pours shall not be less than 14 days or as otherwise directed by the Engineer.

Differential Height between Adjacent Monoliths Pours

The maximum permissible difference in height between adjacent monoliths shall be 20 ft (6m) or as directed by the Engineer.-

When slabs or beams are monolithic with supporting walls or columns, there shall be a construction joint near the top of the wall or column. The position of the joint shall be subject to

the approval of the Engineer.

Placing Temperature

Concrete

Unless specified otherwise for particular parts of the Works, the temperature of the concrete when delivered to the forms shall be as low as practicably can be produced but in no case at a temperature in excess of the requirements specified below for different types will be of concrete sections.

Thin and Moderate Sections

This type covers sections 10 ft and less in thickness when screened and/or formed on both faces, and 5 ft and less in thickness when one face is formed and the other is placed against earth, rock or concrete. The maximum temperature allowed shall be 21°C (70°F).

Heavy Sections and Mass Concrete

This type covers sections with dimensions greater than those given above for thin and moderate sections. Concrete for such sections shall have a temperature of not more than 13°C (55°F) when placed.

Concreting in Hot Weather

All hot weather concrete shall comply with the requirements of ACI 305R. In hot weather, the Contractor shall take steps to ensure adequate protection of concrete work. Hot weather is defined as any combination of high air temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise resulting in abnormal properties. To that end the Contractor shall provide sun shades over stockpiles of aggregates, batching and mixing plant, cement silos, and mixing water tanks and pipelines; insulate facilities and, in addition, shall carry out one or more of the following procedures which shall be submitted to the Engineer for approval.

► Shade and/or wet the outside of the formwork.

► Apply a fine moisture (fog) spray of clean water at a temperature not exceeding 25°C (77°F) in order to cool and moisten the surrounding air and the sub-surface, to cool the formwork and reinforcement, to lessen rapid evaporation from unformed concrete surfaces and to keep concrete surfaces cool.

► Refrigerate the mixing water.

► Add chip, crushed, tube, or other forms of ice up to the full amount of added mixing water.

If, in the opinion of the Engineer, the maximum temperature reached by the concrete during

Hydration could nevertheless damage the finished work, he may order:

- ► avoiding the placement of concrete during the hottest part of the day, or
- ► placement only at night, or
- ► an increase in the minimum period between lifts, or
- ► a combination of these.

Concrete Placed in Water

The Contractor shall not place any concrete in water without prior permission of the Engineer.

Concrete shall not be placed in running water nor shall concrete be allowed to fall through water. The methods and equipment used shall be subject to the Engineer's prior approval. Use of concrete buckets will not be permitted for under water placement of concrete.

When approved, concrete shall be placed in water only by means of a bottom opening watertight box or a tremie of a type approved by the Engineer. Bottom opening boxes shall not be opened until they are resting on the surface on which the concrete is to be placed and the discharge ends of tremies shall always be kept buried within freshly placed concrete and the shaft kept full of concrete to a point above the water surface. Placement shall proceed without interruption until the concrete has been brought to the required height. The tremie shall not be moved horizontally during a placing operation, and a sufficient number of tremies shall be provided so that concrete does not have to flow horizontally a distance of more than 10ft. (3 m).

Compaction

All concrete, other than blinding concrete, shall be compacted with power driven, immersion type vibrators supplemented by hand spading and tamping.

Vibrators for vibrating concrete in structures shall be heavy duty (immersion type vibrators. They shall operate at frequencies and amplitudes of vibration of not less than six thousand impulses per minute and 1/7" respectively, for vibrator heads with a diameter greater than 5”; and seven thousand-impulses per minute and 0.5mm amplitude for smaller vibrator heads. Vibrating equipment shall be fully capable of obtaining satisfactory results and operating reliably and effectively with all types of specified concrete mixes except RCC. The Engineer will test vibrator frequency and amplitude from time to time for compliance with manufacturer’s specifications. Prompt modification or replacement of vibration equipment .will be required if it does not perform satisfactorily under all operating conditions. The use of surface vibration equipment or form vibration equipment will not be permitted unless specified or approved in each case by the Engineer.

Vibrators shall be inserted into the un-compacted concrete vertically and at regular intervals such that the radius of action overlaps that of the previously vibrated concrete. A layer shall not be covered with a succeeding layer until it has been thoroughly vibrated as specified. Where the

un-compacted concrete is in a layer above freshly compacted concrete, the vibrator shall be allowed to penetrate vertically for about 4 inch into the previous layer. In no circumstances shall vibrators be allowed to come into contact with the formwork, nor shall they be withdrawn quickly from the mass of concrete, but shall be drawn back slowly so as to leave no voids. Internal-type vibrators shall not he placed in the concrete in a random or haphazard manner, nor shall concrete be moved from one part of the work to another by means of the vibrators. Care shall be taken properly to vibrate concrete placed in contact with previously placed concrete or embedded parts.

The duration of vibration shall be limited to that required to produce satisfactory compaction, without causing segregation. Compaction of the concrete by vibration shall be such as to produce a concrete that has the maximum practicable density, is free from pockets of coarse aggregate and entrapped air and makes complete contact with the foundation, previously placed hardened concrete, embedded items and the formwork.

Blinding concrete shall be compacted by hand spading and tamping.

Curing of Concrete

Concrete shall be cured by approved methods. Means shall be provided for protecting the newly cast surface from the effects of sunshine, drying winds, frost, rain, running water or mechanical damage. The Contractor shall submit proposals for the means of curing that he proposes to use to the Engineer for approval.

The curing shall be maintained for a continuous period of at least 14 days or until covered by the next lift or as otherwise approved by the Engineer.

If, during the specified minimum period of curing, the-surface temperature of the concrete falls below 10°C (50°F), the period of curing shall be extended to allow the concrete to reach sufficient maturity. The period of extension shall be as approved by the Engineer.

The curing protection shall be applied as soon as practicable after completion of placing and shall include one or more of the following methods as may best suit the circumstances:

► water sprays in continuous operation;

► covering with Hessian or similar absorbent material, or sand, kept constantly wet;

► after thorough wetting, covering with a layer of waterproof fabric kept in contact with the concrete surface;

► keeping the formwork in position;

► applying an approved non-staining liquid curing membrane conforming to ASTM C309, Type 2, Class B. The liquid shall be applied to formed surfaces immediately after stripping the formwork, except to those areas requiring surface repair.

Where the use of a liquid curing membrane is likely to spoil the finished appearance of an

exposed surface, the Contractor shall not use this form of curing. The Engineer may also prohibit the use of liquid curing membrane where potable water will be stored.

Liquid curing membrane shall be applied in compliance with the instructions of the manufacturer and on rough surfaces the rate shall be increased as necessary to obtain the required continuous membrane. Liquid curing membrane shall not be used on concrete where a bond is required.

The underside of deck slabs and surfaces to be backfilled shall be cured with liquid compound.

Care shall be taken to ensure coverage of corners and edges. Equipment for applying liquid curing membrane shall be of the pressure tank type with provision for continual agitation of the contents during application. All operations by the Contractor on membrane-cured concrete shall be such as to avoid damage to the membrane for a period of not less than 27 days. Any membrane that is damaged or that peels from concrete surfaces within 27 days after application shall be immediately repaired by methods to be approved by the Engineer.

All repairs done by epoxy concrete or epoxy mortar shall be protected from rain or seepage water for at least 12 hours and from all types of traffic for a period of 24 hours after placement.

COLD WEATHER CONCRETING

General

Contractor should plan to protect fresh concrete from freezing and to maintain temperatures above the designated minimum for the required time after placing, well in advance of expected freezing temperatures. All equipment and materials necessary should be at the work site before the first frosts are likely to occur. No concreting will be done without prior arrangement of protective measures against freezing point.

In the fail, from the time of the first frost until the mean daily temperature at the job site falls below 40°F (4.5°C)* for more than 1 day in a row, all concrete should be protected from freezing for at least the first 24 hr after it is placed. It should be similarly protected from freezing in the spring, after the mean daily temperature rises above 40°F (4.5°C) for more than 3 successive days. Concrete so protected will be safe from damage by freezing at an early age and, if properly cured, will be unimpaired in ultimate durability. Obviously, protection from freezing for 24 hr does not assure development of the required strength. This is particularly so when considerably colder weather is in prospect. Then, curing and protection should continue long enough - and at a temperature sufficiently above freezing - to produce the strength required.

During colder weather when mean daily temperatures are generally below 40°F (4.5°C), concrete should be placed at a temperature not lower than shown Table 8.1 for the indicated class of concrete. Moreover, it should be maintained at no less than that temperature for the length of time indicated in Table 6.2. This period depends on the type or amount of cement used or on whether an accelerator is added, and whether or not strength development is critical.

TABLE 5.1 - EFFECT OF TEMPERATURE OF MATERIALS ON TEMPERATURE OF VARIOUS FRESHLY MIXED CONCRETES

Line			Very thin sections	Thin sections		Moderately massive sections	Massive Sections	
1	Approximate maximum size rock, in. (mm)		(19)		114(38)	3(76)		6 (152)
2	Approximate percent sand		40		35	30		25
3	Weight of sand for batch. Lb (kg)		1200 (540)		1100 (480)	1000 (450)		900 (410)
4	Weight of coarse aggregate for batch. Lb (kg)		1800 (820)		2100 (950)	2400 (1090)		2700 (1220)
5	Weight of water for batch (total), lb (kg)		300 (135)		250 (115)	200 (90)		150 (70)
6	Weight of cement for batch. Lb (kg)		600 (270)		500 (225)	400 (180)		300 (135)
7	Minimum, temperature of fresh concrete as placed deg F (deg C)		55 (13)		50(10)	45 (7)		40 (4.5)
8	Minimum temperature fresh concrete as	Above 30 F (-1 C)	60 (.15.5)	55 (13)		50 (10)	45(7)	
9	Mixed, for weather*	0 to 30 F	65 (17)	60 (15.5)		55(13)	50 (10)	
10	Deg F (deg C)	(-18-1 C) Below 0 F (- 18 C)	70 (21)	65 (17)		60(15.5)	55 (13)	

			Very thin sections				Thin sections				Moderately massive				Massive Sections			
11	Minimum temperature Of materials	Cement	35 (1-5)	15	15 (-9-5)	-10	35	15 (-9.5)	15 (-9-5)	-10	35	15	15	-10	35	15 (-9.5)	15 (-9.5)	-10
12	To produce indicated temperature	Added water	140	(- 9.5)	140	(-	-1.5	140	140	-23.5	-1.5	(.5)	(	(	-1.5	140	140 (60)	(23.5)
13	Of freshly mixed concrete. Deg	Aggregate Waters:	-60	140	-60	23.5)	140	-60	-60	140	140	140 (60)	9.5)	23.5)	140	-60	40 (4.5)	140
14	F (deg C)	Sand	40 (4.5)	-60	51 (10.5)	140	-60	95	47	-60	-60	99 (35)	140	140	-60	105 (40.5)	40 (4-5)	(60) '
15		Coarse aggregate	40	93	51	-60	37	-35	-8	57	35 (1-5)	99 (35) 15	-60	-60	34	105	40, (4-5)	49
			-4.5	-34	-10.5	63	-3	95	47	-14	35	.(- 9.5)	43	53	(D	-40.5		-9.5
			40	93	51	-17	37	-35	-8	57	(1-5)		-6	-12	34	15 (“9.5)		49
			(4-5)	-34	-10.5	63	-3	15 (- 9.5)	47	-14	35		43	53	-1			-9.5
				15		-17	37		(8) .	57	(1.5')		-6	-12	34			49
				(“ 9.5)		63	-3			-0.14			43	53	-1			(9.5)
						-17							-6	-12				
Line			**For thin concrete sections**								**For massive concrete sections**							
16	Temperature mixed		60	65	65	70	55	60	60	65	50	55 I 55		60	45	50	50	55
	concrete, deg F (deg C)		-15.5	-18	-18	(21) .	-13	-15.5	-15.5	-17	-10	(13) (13)		-15.5	-8	-10	-10	-13
17	Maximum allowable gradual drop in temperature throughout first 24 hr after end of protection, deg F (deg C)		50 (28)				40 (22)				30 (17)				20 (11)			

* For colder weather, a greater margin in temperature is provided between concrete as mixed and required minimum temperature of fresh

concrete in place.

* Cement temperature has been taken the same as that of average air and of unheated materials
* The amount of free water in the sand has been assumed equal to one-quarter the amount of mixing water
* Coarse aggregate is assumed to be surface dry and free of ice

Temperature of fresh concrete = $\frac{0.22(TaWa + TcWc) + TwWw + TaWwa}{0.22(Wa + Wc) + Ww + Wwa}$

T	=temperature
W	= weight
a	= aggregate
c	=cement added water
wa	= aggregate water
0.22	= specific heat of cement and aggregate

During colder weather when mean daily temperatures are generally below 40°F (4.5°C), concrete should be placed at a temperature not lower than shown in Table 6.1 for the indicated class of concrete. Moreover, it should be maintained at no less than that temperature for the length of time indicated in Table 6.2. This period depends on the type or amount of cement used or on whether an accelerator is added, and whether or not strength development is critical.

Table: 5.2 Protection Recommended for Concrete Placed in Cold Weather*

Service Category		Protection recommended at Temperature indicated in Table: 6.1 (days)			
		For durability only		For safe strength	
		Type I or II cement •	Type III, accelerator, or extra sack cement	Type I of II cement	Type III, accelerator, or extra sack cement
1	No load, no exposure	2	1	2	1
2	No load exposed	3	2	3	2
3	Partial load, exposed	3	2	6	4
4	Full toad, exposed	3	2	-	

* Weather likely to have a mean daily temperature less than 40°F.

The actual temperature of concrete determines the effectiveness of protection, regardless of air temperatures or whether the objective is durability or strength. Comers and edges of concrete are most vulnerable to freezing and usually are more difficult to maintain at the required temperature; thus their temperatures should be measured to evaluate and verify the protection, provided.

Heated enclosures, if used, must be strong and windproof. Otherwise, proper temperatures of corners, edges, and thin sections of concrete may not be obtained despite high fuel - consumption. Heating units should not be permitted to locally heat or dry in concrete. Moreover, strict fire prevention measures should be enforced. Concrete at any age can be damaged by fire, but at a very early age it may also be damaged by freezing before new protection can be provided.

Concrete should not be placed at high temperatures. It should always be placed at the lowest allowable temperatures. .

In general, winter concreting practices must be adequate to:

► Prevent damage to concrete from freezing and thawing at an early age. The degree of saturation of freshly-placed -concrete, which has no access to an external source of water, will be reduced as the concrete hardens and water is used in the hydration process. Under such

conditions, the time at which the degree of saturation becomes reduced below that level which would cause damage by freezing corresponds roughly with the time at which the concrete attains a compressive strength of 500 psi (36 kg per sq cm). At temperatures of 50°F (1CPC) most well-proportioned concrete will reach this strength sometime during the second day.

► Allow the concrete to develop whatever strength is necessary in its service category to assure safe removal of forms for prompt reuse, safe removal of shores and restores, and safe loading of the structure when desired during and after construction.

► Maintain curing conditions, which will foster normal strength development without excessive heat, and without critical saturation of the concrete at the close of the protection period.

► Limit rapid temperature changes, particularly before strength has developed sufficiently to withstand temperature stresses. Sudden chilling of concrete surfaces or exterior members in relation to interior structure can promote cracking to the detriment of strength and durability. At the end of the required period, protection should be removed in such a manner that the drop in temperature of any portion of the concrete will be gradual and will not exceed, in 24 hr.

Heating of Materials

To assure freedom from freezing until protection can be established, the temperature of concrete as placed should not be less than that recommended. Appreciably higher concrete temperatures do not afford proportionately longer protection against freezing because heat loss- is more rapid with the greater temperature differentials. Furthermore, higher temperatures require more mixing water, cause slump loss and sometimes-quick setting, and increase thermal shrinkage. Rapid moisture loss from hot exposed concrete surfaces may cause plastic shrinkage cracks. Therefore, the temperature of fresh concrete, as placed, should be kept as close to the suggested minimum temperatures as practicable.

It is not difficult to maintain the concrete as mixed at temperatures of not more than 10°F (5.5°C) above the minimums recommended. Temperatures as high as 20°F (11°C) above these values should be rare. It is difficult to heat aggregates uniformly or to a predetermined temperature, but the temperature of mixing water can be adjusted readily by blending hot and cold water to maintain the temperature of concrete within a range of 10°F (5.5°C).

As the air temperature drops, more ingredients must be heated to produce freshly mixed concrete of the desired minimum temperature. During colder periods, the concrete temperature should be raised to offset heat lost in the interval between concrete mixing and placing, as recommended. Lower minimum temperatures of concrete as placed are recommended as the concrete becomes more massive because the more massive the section in which concrete is

placed, the less rapidly it loses heat. In massive work the concrete is, therefore particularly benefited by low initial temperatures.

For air temperatures above 30°F, when aggregates are free of ice and frozen lumps, the desired temperature of the concrete can usually be obtained by heating only the mixing water. For air temperatures below 30°F it is usually necessary to heat the aggregates, to temperatures shown in Table 6.1. Table 6.1 indicates that heating aggregates to temperatures higher than 60°F is rarely necessary with mixing water at 140°F (60°C). If the coarse aggregate is dry and free of frost, ice, and lumps, adequate temperatures of fresh concrete can be obtained by increasing the temperature of only the sand, which will seldom have to be higher than about 105°F (39.5°C), if mixing water is 140°F (60°C).

Mixing water should be heated under such control and in sufficient quantity to avoid appreciable fluctuations in temperature from batch to batch. To avoid the possibility of flash set when either aggregate or water is heated to a temperature in excess of 100°F, water and aggregate should come together first in the mixer in such a way that the high temperature of one or the other is reduced before cement is admitted. If the mixer is loaded in this sequence, water temperature up to the boiling point may be used, provided aggregate is cold enough to reduce temperature of the mixture of water and aggregate to appreciably less than 100°F (37°C). If loss of effectiveness of the air-entertaining admixture is noted due to hot water, the admixture must be placed in the batch after the water temperature has been reduced.

Heating of aggregates should be such that frozen lumps, ice, and snow are eliminated and overheating is avoided. At no point should aggregate temperature exceed 212°F (100°C); the Average temperature of aggregate for an individual batch should not exceed 150°F (65.5°C). Either of these temperatures is considerably higher than in necessary for obtaining desirable temperature of freshly mixed concrete. Materials should be heated uniformly since considerable variation in their temperature will noticeably vary the water requirement and slump of the concrete.

Steam in pipes is recommended for heating aggregate, but for small jobs aggregates may be thawed by heating them carefully over culvert pipe in, which fires are maintained. When aggregates in stockpiles, cars, or trucks are thawed or heated by steam in pipes, exposed surfaces of aggregate should be covered with tarpaulins as much as practicable to maintain a uniform distribution of heat and to prevent formation of frozen crusts, if steam is confined in a pipe-heating system,, difficulties from variable moisture in aggregate are avoided. Steam jets liberated in aggregate will cause troublesome moisture variation.

Preparation before Concreting

Before any concrete is placed, all ice, snow, and frost should be complete removed and the

temperature of all surfaces to be in contact with the new concrete should be raised to as close as may be practical to the temperature of the new concrete that is to be placed thereon No concrete should be placed on a frozen sub-grade or on one that contains frozen materials Where concrete is to be placed over permanently frozen ground, subgrade material must be thawed deep enough to insure that it will not freeze back up to the concrete during the required period of protection, or it must be covered with a sufficient depth of dry granular material.

Protection

Arrangements for covering, insulating or housing newly-placed concrete should be made in advance of placement and should be adequate to maintain, in all parts of the concrete, the temperature and moisture conditions recommended herein for winter curing temperatures and methods.

Since most of the heat of hydration of the hardening cement is developed during the first 3 days, no heat from outside sources is required to maintain concrete at correct temperatures if heat generated in the concrete is suitably conserved. This heat may be conserved by use of insulating blankets on unformed surfaces and by insulated forms where repeated reuse of forms is possible. Temperature records will reveal the effectiveness of different amounts or kinds of insulation or of other methods of protection, for various types of concrete work under different weather conditions. Appropriate modifications and selections can be made accordingly Methods for estimating temperatures maintainable by various insulation arrangements under given weather conditions are available. For successful use, and efficient reuse, commercial blanket or bat insulation must be adequately protected by means of tough, moisture proof cover martial from wind, rain, snow, or other wetting. Moreover, it must be kept in close contact with concrete or form surfaces to be effective.

Enclosures for heating may be made of wood, canvas, gypsum wallboard, fiber insulation board, plywood, waterproofed paper, plastic sheeting, or other suitable materials, as long as they are reasonably tight and safe for wind and snow loading. Such temporary housings are inherently difficult to make fire resistant and fire is an ever-present hazard. Exhaust steam is safest from this standpoint; airplane heaters located outside the enclosure and blowing hot air into it are perhaps second best. Open fires and salamanders should be avoided; they do not provide circulation obtainable with exhaust steam jets or airplane heaters. Moreover, exposure to the high carbon dioxide contents of open fires during the first 24 hr may seriously weaken concrete at the surface. If such heaters are used, they should be blocked up to avoid damage to the slab on which they are resting and vented to the outside to prevent carbonation damage to the exposed concrete surfaces. Adequate fire-fighting apparatus should be on the job at all times to insure continuous operation of heating units and protection from fire hazards.

During placement of unformed concrete, tarpaulins or other readily movable coverings

supported on horses or framework should follow closely, the placing of the concrete so that only a few feet of finished slab are exposed to outside air at any time. Such tarpaulins should be arranged so that heated air could be circulated freely on both top and, except for pavements, bottom of the slab. Layers of insulating material placed directly on the concrete are also effective in inhibiting freezing.

Housings and enclosures should be left in place for the entire period of protection specified except that sections may be temporarily removed as required to permit placing additional forms or concrete, provided they are replaced as soon as the form or concrete is in its final position and the uncovered concrete is not frozen, and provided time lost from the required period of protection is made up at the required temperature before protection is discontinued and removed.

Temperature Records

Inspection personnel should keep a record of the date, hour, outside air temperature, temperature of concrete as placed, and weather (calm, windy, clear, cloudy etc.). The record should include temperatures at several points within the enclosure and on the concrete surface, corners, and edges in sufficient number to show highest and lowest temperatures of the concrete. Thermometers embedded in the concrete surface are ideal, but satisfactory accuracy and greater flexibility of observation can be obtained by placing the thermometer against the concrete under a temporary cover of heavy insulating material until it registers a constant temperature. Maximum and minimum temperature readings in each 24-hr period should be recorded. Data recorded should clearly, show the temperature history of each part of the concrete. A copy of the temperature readings should be included in permanent records of the job.

Cold Weather Curing

It is essential that new concrete in all-weather be protected from drying out so that adequate hydration may be achieved. This requirement normally means that positive measures must be taken to prevent excessive evaporation of moisture from concrete. During the winter, however, when the air temperature is below 50°F (10°C), atmospheric conditions are most parts of the country are such that undesirable drying will not occur. Furthermore, new concrete is vulnerable to freezing in a saturated condition. Therefore, all concrete should be allowed to undergo some drying before being exposed to freezing temperatures.

Although concrete exposed to cold weather is not likely to dry at an undesirable rate, particular attention should be given to concrete that is undergoing the protection required by Table: 6.2. As long as forms remain in place, surfaces adjacent to the forms are adequately cured in cold

weather. But unformed surfaces, particularly finished floors, are prone to rapid drying in a heated enclosure. When concrete warmer than 60°F (15.5aC) is exposed to air at 50°F (10DC), it is essential that positive measures be undertaken to prevent drying. The preferable technique is the use of steam for both heating and to prevent excessive evaporation. If a curing compound is to be used it should not be applied until the use of steam has been discontinued. When dry heating is used the concrete should be covered with an approved impervious material or “curing” compound, or it may be water cured. Water curing is the least desirable method since in extremely cold weather it produces icing problems wherever water runs out of the enclosures or wherever there is a poor seal in the enclosure, and it increases the likelihood of the concrete freezing in a nearly saturated condition when the protection is removed. When the temperature has fallen to 50°F (10°C) the concrete may be exposed to the air within the enclosure provided the relative humidity is not less than 40 percent During very cold weather it is always necessary to add moisture to heated air to obtain this humidity. For example, if the outside temperature is 10°F (-12°C) the relative humidity of air within the heated enclosure will be less than 20 percent if no moisture is added, if water curing is used it should be terminated 12 hr before the end of the temperature protection period, and the concrete should be permitted to dry prior to and during the 24-hr period of adjustment to ambient cold-weather conditions mentioned in Table.

Following the removal of the temperature protection no positive measures to prevent excessive evaporation are required as long as the air temperature remains below 50°F (10°C). An exception is concrete placed in extremely arid regions where the relative humidity at 50°F (10°C) may be expected to be below 40 percent and at 40°F (4.5°C) below ’ 60 percent. In such' regions concrete may be water cured where no freezing is expected.

Otherwise the use of a "curing" compound or other impervious cover is the preferred procedure. Above 50°F (10°C), drying increases rapidly. During the winter period when freezing occurs, occasional peak temperatures above 50°F (10°C) should not be a cause for concern. However when temperatures above 50°F (10°C) occur during more than half off any 254-hr period, the concrete should no longer be regarded as winter concrete and normal curing practice should apply.

Removal of Non-supporting Forms

warm weather, forms should be removed as soon as this can be done without damage to concrete so that prescribed curing treatment can commence at the earliest possible age. In such weather, curing provided by forms is usually inferior to curing specified. But in cold weather, curing, though important, is not so urgent, and protection afforded by forms, other than of steel, is often of greater importance. In heated enclosures such forms serve to distribute the warmth more evenly and to prevent local heating. With suitable insulation, the forms, including those of steel, in many cases will provide adequate protection without supplemental heating.

Therefore, it is often advantageous not to remove forms until the end of the required minimum period of protection, or even later.

Sometimes, however, the construction schedule or economical reuse of forms will dictate their removal at the earliest practicable time. In this event in winter, as in any season, forms may be removed at the earliest age at which this can be done without damage or danger to the concrete. Only wooden wedges should be used .to separate forms from the green concrete. Except for work requiring support by shoring, it will be found usually that when concrete is sufficiently strong comers and edges will not be damaged during stripping, and it will be amply strong .to support its own weight without visible or measurable evidence of cracking or deflection. The minimum time for this can best be determined by trial on the job, since it is influenced by several job factors, including type and amount of cement and other aspects of the concrete mix, curing temperature, type of structure, design of forms, and skill of workmen.

Joints

Construction Joints

A construction joint is defined as a joint in the concrete introduced for convenience in construction or where shown on the Drawings or where directed by the Engineer at which special measures are taken to achieve subsequent continuity and water tightness with no provision for relative movement.

The positions of construction joints and the size of the formwork panels shall be so coordinated that, where possible, the line of any construction joint coincides with the line of a formwork joint and that in any case all construction joint lines and formwork joints appear as a regular and uniform series. For all exposed horizontal joints and purposely inclined joints, a uniform joint shall be formed with a pattern of approved dimensions to give a straight and neat joint line.

Hardened concrete at a construction joint shall have all laitance, loose or unsound concrete, coatings, stains or other foreign material removed before placement of fresh concrete. The whole of the concrete surface forming the joint shall be cleaned by high • pressure water blasting or by sandblasting.

Wet sandblasting, when employed in the preparation of construction joints, shall be performed immediately before placing the following lift. The impact pressure of the wet sand will be regulated by the Contractor so as to achieve the removal of the laitance without undercutting the edges of the larger aggregate.

High-pressure water blasting utilizing a pressure not less than 21-MPa (3000 psi) may be used in lieu of wet sand-blasting for preparing the joint surfaces. High-pressure water blasting

equipment shall be equipped with suitable safety devices for controlling the pressure, and shall include a shut off switch at the nozzle that will shut off the pressure if the nozzle is dropped.

The operation employed shall be continued until all unsatisfactory concrete, all laitance, coatings, stains, debris and other foreign materials are thoroughly removed. Before concreting is resumed, all loose matter shall be completely removed and the surface shall be clean and slightly wet.

The method used in disposing of wastewater employed in cutting, washing and rinsing of concrete surfaces shall be such that the wastewater does not stain or discolour the exposed surfaces of the structure. Methods of disposal shall be subject to approval by the Engineer.

Should any delay in placement occur so that previously placed concrete begins to stiffen, the exposed leading edge of the placement shall be thoroughly vibrated to a uniform and stable slope. The sloping surface shall be treated as a construction joint and shall be properly cleaned before covering with fresh concrete.

The Contractor shall submit his proposals, which shall be subject to approval by the Engineer, formal construction joints not shown on the Drawings.

Movement Joints

All movement joints (for expansion and/or contraction) shall be constructed according to the details shown on the Drawings. Any projections of the concrete into and around the joint space that are likely to spell under movement or prevent the proper operation of the joint shall be carefully removed.

For expansion joints in bridges, expansion guards at joints between adjacent spans shall be held securely in the correct position during the placing of the concrete. The joint clearance shall be adjusted according to the temperature at the time of placing, so that the specified opening will be secured at a temperature of 25°C (77°F). The opening between the expansion guards shall also be corrected for the anticipated increase in width of the opening resulting from the deflection of the girders upon being loaded.

Placing of Jointing Materials

Joint filler shall be cut from the least practicable number of pieces to fit exactly and completely cover the areas shown on the Drawings. Loose fitting or open joints between sections of filler or between filler and forms will not be permitted.

When required by the Drawings or directed by the Engineer, a space adjacent to the preformed expansion joint filler shall be filled with a joint sealant. Joint sealant shall be as specified and

shall be placed in strict accordance with the manufacturer's recommendations.

As far as possible, jointing of waterstops on Site shall be confined to the making of butt joints in straight runs. Where it is necessary for an intersection, or change of direction, or any joint other than a butt joint in a straight run, to be made on Site, a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer may require.

Flexible waterstops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixture. Any waterstop, which after installation is found to be damaged, shall be removed and replaced. Placing and compacting of concrete in the vicinity of waterstops shall be carried out with care to ensure that the waterstops do not bend or distort and that no voids are left below the waterstop.

The surface of set concrete in a joint shall, where a bond breaker is specified on the Drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry.

Caulking grooves shall be provided as shown on the Drawings. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be sand-blasted, and loose material removed and blown out by compressed air. After the groove has dried, it shall be primed and caulked with approved caulking compound in strict accordance with the manufacturer's recommendations.

Unformed Surfaces-Class of Finish

Finishes to unformed surfaces of concrete shall be classified as U1, U2, U3, U4, or such other special finish as may be particularly specified and type of finish will be given on drawings.

Where the class of finish for unformed surfaces is not specified the concrete shall be finished as follows:

►	Surfaces exposed to high velocity flow	U4
►	Surfaces exposed to flowing water other than high velocity flow	U3
►	Building floors not receiving additional finishing	U3
►	Other surfaces except surfaces against which backfill is to be placed	U2
►	Surfaces against which backfill is to be placed	U1

Class U1 finish shall be leveled and screeded, uniform plain or ridged finish, which (unless it is being converted to Class U2, U3 or bonded concrete) shall not be disturbed in any way after the

initial set, surplus concrete being struck off immediately after compaction.

Class U2 finish shall be produced by manual or mechanical floating of the concrete surface after the initial set has taken place when the surface has hardened sufficiently and free water has disappeared. The concrete shall be worked no more than is necessary to produce a uniform 'sandpaper' finish free from screedmarks.

Class U3 finish shall be the next stage after Class U2 and shall be a hard, smooth, steel-trowelled finish. Trowelling shall not commence until the concrete has hardened sufficiently to prevent excess laitance from being worked into the surface the surface shall be trowelled under firm pressure and left free from trowel marks. The addition of dry cement, mortar or water shall not be permitted.

Clause U4 finish shall have a Class U3 finish and in addition all abrupt irregularities shall be eliminated completely by grinding to a slope of 1 to 50, height to length.

Sloping Surfaces

Where concrete is to be placed on a slope steeper than one vertical to four horizontal and not shuttered, the Contractor shall use a traveling slip-form screed to hold the concrete in. position temporarily so that it can be fully compacted by internal vibrators ahead of the screed. The screed shall be weighted and shall have a leading edge that is normal to the finished surface. The width of form shall be at least (3 ft) 1 m in the direction of movement. The screed shall be drawn up the slope at a steady and uniform rate which shall be consistent with the rate of concrete placement. The screed shall ride on guide rails which shall be located outside the placement. The required finish shall be applied to the concrete emerging from the trailing edge of the form. The slip-form screed shall be subject to the approval of the Engineer.

Formed Surfaces - Class of Finish

Finishes to formed surfaces of concrete shall be classified as F1, F2, F3, F4 or such special finish as may be specified. Where the class of finish for formed surfaces is not specified, the concrete shall be finished as follows. Type of finish have been given on drawings

- Surfaces exposed to high velocity flow F4
- Surfaces exposed to flowing water other than high velocity flow F3
- Other surfaces, except surfaces against which backfill is to be placed F2

  and surfaces receiving additional finishes

- ► Surfaces against which backfill is to be placed F1
- ► Surfaces receiving additional finishes F1

a) Formwork for Class F1 finish shall be constructed of timber, sheet metal or any suitable materials, which will prevent loss of grout when the concrete is vibrated. Surfaces subsequently to be rendered, plastered or tiled shall be adequately scrabbled or roughened as soon as the formwork is removed to reduce irregularities to not more than half the thickness of such rendering, plastering or bedding for tiles and to provide a satisfactory key.

b) Formwork for Class F2 finish shall be faced with tongued and grooved boards or plywood or metal panels arranged in a uniform approved pattern free from defects likely to detract from the appearance of the surface.

c) Formwork for Class F3 finish shall be lined with panels of non-staining material with a smooth unblemished surface such as sanded plywood or hard compressed fiberboard. The panels shall be as large as possible and shall be arranged in a uniform approved pattern. Un-faced boarding or standard steel panels shall not be permitted.

d) Formwork for Class F4 finish shall be used for surfaces subject to high velocity flow as specified on the Drawings. Such surfaces shall have a F3 finish and in addition, all abrupt irregularities shall be eliminated by grinding to a slope of 1 to 50, height to length.

Dimensional Tolerances and Surface Finish of Concrete

Concrete surface for the various classes of unformed and formed finishes shall be true to the lines, levels and dimensions shown on the Drawings within the tolerances stated on the Drawings or, where not so stated, as shown in the Table below.

Surface irregularities shall be classified as 'abrupt' and 'gradual'. Abrupt irregularities include, but shall not be limited to offsets and fins caused by displaced or misplaced formwork, loose knots and other defects in formwork materials, and shall be tested by direct measurement. Gradual irregularities shall be tested by means of a straight template for plane surface or its suitable equivalent for curved surfaces. The template shall be 5ft. (1.5 m) long.

Sr. #	Class of Finish	Maximum Tolerance (inch)			
		Line and Level	Abrupt Irregularity	Gradual Irregularity	Concrete Dimension
1	U1, F1	1/2"	1/4”	1/2"	+ 1/2” -1/4"

Sr. #	Class of Finish	Maximum Tolerance (inch)			
2	U2, F2	1/4"	1/4"	1/4”	+1/2" -1/4"
3	U3, F3	1/4”	1/7"	1/4”	+ 1/4”-1/4”
4	U4, F4	1/4”	0	1/4"	+ 1/4”-1/4"

Defects in Formed Surfaces

Workmanship in formwork and concreting shall be such that concrete does not normally require repair, surfaces being fully compacted smooth and with no irregularities.

Any minor surface blemishes shall be repaired to the satisfaction of the Engineer immediately after removal of formwork. Remedial measures may include, but shall not be limited to the following.

► Holes left by formwork supports shall be thoroughly cleaned out to remove all loose material and the sides shall be roughened, if necessary, to ensure a satisfactory bond. They shall then be filled with dry-pack mortar.

► Fins, pinholes, bubbles, surface discoloration and minor defects shall be rubbed down with sacking and cement immediately after the formwork is removed. Excess cement shall be removed by rubbing down with carborundum after the concrete has been fully cured.

► Abrupt and gradual irregularities shall be rubbed down with carborundum and water after the concrete has been fully cured.

► Small defects and minor honeycombing shall be chipped out perpendicular to the face of the concrete to a depth of at least 1 inch and filled with epoxy mortar. Epoxy mortar shall not be used where the width exceeds the depth of the defects.

Where remedial work is to be carried out using dry-pack mortar, the concrete surrounding the hole shall be thoroughly soaked, after which the surface shall be dried so as to leave a small amount of free water on the surface. The surface shall then be dusted lightly with cement by means of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water by the cement. Any dry cement in the hole shall be removed.

Dry-pack mortar shall be mixed and placed as specified.

Where deeper or more extensive defects occur, the Contractor shall cut out the defective area

to a depth of 1 inch with a diamond saw to give a regular edge to the repair and further chipping to form a hole free of any loose, broken or cracked concrete or aggregate, with a minimum depth of 3 inches and a dovetail shape to sound concrete. If reinforcing steel is exposed, the concrete shall be removed to a depth of 1 inch beyond the backside of the reinforcement. The void shall be refilled with epoxy concrete.

Epoxy mortar and concrete shall be mixed and placed as per specification.

Unsound repairs shall be removed and replaced.

Where, in the opinion of the Engineer, the defect is too extensive to permit satisfactory repair, either from the point of view of structural integrity or appearance, the concrete containing the defect shall be broken out and replaced at no cost to the Employer.

Dry-pack Mortar

Dry-pack mortar for filling holes shall be made from one part by weight of cement and three parts fine aggregate passing a No. 16 sieve. The colour of the mortar shall match that of the surrounding concrete by replacing part of the gray cement with white cement as approved by the Engineer. The mortar shall be mixed with only sufficient water to make the materials stick together when being molded in the hands.

The dry-pack material shall be placed and packed in layers having a thickness not greater than 5/7 inch. The compaction shall be carried out by use of a hardwood stick and hammer and shall extend over the full area of the layer, particular care being taken to compact the dry-pack against the sides of the hole. After compaction the surface of each layer shall be scratched before further loose material is added. Holes shall not be overfilled and the surface shall be finished by laying a hardwood block against the dry-pack fill and striking the block several times. Steel finishing tools shall not be used and water shall not be added to facilitate finishing. All dry-pack fillings shall be cured in an approved manner.

Blinding Concrete

Where concrete is to be placed on a fiat excavated surface or one inclined at not more than 1 V;1.75H, a 4 inches layer of blinding concrete shall be placed immediately after completion of the excavation and cleaning, unless otherwise directed.

The upper surface of the blinding concrete shall not be higher than the required cover below the lowest layer of the reinforcing steel. The final excavated level shall be calculated to allow for the thickness of the blinding layer. Where directed by the Engineer, the excavated surface shall be compacted prior to placing of blinding concrete.

Precast Concrete Members

Structural and non-structural units of precast concrete shall be manufactured to the sizes and details shown on the Drawings. The concrete shall comply, in every respect, with the provisions of these Specifications whether such units are manufactured on the Site or obtained from manufacturers approved by the Engineer.

Non-structural concrete products shall, where appropriate, be manufactured in accordance with the following standards, being hydraulically pressed where possible:

Type of Unit	Standard
Kerbs etc.	BS 340
Flags	BS 368
Masonry units	BS 6073

Where the installation of precast concrete units in any particular structure is such that the faces of the units are to be left exposed, either internally or externally, the exposed surfaces of the units as finished shall be uniform in colour and in texture. Al) cement, aggregates and other materials used in the manufacture of the units shall be obtained from the same approved sources, throughout the period of manufacture.

Surfaces of precast concrete units shall comply with the requirements for U3 unformed surfaces and F3 formed surfaces given in Specification.

The Contractor shall submit full details of his proposed method of carrying out all operations connected with the manufacture and assembly of precast concrete structural members, including:

► schedule of the precast members;

► a description of the types of casting bed, mould and formwork for the various members;

► the procedure for concrete casting and curing;

► the procedure for transporting, handling, hoisting and placing of each type of precast structural member; and

► particulars of temporary supports as deemed necessary to ensure adequate stability against the effects, of construction loads, wind load or other transient loads during and after

erection.

AII units shall be laid, bedded, joined and fixed in accordance with the lines, levels and other details shown on the Drawings. Mortar for bedding and jointing units shall consist of one part by volume of OPC and two parts by volume of sand to the grading of Table 2 of BS 1200.

Dimensional Tolerance of Precast Concrete

Dimensions and shapes of precast concrete structural members shall comply with tolerances given on the Drawings or, when not so given, with those stated hereunder which shall govern when they differ from the provisions of Specification.

Length

The dimensional tolerances for length shall be as follows:

Sr. #	Length	Maximum Difference from Specified Dimension
1	Less than 10 ft	1/4"
2	10ft- 15ft	3/8"
3	15 ft- 20 ft	1/2"
4	Additional for every subsequent 20 ft	1/8"

Cross Section

The dimensional tolerances for cross section shall be as follows:

Sr. #	Cross Section (Each Direction)	Maximum Difference from Specified Dimension
1	Less than 1'-6"	1/4"
2	Additional for every subsequent 9inch	1/8"

Straightness or Bow

The dimensional tolerances for straightness or bow shall be as follows:

Sr. #	Straightness or Bow	Deviation from Intended Line
1	Less than 10 ft	1/4"
2	Additional for every subsequent 10 ft	1/8"

Squareness

When considering the squareness of a corner, the longer of the two adjacent sides being checked shall be taken as the baseline, and a line perpendicular to the baseline shall be taken as the checking. The distance of the shorter side from the check line shall be such that the difference between the greatest and shortest such distances shall not exceed:

Sr. #	Length of Shorter Side	Deviation from Squareness
1	Not exceeding 4 ft	1/4"
2	4-6 ft ,	3/8"
3	Exceeding 6 ft	1/2”

For the purpose of this requirement, any error due to lack of straightness shall be ignored; squareness shall be measured with respect to the straight lines which are most nearly parallel with the features being checked. When the nominal angle is other than 90°, the included angle between the baseline and the check-line shall be varied accordingly.

Twist

No corner of a nominally plane surface shall deviate from the plane containing the other three corners by more than:

Sr.#	Surface Dimensions	Deviation from Plane
1	Not exceeding 2 ft. wide and not exceeding 20 ft long	1/4"
2	Any other size	1/2"

Flatness

The deviation from a 5 ft straightedge placed in any position on a nominally plane surface shall not exceed 1/4".

Installation or Precast Concrete Members

At all stages and until completion of the Permanent Works, precast members shall be adequately protected to preserve all permanently exposed surfaces and architectural features. The protection shall not mark or otherwise disfigure the concrete. All units shall be laid, bedded, jointed and fixed in accordance with the lines, levels and other details shown on the Drawings.

Any precast member, which is found to be cracked, damaged or otherwise unsuitable, either before or after erection, shall be rejected and replaced at no extra cost to the Employer.

CONCRETE FOR BLOCKOUTS

Blockouts for gate guides, seals, and track assemblies and the like shall be provided as indicated on the Drawings. After the assemblies have been installed and adjusted, the blockout recesses shall be filled with concrete. Before installing the components to be embedded in blockout concrete, and before depositing any blockout concrete the concrete surfaces of the blockout shall be cleaned in the manner specified for cleaning construction joints.

FILL CONCRETE

Embankments and Other Fills, specifies that, where directed, fill concrete shall be placed on the foundations of the embankment core to fill cavities and provide a regular surface against which the core material can be placed and compacted. The Engineer may direct the use of fill concrete having a slump and of a method of curing which are appropriate to the circumstances but which do not accord with the slumps and methods of curing specified in this Section.

Fill concrete under the embankment core shall have a U1 finish and shall be kept well moistened until it is covered with fill material.

Fill concrete may also be used elsewhere in the Permanent Works and denotes plain concrete without reinforcing steel.

MEASUREMENT

Admixtures

Measurement and Payment

Measurement and payment for the prevision and use of admixtures shall be made in accordance with the requirements of Clause 57 Provisional Sums, of the Conditions of Contract.

Blinding Concrete (Plain Cement Concrete)

Measurement

Measurement shall be made of the volume of blinding concrete I plain cement concrete of ip1500 psi strength acceptably placed in the Permanent Works. Measurement shall be made in cubic feet by multiplying the nominal thickness or as specified on the drawing by the area covered, measured in the plane of the required surface as shown on the Drawings or as otherwise approved or directed by the Engineer.

Payment

Payment will he made for the number of cubic feet measured as above at the unit price for the Item and shall be deemed to cover all costs of blinding concrete, other than cement, pozzolanic materials and admixtures that are measured separately, including furnishing all ingredients, batching, mixing, cooling, transporting, placing, curing and protecting, finishing and repairing, and all other work related to the Item.

Concrete

General

The following provisions apply to all concrete items, except as modified by the measurement and payment clauses for specific items.

Measurement shall be made of the volume of concrete acceptably placed in the Permanent Works within the lines and grades shown on the Drawings or as otherwise directed or approved by the Engineer. Where concrete is placed upon foundations, measurement shall be made to the foundation lines and grades shown on the Drawings or as otherwise directed and approved by the Engineer.

No deductions shall be made for rounded or beveled edges or for space occupied by reinforcing steel or pre-stressing steel and accessories. No deduction shall be made for voids, piping, electrical conduits or any other embedded items which are each less than sft in cross-section or less than 0.2 cubic yards in volume. No measurement shall be made for concrete that is wasted for any reason or that is rejected.

Where two or more concrete items are contiguous, the division line between these items shall be as indicated on the Drawings or as described in these Specifications. Unless shown otherwise, the division line between two contiguous items shall be a construction joint as shown on the Drawings. In case the Contractor requests, and the Engineer approves, a change in a construction joint that acts as the division line between two items, the Engineer shall establish a new division line at the time of approving the change if, in the sole judgment of the Engineer, such a change is equitable. .

The unit prices for in situ concrete shall be deemed to cover all costs of concrete other than cement, pozzolanic materials, admixtures, reinforcing steel, pre-stressing steel, waterstop and jointing material that are measured separately. The unit prices shall include furnishing all ingredients, batching, mixing, cooling, transporting, placing, curing and protecting, finishing and repairing, and all other work related to the Item for which separate payment is not provided. No separate payment shall be made for grouting of liners, penstock and equipment.

Concrete using Sulphate Resisting Cement:

a) Measurement will be made for the volume of concrete acceptably placed in the Permanent Works within the lines and grades as shown on the Drawings, and not as batched, or as otherwise directed or approved by the Engineer. Where concrete is placed upon earth or blinding concrete layer, measurement will be made to the foundation lines and grades shown on the Drawings or as otherwise directed and approved by the Engineer. No deductions will be made for rounded or bevelled edges or for space occupied by reinforcing steel. No deduction will be made for voids, piping, electrical conduits or any other embedded items which are each less than 100 square inches (645.16 square cm) in cross-section. No measurement will be made for concrete that is wasted for any reason or that is rejected.

b) All concrete required for work under these specifications shall be included in the unit rates tendered in the Bill of Quantities for the appropriate items in which such concrete is incorporated. The unit rates tendered for such work shall be deemed to cover all costs of concrete, other than reinforcing steel which is measured separately, including, but not limited to furnishing water, sand and aggregates, concrete admixtures, curing/sealing compound, formwork joint sealants, forms and form oil or compound and also including all operations, but not limited to, batching, mixing, temperature control, transportation, preparation for placing, placing, curing, protection, finishing and repairing concrete surfaces, installing and removing forms, shuttering, scaffolding and preparation of construction joints, and carrying out all tests and other operations, procedures, stipulations and requirements set forth herein or otherwise related to the item.

c) No payment will be made for the concrete used for casting concrete specimens for testing, their curing, transportation to the laboratory and their testing. No additional payment except that mentioned in the respective BOQ Items will be made to the contractor for any change in mix design of concrete to achieve the required strength. No separate payment will be made for cement an slag and cost therefore shall be deemed to be included in BOQ Unit Rates of Concrete.

Concrete using Ordinary Portland Cement

a) Measurement will be made for the volume of concrete acceptably placed in the Permanent Works within the lines and grades as shown on the Drawings, and not as batched, or as otherwise directed or approved by the Engineer. Where concrete is placed upon earth or blinding concrete layer, measurement will be made to the foundation lines and grades shown on the Drawings or as otherwise directed and approved by the Engineer. No deductions will be made for rounded or bevelled edges or for space occupied by reinforcing steel. No deduction will be made for voids, piping, electrical conduits or any other embedded items which are each

less than 100 square inches (645.16 square cm) in cross-section. No measurement will be made for concrete that is wasted for any reason or that is rejected.

b) All concrete required for work under these specifications shall be included in the unit rates tendered in the Bill of Quantities for the appropriate items in which such concrete is incorporated. The unit rates tendered for such work shall be deemed to cover all costs of concrete, other than reinforcing steel which is measured separately, including, but not limited to furnishing water, sand and aggregates, admixtures, curing/sealing compound, formwork joint sealants, forms and form oil or compound and also including all operations, but not limited to, batching, mixing, temperature control, transportation, preparation for placing, placing, curing, protection, finishing and repairing concrete surfaces, installing and removing forms, shuttering, scaffolding and preparation of construction joints, and carrying out all tests and other operations, procedures, stipulations and requirements set forth herein or otherwise related to the item.

c) No payment will be made for the concrete used for casting concrete specimens for testing, their curing, transportation to the laboratory and their testing. No additional payment except that mentioned in the respective BOQ Items will be made to the contractor for any change in mix design of concrete to achieve the required strength. No separate payment will be made for cement and slag and cost therefore shall be deemed to be included in BOQ Unit Rates of Concrete.

Measurement

Measurement shall be made in Cft. As provided under various BOQ Items.

Payment

Payment for concrete will be made for the number of cubic feet measured as above at the unit rate for the respective Item.

Waterstop

Measurement

Waterstops shall be measured as the net length in linear feet of waterstop shown on the Drawings and acceptably installed in the Permanent Works. The measurement shall be of the centreline length. At angled joints or junctions, in a waterstop, the centreline length of each branch shall be measured up to the point of intersection of the centreline.

Waterstops placed in construction joints which are for the convenience of the Contractor shall not be measured.

a) Measurement, for payment, of furnishing and placing PMC and Hypalon waterstops will be made only of the lengths, placed in accordance with the Drawings or as directed. No allowance will be made for laps at joints. Waterstops installed by the Contractor in

construction joints in locations other than those shown on the Drawings or directed-will not be measured for payment.

Payment

Payment will be made for the number of linear feet measured as above at the unit price for the respective Item.

The unit rates for waterstops shall be deemed to cover all costs of waterstops including supplying, fixing and jointing and all other work related to the Item. No additional payment will be made for forming joints in water stops.

a) Payment for furnishing and placing, pvc water stops will be made at the applicable rate per linear ft. tendered there for in the priced Bill of Quantities. Payment for furnishing and placing 300 mm wide Hypalon water stop will be made at the rate per linear ft. tendered there for in the priced Bill of Quantities.

b) Payment for furnishing and placing copper water stop will be made at the rate per linear foot tendered there for in the priced Bill of Quantities. This rate shall include the cost of provision of mortar or sand asphalt joint pads, polyethylene foam filler and neoprene rod in the water stop rib, painting of the water stop, and furnishing and installing the bituminous felt strip under the water stop.

c) The cost of preparing the perimetric joint, including the supply and removal of the timber and steel protection for the waterstops shall be included in the various rates tendered in the priced Bill of Quantities for furnishing and placing the waterstops, joint fillers and sealants and their placing between and underneath the adjacent concrete efface and toe slab.

Joint Sealing Compound Neoprene Pad

Measurement

PVC Hyplan membrane strip over mastic joint filler shall be measured in Rft.

Joint sealing compound shall be measured as the weight in kg. of joint sealing compound shown on the Drawings and acceptably installed in the Permanent Works. The measurement shall be of the product of the centre line length, the cross section and the nominal density.

Measurement, for payment, of furnishing and placing polysulphide mastic joint fillers and bitumen-rubber mastic joint filler will be made of the volume of joint filled with mastic as shown on the Drawings or as directed.

Measurement, for payment, for furnishing and placing expanded polystyrene joint filler and bituminous fiber sheet joint filler will be made of the area required to be covered with joint filler as shown on the Drawings and deductions will not be -made for openings required to be made in the joint filler.

Joint filler required to be raked out of the joint after the concrete has set and will be measured

for payment.

Payment

Payment will be made for the number of kg measured as above at the unit price for the Item.

The unit rates for joint sealing compound, shall be deemed to cover all costs of joint sealing compound including supply, application and all other work related to the Item.

Payment for furnishing and placing polysulphide mastic joint fillers and bitumen-rubber mastic joint filler will be made at the applicable, rate per liter tendered the refor in the priced Bill of Quantities.

Payment for furnishing and placing expanded polystyrene joint filler and bituminous fiber sheet joint filler will be made at the applicable rate per square meter tendered there for in the priced Bill of Quantities.

Coating for Breaking Bond

Measurement

Coating for breaking bond shall be measured as the area in square feet of coating shown on the Drawings and acceptably applied in the Permanent Works.

Payment

Payment will be made for the number of square feet measured as above at the unit price for the Item.

The unit rates for coating for breaking bond shall be deemed to cover all costs of coating for breaking bond including supply, application and all other work related to the Item.

Preformed Expansion Joint Filler

Measurement

Preformed expansion joint filler shall be measured as the equivalent area in square feet of 3/4 inch thick preformed expansion joint filler shown on the Drawings and acceptably installed in the Permanent Works.

For joint fillers of a different thickness, the area acceptably installed shall be adjusted in the proportion of the actual thickness to 3/4'.

Payment

Payment will be made for the number of square feet measured as above at the unit price for the item.

Polyethylene Foam Rod

Measurement

Polyethylene foam rod shall be measured as the length in linear feet of polyethylene foam rod shown on the Drawings and acceptably installed in the Permanent Works.

Payment

Payment will be made for the number of linear feet measured as above at the unit price for the respective Item.

The unit rates for polyethylene foam rod shall be deemed to cover ail costs of polyethylene foam rod including supplying, installing and all other work related to the item.

The unit rates for preformed expansion joint filler shall be deemed to cover all costs of preformed expansion joint filler including supply, installation and all other work related to the Item.

Galvanized Steel Pipe Railing

Measurement

Measurement for payment shall be made in linear feet along the topmost pipe only of galvanized steel pipe railing acceptably placed and installed in position, as shown on the Drawings.

Payment

Payment for galvanized steel pipe railing shall be made at the Contract unit rate for the linear feet of railing installed as measured above, and shall constitute full compensation for al! works, including all costs of supply of materials, fabrication, accessories, installation including welding and grouting, fuel, labour painting all as shown on the Drawings.

Aluminum Tubing for Railing

Measurement

Measurement for payment shall be made in linear feet along the topmost pipe only of galvanized steel pipe railing acceptably placed and installed in position, as shown on the Drawings.

Payment

Payment for galvanized steel pipe railing shall be made at the Contract unit rate for the linear feet of railing installed as measured above, and shall constitute full compensation for al! works, including all costs of supply of materials, fabrication, accessories, installation including welding and grouting, fuel, labour painting all as shown on the Drawings.

SECTION 6

STEEL REINFORCEMENT

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STEEL REINFORCEMENT

General

Steel reinforcing bars, dowel bars and reinforcing fabric shall be placed in concrete where shown on the drawings or as directed.

The Contractor shall furnish and install all reinforcement and dowel bar required for execution of the works as shown on the drawing

Reference Standards

STANDARD	SUBJECT
American Society for Testing and Materials (ASTM)	
ASTM A36	Specification for structural steel
ASTM A53	Specification for pipe, steel, black and hot-dipped, zinc-coated, welded and seamless
ASTM A 174M	Specification for fabricated deformed steel bar mats for concrete reinforcement
ASTM A185	Specification for steel welded wire fabric, plain, for concrete reinforcement
ASTM 416	Specification for Steel strand, uncoated seven wire stress- relieved for prestressed concrete
ASTM 421	Specification for uncoated stress-relieved wire for prestressed concrete
ASTM A615	Specification for deformed and plain billet-steel bars for concrete reinforcement
British Standards (BS)	
BS 4871	Approval testing of welders working to approved welding procedures

STANDARD	SUBJECT
BS 5135	Metal-arc welding of carbon and carbon manganese steels
BS 5896	Specification for high tensile steel wire strand for the prestressing of concrete

SUBMISSIONS BY THE CONTRACTOR

6.3.1 General

The Contractor shall submit the following to the Engineer for record or approval.

6.3.2 Certificates and Mill Test Data

Manufacturers' or suppliers' certificates of compliance with relevant standards for each shipment of all materials and accessories used in the Permanent Works, including

- Steel
- Mechanical coupling for reinforcing steel

Appropriate mill analysis and laboratory test data of samples tested by the supplier. Mill analysis and test data shall be representative of materials furnished for the Permanent Works. The frequency of sampling and testing by the supplier shall conform to applicable standards.

6.3.3 Results of Tests Performed by the Contractor

- Daily reports and monthly summaries of test performed on steel reinforcement and mechanical coupling.

6.3.4 Samples

Samples of all materials viz steel and mechanical couplers together with manufacturers' technical information, to be used in the Permanent Works as may be required by the Engineer. Reference samples shall be kept in suitable containers, properly labeled, and stored on Site.

6.3.5 Welding of Reinforcement

The Contractor shall obtain approval of the Engineer for any welding of reinforcement. The approval shall cover:

- Welding procedures.

- Qualifications of welders to work at site.
- - Methods of inspection of welds.

sor as directed. Reinforcement shall be detailed in accordance with ACI 315.

Material

Reinforcing bars shall be deformed bars complying with ASTM A615. The specified characteristic grade will be GRADE 40 and GRADE 60.

Fabricated reinforcement mats shall conform to the requirement of ASTM-A-184 or ASTM- A-185.

Test certificates will be required for all reinforcement to be used on the works when required-by the Engineer, the Contractor shall take sample in presence of the Engineer from reinforcement delivered to site and shall arrange for the sample to be tested by an approved agency / lab. Test certificates from that agency shall be submitted to the Engineer.

Drawings and Bar Lists

The Construction Drawings furnished to the Contractor will show the amounts of steel reinforcement to be included in the various parts of the Permanent Works. From the information given on these drawings, the Contractor, shall prepare detailed reinforcement drawings and schedules for approval. The detailed reinforcement drawings and schedules shall clearly show the numbers, shapes, lengths, sizes and weights of the bars and the laps and couplings to be used. The reinforcement detailing shall be in accordance with the recommendations of ACI 315, with lap lengths chosen to transmit 90% of the yield stress of the steel except where otherwise directed.

The reinforcement drawings issued with the specification indicate only the engineering requirements for reinforcing bars and fabric in the various structures.

The Contractor shall prepare, in an approved manner, reinforcement detail shop drawings showing reinforcement bar lists, bar placement details and bar bending details for each structure and submit to the Engineer for approval.

All reinforcing bars shown on the reinforcement detail shop drawings shall be identified on the bar lists in accordance with the standard reinforcing bar shapes as shown on the

All bar lists shall be identified with the relevant reinforcement detail shop drawing and all bars scheduled on the bar lists shall be defined and dimensioned in an approved manner.

The Contractor shall be responsible for correctness of the bar list.

Placing Reinforcement

The Contractor shall be responsible for accuracy of the cutting, bending and placing of the reinforcement. Reinforcement will be inspected for compliance with the requirements as to grade, size, and shape, length, splicing locations, position and amount after it has been placed.

Before the reinforcement is placed, the surfaces of the bars and the surfaces of any metal bar supports shall be cleaned of heavy rust, loose mill scale, dirt, grease and other objectionable foreign substances. Heavy flaky rust which can be removed by firm rubbing with Hessian or equivalent treatment is considered objectionable. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete. Reinforcing bars, dowel bars or fabric shall be accurately placed and secured in position so that there will be a clear distance of at least 1 inch between the bas or fabric and any adjacent embedded metalwork and so that the bars will not be displaced during the placing of the concrete, and the Contractor shall ensure that there is no disturbance of the reinforcing bars or fabric in concrete that has already been placed.

Chairs, hangers, spacers and other acceptable metal, plastic or concrete supports may be furnished and used by the Contractor for supporting reinforcing bars or fabric. Concrete supports where used shall conform to the concrete requirements of this Specification. Steel spacers which are liable to cause rust staining of finished surfaces shall not be used.

Reinforcing bars partially embedded in concrete during construction shall not be bent or straightened without prior approval. Such bending or straightening shall only be carried out by using an approved tool. In the case of bending, a former shall be used to ensure that the internal diameter of the bend is maintained at not less than 5 bar diameters. Before a bar is straightened or bent after straightening, the length affected by bending and 2“ beyond shall first be annealed by heating it to a dull red heat with oxyacetylene torch and then allowing it to air-cool. Quenching will not be approved.

Installation

Where it is necessary to splice reinforcement the splices shall be made by lapping by mechanical means. No welding will be done.

Joints or splices in reinforcing bars shall generally be made at the positions shown on the drawings, but the Contractor will be permitted to make joints or splices at positions other than those shown on the drawings; provided that such positions are approved and that the joints and splices in adjacent bar are staggered if directed.

Bending of Reinforcement

Bars shall be cut and bent in accordance with the provisions of ACI 315. Bending shall be carried out slowly, at a steady even pressure, and without jerking, impact or heating. The temperature of the steel at the time of bending shall not be less than 5“C (40°F). Bent bars shall not he re-bent unless permitted by the Engineer.

Storage of Reinforcing Bars and Fabricated Mats

The Contractor shall stack separately and label different types of reinforcement for positive identification of the manufacturer, size and production run or other number which relates to the test certificates furnished by the manufacturer.

Steel reinforcing bars shall be kept clean and shall be free from pitting, loose rust, mill scale, oil, grease, dirt, paint or any other material, which may impair the bond between the concrete and the reinforcement. Ail reinforcement shall be stored under cover on wooden or concrete supports at least 6 inch clear of the ground.

Welding of Reinforcement

No welding of reinforcement whatsoever, including tack welds, shall be permitted unless shown on the Drawings or authorized in each case by the Engineer.

Where shown on the Drawings or authorized, welding shall be in accordance with the requirements of BS 5135 and the recommendations of the manufacturer of the steel. The Contractor shall demonstrate by bend and tensile tests bn specimen welds that the strength of the parent metal is not reduced and that the weld possesses a strength not less than that specified for the parent metal. The welding procedure established by successful test welds shall be maintained and no departure from this procedure shall be permitted.

Following the establishment of a satisfactory welding procedure, each welder to be employed on the Works shall carry out welder performance qualification tests on reinforcing bars for the same metal and bar sizes as those to be used in the Permanent Works. The requirements of BS 4871 shall be observed.

Details of welding procedure and welder qualification tests shall be submitted to the Engineer for approval before welding of reinforcement commences.

Elastomeric Bearing Pads

General

Elastomeric bearing pads as herein specified shall include plain bearings, consisting of elastomer only, and laminated bearing pads, consisting of layers of elastomers restrained at their interfaces by bonded laminates. The elastomer portion of the elastomeric compound shall be 100% virgin chloroprene (neoprene) meeting the requirements of Section 2.25.2, Table B-of the AASHTO Standard Specifications for Highway Bridges. Materials having a nominal Durometer hardness of 70 shall be used for plain elastomeric bearings and a Durometer hardness of 50 for laminated bearings.

Laminates shall be rolled mild steel sheets conforming to ASTM A36 unless otherwise specified.

Elastomeric bearings, when specified, shall be furnished in assemblies, and shall be installed as shown on the Drawings. Any damaged bearing shall be replaced by the Contractor. The elastomeric bearing assemblies shall be furnished as complete units from one manufacturing source unless otherwise approved in writing by the Engineer.

Fabrication

Plain bearings may be molded individually, cut from previously molded strips or slabs, or extruded and cut to length. Cut edges of plain bearings shall be at least as smooth as ANSI 250 finish.

Laminated bearings shall have all components molded together into an integral unit. All edges of the non-elastic laminations shall be covered by a minimum $^{1/8}$" thickness of elastomer, except at laminate restraining devices and around holes that will be entirely closed on the finished surface.

Bearing assemblies, which include a top structural steel bearing plate to be bonded to the bearing, shall be furnished as a complete unit. The elastomeric bearing shall be bonded by vulcanizing to the structural steel bearing plate. Epoxy-type bonding shall not be permitted. Bonding of the structural steel bearing plate shall be done in the shop. Field bonding shall not be permitted.

Tolerances

For both plain and laminated bearings, the variation from the dimensions and configurations shown on the Drawings shall not be greater than the following:

Dimensions	Permissible
Overall Vertical Dimensions	
Total thickness 1 1/4″ or less	0 to 1/8"
* Total thickness over 1 1/4″	0 to ¼”
Overall horizontal dimensions	
3 ft and less	0 to ½”
Over 3ft.	0 to ¼”
Thickness of individual layers	
Thickness of individual layers elastomer (laminated bearings only)	0 to 1/8"
Variation from plane	
Variation from a plane parallel to the theoretical surface (as determined by measurements at the edges of the bearings):	
Top	1/8"
Sides	1/4”
Individual non-elastic laminates	1/8”

Construction Methods

The bearings shall be attached to the structures as shown on the Drawings. Exposed edges and other exposed portions of the structural steel bearing plates shall be cleaned and painted. During cleaning and painting, the elastomer shall be protected from abrasion and paint.6.4.10 Conduits for Post-tensioned Tendons

The conduits through which the tendons will be threaded shall be standard seamless black steel pipe conforming to ASTM A53 Type S, Grade A and shall be supplied with suitable connecting fittings to form tight joints along the full length of the tendons and to seal completely against mortar leakage into the formed conduits. Alternatively, tendons may be placed in circular sheaths made of spiral steel strip with a corrugated profile to give strength, supplied with suitable mortar-tight connecting fittings. The Contractor shall submit samples of the flexible sheaths, together with the manufacturer's technical data and recommendations, to the Engineer for approval.

Measurement

Reinforcing steel bars, Grade 60 & Grade 40

Measurement

Reinforcing steel bars shall be measured as the net weight of reinforcing steel bars in metric

tons (long tons) acceptably placed in the Permanent Works. The net weight of reinforcing steel bars shall be calculated as the lengths of bars placed in accordance with approved Drawings or bar schedules multiplied by the appropriate nominal weight per unit length- The nominal weights per unit length are as follows:

Bar Size	Nominal Weight (lb/ft)
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.67
9	3.40
10	4.303
. 11	5,313

Laps in reinforcing steel which are for the convenience of the Contractor shall not be measured.

The wire, chairs, spacers, supports, bracings and other means of holding reinforcement in position shall not the measured.

Payment

Payment will be made for the number of metric tons (long tons) as measured above at the unit price for the respective Item.

The unit price for reinforcing steel shall be deemed to cover al! costs of reinforcing steel including preparing detailed reinforcement drawings and schedules and supplying, cutting, bending and fixing the reinforcing steel, including cost of binding wire, wastage and all other work related to the Item.

Fabricated Wire Mesh

Measurement

Fabricated reinforced mesh shall be measured as the net weight of in metric tons acceptably placed in the permanent works. The net weight shall be calculated as the area of fabricated reinforced mesh acceptably placed in accordance with approved Drawings multiplied by the appropriate nominal weight per unit area.

Laps in fabricated reinforced mesh, which are for the convenience of the Contractor shall not be measured.

Payment

Payment will be made for the number of metric tons as measured above at the unit price for the respective Item.

The unit price for the fabricated reinforced mesh shaft be deemed to cover all costs of fabricated reinforced mesh including preparing detailed drawings and schedules and supplying, cutting and fixing the mesh, wastage and all other work related to the Item.

Elastomeric Bearing Pads

Measurement

Elastomeric bearing pads shall be measured as the weight in kilograms of elastomeric bearing pads shown on the Drawings and acceptably installed in the Permanent Works.

Payment

Payment will be made for the number of pounds measured as above at the unit price for the Item.

The unit rates for electrometric bearing pads shall be deemed to cover all costs of electrometric bearing pads including supply, installation and all other work related to the Item.

SECTION 7

STONE PITCHING AND STONE APRON

SECTION 7 STONE PITCHING AND STONE APRON ii

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STONE PITCHING AND STONE APRON

STONE PITCHING

The work to be done under stone pitching consists of furnishing and transporting materials and placing them at locations shown on the Drawings or as directed by the Engineer in accordance with these Specifications.

MATERIALS – BASE FILTER LAYER, STONE PITCHING & ROCK SPAWL

(a) **Base Filter layer:** Base filter layer under stone pitching shall consist of a mixture of 20% medium to coarse sand with 80% graded material. The graded material shall consist of gravel well graded to a maximum size of less than 1½ inches.

(b) **Stone Pitching for Structures on Main Canal:** Stone for pitching shall consist of rock fragments or boulders/pebbles which are dense, sound, angular and resistant to abrasion. The stones shall be generally cuboid in shape with the largest dimensions not exceeding twice the smallest dimensions. The stones individually shall weigh between 40-120 lbs with 80 percent shall be 80 lbs or larger and not more than 5 percent shall weigh less than 40 lbs.

(c) **Stone Pitching for Areas Other than Main Canal:** Stone for pitching shall consist of rock fragments which are dense, sound, angular and resistant to abrasion. Individual fragments shall be free from cracks, seams and other defects that could tend to increase unduly their destruction by water. The required size of stone shall be determined by the specified nominal weight P50. At least 50% by weight of the material shall consist of stones having a mass heavier than the nominal mass P50.

P50 = 40 pounds and range 15 to 50 pounds.

The heaviest stone shall not have mass higher than 1.2 times the maximum specified mass. No more than 15% by mass of the material shall consist of stone having a mass more than the maximum specified. The upper limit of P50 shall be less than 1.4 P50. No more than 5% by mass of the material shall consist of stone having a mass less than the minimum specified.

(1) Rock Spawl: All interstices in stone pitching shall be well filled with rock spawl. The rock spawl shall be rock fragments size between 2 inches and 4 inches.

(2) Testing of Materials: Stone & rock spawl may be rejected if they fail to meet the following test requirements:

(a) Los Angeles abrasion test (large size Coarse Aggregate ASTM Designation: C535-96). If the loss exceeds ten percent, by weight, at 200 revolutions, or 40 per cent, by weight, at 1000 revolutions;

(b) Los Angeles abrasion test (small size Coarse Aggregate ASTM C131-96). If the loss exceeds ten percent by weight at 100 revolution or 40 percent by weight at 500 revolution;

(c) Specific gravity (ASTM Designation: C127-88). If the specific gravity (saturated surface-dry basis) is less than 2.60.

(d) Test for Rock Slabs to Evaluate Soundness of Rip Rap by use of Sodium Sulfate or Magnesium Sulfate, ASTM
D 5240.

(e) Test for Evaluation of Durability of Rock for Erosion Control under Wetting and Drying Conditions, ASTM D5313.

Material Sources

The contractor shall propose the sources of base filter layer, stone pitching and rock spawl for approval of the Engineer. The use of the materials shall always be subject to approval of the Engineer. All the requisite tests will be carried out by the Contractor under supervision of the Engineer either at Contractor's Laboratory or at an approved laboratory at the cost of the Contractor.

Placement

Structures and locations where stone-pitching is required shall include, but not be limited to the guide banks, spurs, link channels and other locations as shown on the drawings.

The base filter layer shall be placed to a uniform thickness and finished to a reasonably smooth and even surface as shown on the Drawings or as directed by the Engineer. Before placement of the base filter, the surface over which the base filter is to be placed shall be trimmed to the proper lines and grades and shall be moistened with water and tamped or rolled with suitable tools or equipment for the purpose of forming a firm foundation.

Stone used in the stone pitching shall be hand picked and placed and bedded in such a manner that the completed stone pitching is stable and without tendency to slide. Large open spaces between the stone shall be avoided. Care shall be taken to ensure that all stone is well-bedded on its flattest surface. The stone shall be placed so as not to project above the neat lines shown on the Drawings or as directed by the Engineer. All interstices in the stone pitching shall be well-filled with rock spawl. The amount of rock spawl used shall not be in excess of that required to fill the voids in the revetment stone.

Measurement and Payment

(a) Measurement for stone pitching shall be made in hundred cubic feet as volume of the material placed over the excavated sloping surfaces of channel cross-section or elsewhere as shown on Drawings.

(b) Unit rates tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and as shown on Drawings for stone pitching and all other work related to the item. No separate payment shall be made for any dewatering required for placing stone pitching and its cost shall be deemed to have been included in the unit rates tendered in the BOQ.

Measurement

(a) Measurement for base filter layer shall be made in hundred cubic feet as volume of the material placed over the excavated sloping surfaces of channel cross-section as shown on Drawings.

(b) Unit rates tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and as shown on Drawings for base filter layer and all other work related to the item. No separate payment shall be made for any dewatering required for placing base filter layer and its cost shall be deemed to have been included in the unit rates tendered in the BOQ.

Measurement and Payment

Measurement and payment for stone pitching grouted in 1:3 cement sand mortar shall be made in hundred (%) square feet of the specified stone actually placed as per drawings and shall constitute full payment for procurement of materials and all operations involved for completion of works specified herein.

Stone Apron

The work to be done under stone apron consists of furnishing, transporting materials and placing them in stone apron at locations shown on the Drawings or designated by the Engineer in accordance with the specifications and Engineer's instructions.

Materials

(1) **Base Filter Layer:** Base layer for the stone apron shall consist of a mixture of 20% medium to coarse sand with 80% graded material. The graded material shall consist of gravel well graded to a maximum size of 3 inches.

(2)

(a) Stone Apron for Structures on Main Canal: Stone for apron shall consist of rock fragments or boulders/pebbles which are dense, sound, angular and resistant to abrasion. The stones shall be generally cubical in shape with the largest dimensions not exceeding twice the smallest dimensions. The stones individually shall weigh between 40-120 lbs with 80 percent shall be 80 lbs or larger and not more than 5 percent shall weigh less than 40 lbs.

(b) Stone Apron for Areas Other than Main Canal: Stone for apron shall consist of rock fragments which are dense, sound, angular and resistant to abrasion. Individual fragments shall be free from cracks, seams and other defects that could tend to increase unduly their destruction by water. The required size of stone shall be determined by the specified nominal weight P50. At least 50% by weight of the material shall consist of stones having a mass heavier than the nominal mass P50.

P50 = 40 pounds and range 15 to 50 pounds.

The heaviest stone shall not have mass higher than 1.2 times the maximum specified mass. No more than 15% by mass of the material shall consist of stone having a mass more than the maximum specified. The upper limit of P50 shall be less than 1.4 P50. No more than 5% by mass of the material shall consist of stone having a mass less than the minimum specified.

(3) Rock Spawl: All interstices in stone apron shall be well filled with rock spawl. The rock spawl shall be rock fragments size between 2 inches to 4 inches.

(4) Testing of Materials: Stone & rock spawl may be rejected if they fail to meet the following test requirements:

a) Los Angeles abrasion test (large size ASTM Designation: C535-96). If the loss exceeds ten percent, by weight, at 200 revolutions, or 40 per cent, by weight, at 1000 revolutions;

b) Los Angeles abrasion test (small size Coarse Aggregate ASTM C131-96). If the Loss exceeds ten percent by weight at 100 revolution or 40 percent by weight at 500 revolution;

c) Specific gravity (ASTM Designation: C127-88). If the specific gravity (saturated surface-dry basis) is less than 2.60.

Material Source

The Contractor shall propose the source of base filter layer, stone apron and rock spawl for approval of the Engineer. The use of the materials shall always be subject to approval of the Engineer. All the requisite test, will be carried out by the Contractor either at Contractor's Laboratory under the supervision of the Engineer or at an approved laboratory at the cost of the Contractor.

Placement

The area designated for placement of stone apron shall be excavated to the lines and grades shown on the Drawings or as directed by the Engineer.

The base filter layer shall be placed to a uniform thickness and finished to a reasonably smooth and even surface as shown on the Drawings or as directed by the Engineer. Before placement of the base filter, the surface over which the base filter is to be placed shall be trimmed to the proper lines and grades and shall be moistened with water and tamped or rolled with suitable tools or equipment for the purpose of forming a firm foundation.

The stone shall be hand-placed over the filter layer in such a manner that open spaces between stones are avoided. The stone for apron shall be placed in such a manner that open spaces between stone are avoided (open joints throughout the entire depth being filled with smaller stones and rock spalls).

At locations where stone apron in the trough is to be placed below ground water table level, the water in the trough shall be pumped out and water table to be brought sufficiently below the formation level to form a stabilized bed for stone apron. The method used to draw down the water table level shall be subject to the approval of the Engineer.

After dewatering, the trough section shall be formed to the proper lines and grades and shall be tamped with suitable equipment to form a firm foundation for stone apron.

Measurement and Payment

(a) Measurement for payment for stone apron shall be made in hundred cubic feet, within outlines of the stone in place and on the basis of their thickness shown on the Drawings. No separate measurement for payment shall be made for excavating and preparing trough, dewatering if required and all costs on their account shall be deemed to be included in the unit rate for the BOQ item stone apron.

(b) Unit rate tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and on Drawings for stone apron.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for stone apron including excavation of trough for the stone apron and all work related thereto.

Measurement

(a) Measurement for payment for base filter layer shall be made in hundred cubic feet, within outlines of the base filter layer in place and on the basis of their thickness shown on the Drawings. No separate measurement for payment shall be made for excavating and preparing trough, dewatering if required and all costs on their account shall be deemed to be included in the unit rate for the BOQ item stone apron.

(b) Unit rate tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and on Drawings for stone apron.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for stone apron including excavation of trough for the base filter layer and all work related thereto.

Measurement and Payment

Measurement and payment for 12 inch thick stone apron/stone pitching grouted in 1:4 cement sand mortar shall be made in hundred (%) square feet of the specified stone actually placed and shall constitute full payment for procurement of materials and all operations involved for completion of works specified herein.

SECTION 8

LINING OF CANAL AND DISTRIBUTARY SYSTEM

SECTION 8 LINING OF CANAL AND DISTRIBUTARY SYSTEM ii

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LINING OF CANAL AND DISTRIBUTARY SYSTEM

SCOPE OF WORK

The work to be done by the contractor under this item shall include preparation of the subgrade and dressing, constructing concrete lining and all incidental operations necessary to construct concrete lining in main canal, distributaries and minors, in accordance with the Drawings and these Specifications and subject to approval of the Engineer.

Trial Section

Before starting full scale canal/distributaries lining operations, the Contractor shall carry out a trial section of the complete prism of the canal and distributaries for a length of not less than 50 feet. This trial section should be carried out in the same area on which trial section for earthwork has already been accepted and approved by the Engineer. The Contractor shall submit his proposals for this trial section to the Engineer for approval at least 14 days before he proposes to start the trial.

The trial section shall demonstrate the sequencing of lining operations, the effectiveness and the quality control of the Contractor's methods including, but not limited to the following matters:

- Preparation of sub-grade and dressing'
- Provision of stabilizing layer,
- Concrete batching arrangements,
- Arrangement for construction of concrete lining, forms, transporting, placing, vibrating, screeding and finishing concrete, placement of joints and associated fillers, sealants, curing etc.

The trial section will be incorporated into the Works, provided it complies in all respects with these Specifications. Should it not so comply, the Engineer may either instruct remedial measures, or complete removal of the trial section, reinstatement of the foundations, and a repeat trial, all at the Contractor's expense.

Preparing of Subgrade for Canal Lining

(1) Ensuring proper compaction of subgrade: Prior to canal/distributaries lining, the contractor shall prepare the subgrade including dressing of bed and side slopes filled or excavated sections of canal/distribution and any other backfill over which canal lining is to be placed. Before proceeding with canal/distributaries lining, the contractor shall ensure and prove to

the satisfaction of the Engineer by means of compaction tests that the subgrade of the whole canal/distributaries prism (slopes and bed) is in a state of compaction equal to 95% Standard Proctor or 70% relative density depending upon the type of material, to a minimum depth of one (1) foot below the final grade, measured perpendicular to the surfaces of the canal prism. No separate payment shall be made for compaction tests and their cost shall be deemed to have been included in the unit rates quoted for the other relevant items given in the BOQ. The Contractor shall re-work the areas which fail to meet the compaction requirements as described above and shall perform compaction by employing appropriate equipment and methods in order to ensure that the reworked portions meet the compaction requirements described above.

(2) Refilling of Over-excavated Areas: If at any point, material has been excavated beyond the neat lines required to receive the canal/distributaries lining, the excess excavation shall be refilled with compacted fill material and according to Section 3 – Earthwork. If at any point the foundation material is disturbed or loosened during the excavation process or otherwise, it shall be moistened if required and thoroughly compacted by tamping, rolling or other approved methods in accordance with Section 3 – Earthwork to form firm foundations to place the concrete lining.

(3) Finishing to Lines and Grades: In addition to the above, the work under subgrade preparation shall include but not be limited to cutting, filling, compacting, reworking, dressing and finishing the canal/distributaries prisms to true and even surfaces to the lines and grades shown on the Drawings in accordance with these Specifications and as directed by the Engineer.

PC Profiles

In case the Contractor opts to carry out concrete lining without using a lining machine, PC profiles shall be provided under the lining as shown on the Drawings. As such profiles are shown provisionally on the Drawings. After the preparation of sub-grade, a trench of size 9″ wide and 3″deep shall be excavated at the location of profiles. The PC profiles shall be allowed to harden and shall be water cured for 10 days and top surface shall be painted with two coats of hot bitumen before concrete lining is placed.

Concrete Lining

(1) General: Concrete for canal/distributaries lining shall be of Class B unreinforced, and shall be constructed in the canal/ distributaries prisms as shown on the Drawings, and its

strength shall be as specified herein.

Plain cement concrete for canal/distributaries lining shall be plastic enough to consolidate well and stiff enough to stay in place on specified slopes over 2" thick 1:30 cement sand stabilized layer on the compacted subgrade as shown on the drawings. Slump of concrete shall be in the range of 1 to 3 inches. The water-cement ratio shall be adjusted to achieve the specified slump and strength but shall not exceed 0.45 in any case. The compressive cylinder strength of the concrete (28 days) shall be 3,000 psi and the concrete will be cured by application of a curing compound subject to approval of the Engineer following the submission of a request including supporting procedural methods and documentation by the Contractor. Nominal maximum size of aggregate for concrete in canal/ distributaries lining shall be 3/4 inches. The subgrade shall be well moistened but not muddy at the time of placing concrete.

(2) Materials and Procedures: All the materials used in concrete canal/distributaries lining including Sulphate Resisting Cement, slag, sand, aggregate, water, curing compound and admixtures etc., mixing and batching, sampling and testing shall be in accordance with the standards and specifications given in other sections of these specifications relevant to these items.

(3) Formwork: Forms for the concrete canal/distributaries lining shall be in accordance with Section 5 – "Concrete, General" and as approved by the Engineer.

(4) Construction Joints: The place where contraction joint is not required but the concrete lining operations are interrupted because of breakdown or delayed by other causes, the edge of the fresh concrete lining shall be bullheaded to a perpendicular surface to the lining along transverse or longitudinal lines. When placing operations are resumed, the surface of the hardened concrete shall be prepared as a construction joint as specified herein. The fresh concrete shall then be placed against the existing concrete to form a permanent bond with the existing concrete. No payment shall be made to the contractor for making construction joints.

(5) Concrete Temperature: For concrete temperatures, refer to sub-section `Temperature' of the Section 5`Concrete – General' of the Specifications.

(6) Method of Concrete Lining: The contractor may carry out concrete lining with the lining machine(s) or manually.

(a) In case of machine lining, the contractor shall deploy the concrete lining machine(s) comprising Trimmer and Trimmer discharge conveyor, concrete liners, bottom feed conveyor, concrete curing jumbo, finishing jumbo and working bridge jumbo till the completion of canal lining. The concrete liner component for lining machine set should be capable of concrete lining at least 165 yd3 (125m3) per hour for 4 inch (100 mm) thick lining layer.

(b) The concrete batching plants, transit mixers, concrete pump, water chiller plants, crushing plants and other related equipment should manufacture and maintain the supply of concrete in such a capacity that the concrete liner can yield at least 165 yd3 (125m3) per hour.

(7) Replacement of Damaged/Rejected Concrete Panels: Where a damaged/rejected panel of concrete canal/distributaries lining is to be replaced, the old concrete shall be removed to the edges of the adjacent panels. The surfaces of the existing concrete shall be prepared as a contraction joint. Fresh concrete shall then be placed against the existing concrete with the full groove contraction joint formed adjacent to the existing concrete. The groove shall be sealed with elastomeric sealant in accordance with para 11.6(7) of this section.

(8) Joints: Contraction and dummy joints in lining shall be constructed as shown on the Drawings, according to the specification provided in this section. The joint formed at the end of the day's work in case of continuous lining, shall be made as contraction joint. Expansion joints would be provided where the lining abuts against the structures (where shown on the drawings) according to the specifications given for Expansion Joints in Section-14 "Miscellaneous Works".

(9) Curing: The Contractor shall cure lined surfaces of the Canal/Distributaries etc. as follows:

a) The exposed surfaces of the concrete shall be membrane cured with an approved, white pigmented curing compound which forms a water-retaining membrane on the surfaces of the concrete. Curing compound shall conform to ASTM Designation: C-309. The compound shall be of uniform consistency and quality within each container and from shipment to shipment. No water curing will be permitted for concrete placed for lining.

b) Curing compound shall be applied to the concrete surfaces by spraying in one coat to provide a continuous, uniform membrane over all areas. Coverage shall not exceed 150 square feet per gallon and on rough surfaces coverage shall be

decreased as necessary to obtain the required continuous membrane. Mortar encrustation and fines on surfaces shall be removed prior to application of the curing compound. The repair of all other surface imperfections shall not be made until after application of curing compound.

c) When curing compound is used on concrete surfaces where forms are not used, application of the compound shall commence immediately after finishing operations are completed. When curing compound is to be used on concrete surfaces where forms are used, the surfaces shall be moistened with a light spray of water immediately after the forms are removed and shall be kept wet until the surfaces will not absorb more moisture. As soon as the surface film of moisture disappears but while the surface still has a damp appearance, the sealing compound shall be applied. Special care shall be taken to ensure ample coverage with the compound at edges, corners and rough spots of formed surfaces. When application of the sealing compound has been completed and the coating is dry to touch, any required repair of concrete surfaces shall be performed. Each repair, after being finished shall be moistened and coated with sealing compound in accordance with the foregoing requirements.

d) Equipment for applying sealing compound and the method of application shall be in accordance with the provisions of Chapter VI of the 8th Edition of the Bureau of Reclamation Concrete Manual. Any sealing membrane that is damaged or that peels from concrete surfaces, prior to 28 days after application, shall be repaired without delay in an approved manner.

e) Sealing compound will be accepted on Manufacturer's certification of compliance with specifications, but the acceptance on certification shall in no way relieve the Contractor of the responsibility for furnishing the compound meeting specification requirements. Sealing compounds shall be subject to sampling and testing. The Contractor shall provide without charge to the Employer such facilities and assistances as may be necessary to obtain test samples. Sampling will be in accordance with Designation 38 of the 8th Edition of the Bureau of Reclamation Concrete Manual.

f) The costs of furnishing and applying all materials for curing concrete shall be included in the unit rate tendered in the Bill of Quantities for the applicable concrete item on which the curing materials are used.

(10) Tolerances for Concrete Construction: The canal/ distributaries lining shall be built to the lines, grades and dimensions shown on the Drawings. The dimensions shown on the Drawings will be subject to such modifications as may be found necessary by the

Engineer to adapt to the conditions exposed by the excavation or to meet other site conditions. Where the thickness of any portion of concrete is variable, it shall vary uniformly between the dimensions shown.

Tolerances for Canal/Distributaries Lining

	Description	Limit
(i)	Departure from established alignment	± 2 in. on tangents ± 4 in. on curves
(ii)	Departure from established profile grade. Departures set forth above shall be uniform and no correction shall be made in less than 100 feet.	±1 in.
(iii)	Reduction in thickness of lining	(-¼) inch of specified thick-ness provided that average thick-ness over any 20 feet length is not less than the specified thickness.
(iv)	Variation from specified width at any height.	± 1 inch of specified width.
(v)	Variation from specified height of lining.	± 1 inch of established height.

Joints in Canal/Distributaries Lining

(1) General: Types of joints as shown on the Drawings are generally contraction and dummy joints which shall be constructed or placed in concrete canal lining.

The joints shall be made along straight lines and the required shape and dimensions shall be maintained during any subsequent finishing operations until the concrete has hardened.

The Contractor shall drill 6 inch diameter cores for inspection of joints at locations designated by the Engineer to determine the effectiveness of the Contractors joint installation procedures. Additional cores shall be drilled by the Contractor for any other purpose so designated by the Engineer. All core holes shall be repaired by and at the cost of the Contractor immediately following completion of the inspection of the holes by the Engineer unless otherwise directed. The method and manner of repair shall be approved by the Engineer.

If inspection reveals that the joint does not meet these Specifications, the Contractor shall promptly modify equipment and installation procedures to ensure compliance with these Specifications and in addition shall, at his own expense, correct the defective work as required.

(2) Construction joints: Construction joints are purposely placed in concrete at spacings that vary from the spacing shown on the Drawings and in order to facilitate special conditions at structures, interruption because of breakdown, or delayed by other causes. The spacings shall not be less than one-half of the spacing shown on the Drawings. These joints are provided to reduce initial shrinkage stresses and cracks; to allow time of the installation of embedded metal work; or to allow for the subsequent placing of other concrete. Bond shall be ensured at construction joints.

The location of all construction joints in concrete work shall be subject to approval of the Engineer, and the joints shall be constructed in accordance with the Specifications. No payment shall be made to the Contractor for making construction joints.

(3) Contraction Joints: Contraction joints shall be the joints placed in concrete to provide for volumetric shrinkage of a monolithic unit or movement between monolithic units. The concrete lining placing operations should be scheduled such that stoppage of day's work is at specified location of the contraction joint as for as possible. The joints shall be so constructed that there will be no bond between the concrete surfaces forming the joint.

Contraction joints shall be constructed at location shown on the Drawings. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The surface of the concrete first placed at the contraction joint shall be coated with curing compound and two coats of bitumen before the concrete is placed on the other side of the joint. Special care shall be taken to ensure proper compaction of concrete near the joint faces.

A groove will be formed at the top of lining on one side of the joint as shown on the Drawings and filled with elastomeric sealant in accordance with paragraph (7) below.

(4) Dummy Joints: Dummy joints shall be the joints provided in the lining in the slopes and bed of the canal/distributaries lining as shown on the Drawings. They are to be grooved into fresh concrete and filled with elastomeric sealant in accordance with the paragraph (7) below.

(5) Approval of Joints: One copy and one reproducible of the drawings and data showing the joints, joint intersections, and the method of construction shall be submitted by the Contractor to the Engineer for approval.

(6) Edges: The Contractor shall tool or chamfer edges of concrete where shown on the Drawings and elsewhere as directed by the Engineer.

(7) Sealant: The elastomeric sealant to be used in joints shall be of the type suitable for immersion in water and conforming to ASTM C920-98 type S or M or equivalent subject to approval by the Engineer.

(8) The sealant shall be filled in the groove as soon as the concrete has gained its 14 days strength in order to avoid deposition and consolidation of any undesirable material in the groove which may impair the function of the joint.

The concrete groove shall be sand blasted to produce a rough surface and to remove all debris, scale, dirt, oil, laitance, curing compound, and other foreign materials just before the application of the elastomeric sealant. The concrete shall be at least 14 days old before it is sand blasted. The joint groove that has been sandblasted shall be blown out under high pressure compressed air to remove all residue. Elastomeric sealant shall not be placed in dusty weather or while rain is falling. At the time of placing the joint sealant, the joint groove shall be clean and dry.

The storage and application of the sealant and any necessary primer shall be strictly in accordance with the manufacturers recommendations. The method of mixing the sealant shall result in homogeneous material.

The sealant shall be extruded at the bottom of the joint groove and shall be tooled as necessary to work the sealant into intimate contact with the concrete without entrapping air. The top surface of the sealant shall be tooled to the shape shown on the Drawings.

Elastomeric sealant which does not cure to a homogenous, rubber like compound, or which does not bond to the joint-groove faces or to this Specification shall be removed and replaced by the Contractor at no additional cost to the Employer.

Measurement and Payment

(1) Sub-grade Preparation including dressing: Measure-ment for payment of sub-grade preparation including dressing shall be made for the surface area of sub-grade prepared under the canal/Distributaries lining in bed and side slopes and shall be measured in hundred square feet.

Payment shall be made at the unit rate tendered per hundred square-feet in the BOQ for preparation of sub-grade and dressing and shall constitute full compensation for the work performed for sub-grade preparation and dressing including all labour, equipment, operations and compaction testing etc., complete in all respects.

(2) Concrete Lining: Measurement for payment of concrete placed in lining shall be made of the volume of the concrete placed for canal/distributaries lining according to the design lines in hundred cubic feet.

Payment shall be made at the unit rate tendered per hundred cubic-feet in the BOQ for concrete for main canal and distributaries lining and shall constitute full compensation for the work performed for moistening of subgrade prior to concrete placement and concrete placement including material, labour, equipment and its operation, curing compound, admixtures and testing etc., complete in all respects.

(3) Stabilized Layer 1:30 Cement Sand Under the Canal/Distributaries Lining: Measurement of 1:30 cement sand stabilized layer under the canal/distributaries lining shall be made of the area in hundred square feet.

Payment shall be made at the unit price quoted per hundred square feet in the Bill of Quantities for completion of work.

The amount tendered shall be full payment for completion of the work including but not limited to procurement, transportation, placing and compaction according to the specifications and as directed by the Engineer.

(4) Contraction Joints: Measurement of contraction joints in canal/distributaries lining shall be made of the length of the joints prepared according to design lines for canal/distributaries linings in running feet.

Payment shall be made at the unit rate tendered per running-foot in the BOQ for joints in canal/distributaries lining and shall constitute full compensation for the work of providing joints in canal/distributaries lining complete in all respects including two coats of bitumen on vertical face of contraction joint and providing sealant in the groove.

(5) Dummy Joints: Measurement of dummy joints in canal/distributaries lining shall be made of the length of the joints prepared according to design lines for canal/distributaries linings in running feet.

Payment shall be made at the unit rate tendered per running-foot in the BOQ for joints in canal/distributaries lining and shall constitute full compensation for the work of providing joints in canal/distributaries lining complete in all respects including providing sealant in the groove.

(6) Rainwater Drain Inlet Structures: Measurement for rainwater drain inlet structures shall be made in number of complete inlet structures constructed in canal banks as per drawings.

Payment shall be made in number of inlet structures for specified pipe diameter measured as above and shall constitute full payment for provision of MS grating, stone pitching, RCC pipes, concrete and other materials and operations required to complete the specified works in all respects.

(7) Rainwater Drain Manhole Structures with Chutes: Measurement for rainwater drain manhole structures with chutes shall be made in number of completed manhole structures along with chutes constructed in deep cut areas in specified reaches as per drawings.

Payment for rainwater drain manhole structures for the specified chute size as measured above shall be made at the unit rate tendered per number of each size and shall constitute full payment for manhole structure and chute constructed of plain cement concrete and brick masonry, lean concrete, etc. including all material, labour, operations (curing), and equipment to complete the specified works in all respects.

(8) Bathing Steps: Measurement for installing reinforced concrete class B bathing steps using slag and SRC, shall be made in hundred cubic feet of reinforced concrete placed in bathing steps as per drawings.

Payment for installing reinforced concrete bathing steps shall be made at the unit rate tendered per hundred cubic feet and shall constitute full payment for materials including curing compound, admixtures, etc. complete in all respects excluding reinforcement pletion of works specified herein.

SECTION 9

METAL WORK

SECTION 9 METAL WORK iii

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METAL WORK

SCOPE

Coverage

This Section covers general requirements for metals, metalwork fabrication, methods and precautions for erection of metal structures and machines, and other miscellaneous general requirements incidental to metalwork, including all metalwork not otherwise specified under other sections of these Specifications.

General Description

In accordance with these Specifications and as shown on the Drawings or as directed, the Contractor shall detail, furnish, fabricate, install, test, paint and galvanize (when metalwork specified). .

Ferrous metalwork shall include but not be limited to the following:

- ► Chain-link fence and gates
- ► Steel crash barriers
- ► Steel pipe handrail

Miscellaneous ferrous metalwork, complete with anchors, bolts, expansion anchors, shear connectors and fastenings, including but not limited to the following:

- ► Structural steel for precast concrete covers, structural steel frames, covers, gratings, embedded rungs, walkways, supports, platforms, gates; steel ladders, and safety cages;
- ► Galvanized corrugated sheet metal for control joints and sub-drained floors;
- ► Cast-iron frames, covers, gratings and drain scuppers;
- ► Stair nosing;
- ► Expansion joint covers;
- ► Pipes and fittings for drain, grout and check holes, and embedded pipe sleeves

- ► Welding pads, including those required for manufacturer-furnished guides for gates,
- ► Electrical and mechanical equipment.

REFERENCE STANDARDS

Reference standards are referred to in the text in abbreviated form (e.g. ASTM A36). Full titles are given below for convenience.

American Society for Testing and Materials (ASTM)	
Standard	**Subject**
ASTM A 1	Open-hearth carbon steel rails
ASTM A6	General Requirements for rolled steel plates, shapes, sheet piling and
ASTM A36	Structural steel
ASTM A48	Grey iron castings
ASTM A53	Welded and seamless steel pipe
ASTM A90	Methods of test for weight of coating on zinc coated (galvanized iron or steel articles
ASTM A 108	Steel bars, carbon, cold finished, standard quality
ASTM A 120	Black and hot dipped zinc-coated (galvanized welded and seamless steel pipe for ordinary use,
ASTM A 123	Zinc (hot-dip galvanized coatings on iron and steel products
ASTM A 153	Zinc-coating (hot-dipon iron and steel hardware
ASTM A276	Stainless and heat-resisting steel bars and shapes
ASTM A307	Carbon steel bolts and studs
ASTM A325	High strength bolts .for structural steel joints
TM A392	Zinc-coated steel chain-link fence fabric
ASTM A492	Stainless steel and heat resisting steel rope wire
ASTM A502	Steel structural rivets
ASTM A563	Carbon and alloy steel nuts
ASTM A588	High-strength low-alloy structural steel with 50,000 psi minimum yield point to 4 in. thick
American Welding Society (AWS)	
AWS A5.1	Mild steel covered arc-welding electrodes
AWS A5.4	Corrosion-resisting chromium and chromium-nickel steel covered arc welding electrodes

American Society for Testing and Materials (ASTM)	
Standard	**Subject**
AWS A5.5	Low alloy steel covered arc-welding electrodes
AWS D1.1	Structural welding code - steel
AWS D1.3	Structural welding code - sheet steel
US Federal Specification (US)	
FF-P-101	Padlocks
FF-W-84	Washers, lock (spring)
RR-F-183	Fence posts, gates and accessories
RR-F-221	Fencing (barbed wire, woven wire and wire netting)

SUBMISSIONS BY CONTRACTOR

The submissions, which the Contractor shall provide in relation to Metalwork are specified below.

Shop Drawings

Before any fabrication is started, the Contractor shall prepare and submit detailed shop drawings to the Engineer for approval. The shop drawings for fabrication shall give full detailed dimensions and sizes of component parts of the structure and details of all miscellaneous parts, such as pins, nuts, bolts and rivets. During the preparation of shop drawings, the Contractor shall check all dimensions for the metalwork and shall report any discrepancies to the Engineer. The shop drawings shall be prepared in accordance with Clause under the Special Provisions. Metalwork shall be detailed and fabricated so that the formation of pockets to hold water or - dirt is minimized where such pockets are unavoidable, suitable drainage shall be provided.

Erection Drawings

Not later than prior to erecting metalwork items, the Contractor shall submit detailed erection drawings to the Engineer for approval.

Erection drawings shall indicate the weight of each major lifted part and the application of lifting devices, and shall include lifting brackets, temporary connections for erection, holding supports and the equipment to be used. Maximum stresses occurring during handling shall be indicated.

Certificates and Records.

As specified herein or upon request by the Engineer, the Contractor shall submit to the Engineer the following:

- Two certified copies of mill orders.
- Certified copies of test reports of all pertinent required tests of applicable AWS codes, made on electrodes of the same class, size and brand, or on the same flux electrode combination and which were manufactured by the same process and with the same materials as the electrodes and flux furnished.
- Certification of welders' examinations including certified copies of the reports of the results of the physical tests conducted-for qualification of welders, welding operators and welding procedures as recommended by AWS D 1.1.

MATERIALS

Structural Steel

Structural carbon steel for structural steel shapes, plates, bars, and steel threaded fasteners unless otherwise noted shall conform to ASTM A36.

The tolerances of mill materials shall conform to the requirements of ASTM A6.

Black Pipe and .Steel Pipe Handrails

Black pipe (welded and seamless for ordinary uses for drain, grout and check holes shall conform to ASTM A 120. Steel pipe for handrails and posts shall conform to the requirements of ASTM A53.

High Strength Structural Bolts

High strength structural bolts shall be friction type, with nuts and plain hardened washers, conforming to ASTM A325 unless otherwise approved.

Miscellaneous Structural Hardware

Anchor bolts, nuts and washers for handrails and other concrete-embedded bolts shall conform

to ASTM A307. The ends of all exposed anchor bolts shall be galvanized to a point at least 2 inches (50mm) below the concrete surface.

Expansion Anchors

Expansion anchors shall be WEJ-IT Type as manufactured by WEJ-IT Expansion Products, Inc., industrial Park, Broomfield, Colorado, USA, or equivalent.

Lock Washers

Lock washers shall conform to the requirements of US Federal Specifications FF-W-84 for Washers, Lock (spring). Unless otherwise indicated or specified, washers shall be Class A carbon steel, style 3, heavy.

Stair Nosing

Ferrous stair safety tread nosing shall be “Ferrulum" as manufactured by American Abrasive Metals Company, Irvington, New Jersey, USA, or equivalent

Cast Iron

Cast iron for frames, covers, gratings and drain scuppers shall conform to ASTM A48.

Welding Rod

Unless otherwise shown on the Drawings, welding rods shall conform to the requirements specified below.

Structural Welding Rod

Electrodes conforming to AWS A5.1, E-60 or E-70 Series, shall be used for structural-.carbon steels and AWS A5.5 E-70 series low-hydrogen electrodes shall be used for high- strength low alloy steels.

Corrosion-resisting Welding Rod

Corrosion-resisting chromium and chromium nickel steel covered welding electrodes shall conform to AWS A5.4, E-308 series for type 304 steel and E-309 series for structural carbon

steel.

Chain-Link Fence and Gates

Description

Fence shall be the chain-link type, having a fabric 8 ft high surmounted with 3 strands of aluminum-coated steel barbed wire unless otherwise noted on the Drawings.

Accessories

Accessories shall be of the design that is standard with the manufacturer. The accessories shall be of the following materials and equal to the materials specified in US RR-F-183. All ferrous pipe, posts, fittings and accessories shall be hot-dip galvanized after fabrication in accordance with ASTM A153.

Post tops, extension arms, gate hinges, stretcher bars, top-rail fittings, stretcher-bar bands, clips, fabric bands, bolts and nuts shall be steel, wrought iron or malleable iron.

Fence Fabric

The fabric shall be composed of 9-gauge coated steel wire, interwoven to form a chain-link fabric having a 2 inches (50 mm) diamond mesh. Zinc-coated fabric shall be provided. This coating shall be by the hot-dip process after fabrication, or fabric shall be fabricated from wire with an electrolyticaily deposited zinc coating. Weight of zinc coating shall be Class 2, not less than 0.13lb/ft2 (0.60 kg/sq. m) of uncoated wire surface. Fabric shall conform to ASTM A392.

Padlocks

Padlocks shall conform to US FF-P-101, Type EPB, and 2 inches (50 mm) size with chain.

Fence Post and Gates

Fence posts and gates shall conform to US RR-F-183. The sizes shall be as shown on the drawings. Steel pipe for posts and gates shall be standard weight pipe (Schedule 40un less otherwise specified.

Wire

Barbed wire shall be according to US RR-F-221, Type A, zinc-coated, 2 twisted strands of 12 1/2 gauge wire with 4-point, 14-gauge, round barbs spaced at not more than 5 inches (125 mm) centers.

Bottom reinforcing wire shall be 7 gauge coiled spring wire conforming to US RR-F-183.

Stud Shear Connections

Welded stud shear connectors shall conform to ASTM A108, Grades 1015, 1018 or 1020.

G.I. Sheet for Roofing

Scope

Unless otherwise specified, galvanized steel sheet roofing (corrugated shall be constructed in accordance with the following specifications:

Materials

a) Galvanized corrugated steel sheets shall conform to the approved drawings.

b) Fixing accessories, hook bolts, screws, bolts, nut rivets, Washers shall be galvanized or shall be of any other approved quality.

c) Sealing material shall be bituminous mastic or of any other approved quality.

d) Flashing gutters shall conform to the approved drawings for Flashing Gutters.

Lap

a) End lap shall be minimum 6 inch for slope and 4 inch for vertical fall which shall be sealed with specified sealing material.

b) Side lap shall be formed on the sides of the sheet, away from the prevailing direction of wind. The side lap shall vary from one to two corrugations as specified.

Insulating Material

Wherever specified, insulating material of approved quality shall be laid either between the purlins and the sheet or under purlins incorporating air gap.

Purlin Spacing

Purlin spacing for roof covering with G.C.S. sheet shall be arranged with a view to using standard sheets of uniform length throughout and the trusses shall be designed for purlin spacing to suit the standard length of these sheets to avoid unnecessary cuttings. Ridges purlins shall be as near to the ridge as possible having regard to the type of ridge capping to be used and the manner in which it is to be fixed.

Holes

The hole for fixing bolts shall be made through crown of the corrugations and shall be either punched or drilled and shall be 0.06 inches (1.5 mm) larger in diameter than the bolts or fixing screws to be used.

Holes shall be in the exact position to suit the purlins and no hole for fixing bolts hail be nearer than 1.5 inch to the end of the sheet. These holes shall be made in a manner that the rises of the punched hole shall come on top when the sheets are laid. Where 4 sheets overlap, holes shall be drilled and not punched.

Laying of Sheet

Before the laying of sheet begins it shall be seen that all purlins are in true plane correctly spaced and securely fixed. The purlins spacing and the length of sheet shall first be checked to see that the arrangement will provide the specified overhanging at the eaves and the laps. The eave course shall be laid first and work shall start at the leeward end of the building so that side laps have better protection from the rain driven by the prevailing wind. The top edges of eave sheet shall extend at least 1.5 inch beyond in back of steel purlins or 3 inch beyond the center line of the timber purlin.

Fixing Sheets

Sheets shall be fixed to steel purlins by hook bolts and to timber purlins by mushroom headed galvanized drive screw. Hook bolts and drive screw shall be form 6mm to 9mm in diameter as specified and shall be spaced at an interval of not more than 1.25 ft. Sheets shall be secured at every purlin by at least 2 bolts. Nuts or heads of drive screws shall have specifically made washer to render the hole to waterproof. Washers shall be “Limpet” patent doom and shall be bedded on bituminous felt. Screws or bolts shall be tightened sufficiently to seat washer over the corrugation.

Ridges & Hips

a) General accessories. Ridge or hip capping, whenever possible, shall be secured to the purlins by the same bolts or screw which secured the sheeting.

b) Ridge cap shall be made up of galvanized flat steel conforming to the approved drawing or otherwise specified. In case (above is not possible as the purlin is not sufficiently near the ridge, the capping shall be secured to the sheet by 0.25 inches to 0.36 inches (6 mm to 9 mm) diameter bolts: two roofing bolts to each wing capping at center not further apart than the bolts used for sheets. The lap of the capping along the ridge shall not be less than 6 inch and shall be so arranged as to protect the joints from the prevailing.

Hip cap shall be cut to the required miter and shall be close butted. The slope joints shall be covered with plain ridge cap which shall be secured through the roof sheet or the slope runner by one bolt on each side at the same spacing as for the roof sheets. Hip caps shall have a minimum lap of 6 inches (15 cm).

Special Fastenings against Cables

For any situation exposed to strong winds, sheet shall be fastened down above the eave by continuous length of 1 ½ x 1 ½ flat iron bars bolted down every 5 x 14 by 0.5 inches (12 mm) bolt built 1 feet into the wall and secured at the lower end by a 3 square washer.

Painting of Sheet

A Wherever desired, sheets shall be painted with specified paint.

Steel Sheet Piles

Steel sheet piles shall comply with BS 4360, grade 50 B. Steel sheet piles shall be of the straight web type. The Engineer shall approve the sections. Piles shall be straight.

Steel sheet piles shall be capable of being interlocked, with each other, to form a continuous wall or diaphragm. Special corner plates shall be provided at all abrupt changes of directions.

Steel sheet piles shall be rolled, shaped and cut to length under factory conditions. Maximum rolling margins shall be 4% above and 2.5% below the calculated masses, and 3 inch over and 2 inch under the required lengths.

WORKMANSHIP

General

Design, fabrication and erection of ferrous metalwork shall conform to the applicable provisions of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings and the AISC Code of Standard Practice for Steel Buildings and Bridges.

Stud Shear Connectors.

Stud shear connectors shall be of a design suitable for electric end welding and shall be end welded to steel beams, girders or plates with automatically timed stud welding equipment connected to a suitable power source. The type, diameter, and length of stud shall be as specified on the Drawings. Shear connectors, welding procedure, and testing shall conform to the provisions of the AASHTO ''Standard Specifications for Highway Bridges'.

Electric Welding

General

Welding of metalwork shall conform to AWS D1.1, Sections 1 through 8. Temporary or permanent welds not shown on the Drawings will not be permitted without authorization by the Engineer.

Preparation for welding

Members to be joined by welding shall be cut accurately to size, with edges sheared, flame cut or machined to suit the required type of welding and to allow thorough penetration. The surfaces of plates to be welded shall be free from rust, grease and other foreign matter along the edges prepared for welding. The cut surfaces shall be free of all injurious defects.

Welding-

The techniques of welding employed, the appearance and quality of the welds made, and the methods used in correcting defective work shall-conform to AWS D1.1. Gas metal welding shall not he used. Flux core arc welding shall be limited to low-hydrogen type electrodes. All welds on hand railing shall be ground smooth and flush.

Qualification of Welders and Welding Operators

All welders and welding operators assigned to the Work shall have passed, within the preceding 6 months, the qualification tests recommended by AWS D1.1 as appropriate for the work they are assigned to undertake.

Bolting

Bolt Holes

Holes for unfinished bolts shall be not more than 0.06 inches (1.5 mm) larger than the nominal diameter of the exits, and holes for turned bolts shall be not more than 0.02 inches (0.5 mm) larger than the nominal diameter of the bolt. Where the thickness of material is greater than the nominal diameter of the bolts, holes for unfinished bolts shall be sub-punched and reamed, or sub-drilled and reamed, or drilled from the solid. Holes for turned bolts shall be truly cylindrical throughout and drilling and reaming shall be done after the parts to be connected are assembled. Poor matching of holes shall be cause for rejection.

High Strength Bolted Connections

High strength bolts- shall be installed in. accordance with ASTM A325. Burrs shall be removed from around bolt holes.

At the time of assembly the surfaces in contact shall be free of paint or any other applied finish, oil, dirt, loose rust, loose scale, burrs and other defects which may prevent solid seating of the

parts.

Bolts used to transmit shear shall be 0.04 inches (1 mm) less in diameter than the hole and the threaded portion 0.08 inches (2 mm) less than the shank. The length of the shank shall be 0.08 inches (2 mm) greater than the grip. A washer not less than 0.25 inches (6 mm) thick shall be used under the nut.

Bolts shall be tightened to the specified tension with the help of preset torque wrenches, the setting of these being checked frequently for accuracy

Protection of Surfaces

Machine-finished surfaces shall be thoroughly cleaned of foreign matter and coated with an approved rust preventive compound prior to removal from the shop. Finished surfaces of larger parts and other surfaces shall be protected with wooden pads or other suitable means.

Unassembled pins and bolts shall be oiled and wrapped with moisture-resistant paper or protected by other approved means.

Finished surfaces of ferrous metals to be in bolted contact shall be cleaned, washed with a rust inhibitor and given one thin coat of white or blue lead and tung oil.

Finished surfaces of ferrous metals, which will be exposed after installation shall be painted in accordance with. The requirements of Painting Specification or as directed by the Engineer.

Fabrication

General

All members shall be free of twists, bends or other deformations, and all surfaces that will be in contact shall be thoroughly cleaned before assembly. Parts shall be adjusted to line and fit and shall be firmly bolted or otherwise held securely together so that surfaces are in close contact before welding or drilling is commenced. Equipment shall be fabricated in subassemblies as large as shipping clearances permit. All sub-assemblies shall be clearly identified by proper markings, which shall conform to markings on the Contractor’s assembly drawings. Bolts, nuts, washers and other small parts shall be boxed for shipment.

Fit and Tolerance

Structural steelwork shall be fabricated and assembled in accordance with the dimensional and

fit tolerances specified herein.

- A maximum variation of 1 mm is permissible in the overall length of members with both ends finished. A finished surface shall be defined as having a maximum ANSI roughness height value of 500 and it shall be used for contact bearing.

- Members which are to be framed shall be without ends finished and their length may have a variation from the detailed length not greater than 0.06 inches (1.5 mm) for members 9 m or less in length and not greater than 3 mm for members over 9 m in length.

- Where a permissible deviation in depth of girders results in an abrupt change at a splice, it shall be taken up by fill plates at a bolted joint. At a welded joint the weld profile shall be adjusted to conform to the variation in depth, provided that the minimum cross-section of the required weld is furnished and that the slope of the weld surface meets AWS code requirements.

- A temperature correction shall be applied where necessary in the layout of critical dimension for steel work. The coefficient of expansion for structural steel shall be taken as 0.000012 per degree Centigrade.

Fit of Stiffeners.

End stiffeners of girders and stiffeners intended as supports for concentrated loads should have full bearing (either milled, ground or, on weld-able steel in compression areas of flanges, welded as shown on the Drawings or specified on the flanges to which they transmit load or from which they receive load. Stiffeners not intended to support concentrated loads shall, unless shown or specified otherwise, fit sufficiently tightly to exclude water after being painted. Ends of stiffeners shall not be welded to the tension flanges.

Straightness

Rolled material shall be straight and true before being laid out or worked. Necessary straightening shall be accomplished by methods that will not injure the metal. Sharp kinks bends shall be cause for rejection. Permissible variation in straightness for rolled shapes or built-up members shall be within the tolerances specified for wide flange shapes by ASTM A6 except that for compression members the deviation from straightness shall be less than 1/1000 of the axial length between points which are to be laterally supported.

Camber

Camber for webs of steel girders shall be obtained by cutting the plates to the prescribed

camber with suitable allowance for shrinkage due to cutting and welding. The beat-curving process for girder cambering shall not be permitted. Beams and trusses detailed without specified camber shall be fabricated so that after erection any camber due to rolling or shop fabrication is upwards.

Shearing and Cutting

Shearing, chipping and cutting shall be done neatly and accurately, and ail exposed edges shall be smooth. Where explicitly shown on the approved Contractor's drawings, structural shapes and plates may be cut by an oxyacetylene flame, guided by mechanical means. No material shall be cut by electric arc means.

Holes

All holes shall be accurately spaced, cylindrical, and perpendicular to the member. All counter-sinking shall be true and square with the holes.

All holes in metal thickness of 0.5 inches (12 mm) and more shall be drilled.

Punching

The diameter of the die shall.be not more than'0.13 inches (3 mm) larger than the diameter of the punch. All holes shall be clean cut, without torn or ragged edges. Burrs resulting from punching, reaming or drilling shall be removed with a suitable tool.

Dimensional Tolerance Limits

Dimensional tolerance limits for steel girder webs and flanges shall be applied to each completed but unloaded member and shall be within tolerances comparable to the tolerances specified in ASTM A6 for structural shapes and AISC Specifications.

Galvanizing

Galvanized Coatings

Material, including bolts, expansion anchors, nuts, and lock nuts, handrails, and posts gratings and grating frames, where shown on the Drawings or specified, shall be hot-dip galvanized. Material shall not he galvanized until all shop operations upon it have been completed, except

that nuts may he threaded after galvanizing. Tops of all exposed anchor bolts shall be galvanized to a point 2 inches (50 mm) below the concrete surface.

Structural shapes and plates shall be galvanized in accordance with the requirements of ASTM A123. Sharp edges of radius less than 0.13 inches (3 mm) shall withstand 4 immersions of the Standard Preece .Test, and all other coatings shall withstand 6 immersions. Bolts, nuts, washers, lock nuts and similar hardware shall be galvanized in accordance with ASTM A153, which specifies the number of immersions of the Standard Preece Test that the coating shall withstand.

Warp and sweep required to be removed after galvanizing shall be removed by pressing or rolling the material. Material that cannot be straightened without injury to the galvanizing will be rejected.

Defective or Damaged Galvanized Coatings

Defective or damaged galvanized coatings shall be identified under defects and major damage or minor damage as specified herein. The classification of galvanizing defects and damage shall be determined by the Engineer, and his decision shall be final.

Defects and Major Damage

Defects, including non-adherence of zinc to the steel, excessive variation in coating thickness, thick localized zinc deposits, excessive roughness of coatings, or other faults cause for showing evidence that the galvanizing has been unsatisfactorily applied, shall be rejection.

Major damage is removal of the zinc coating to such extent that the hare steel is such damage shall be cause for rejection, whether resulting from abrasion in handling during loading operations.

All steel adjudged to have galvanized coatings with defects or major damage shall be re-galvanized. Repair work on defects or major damage will not be permitted either in the shop or the field. Repairs by a metal spray process, 'soldering or other similar methods will not be permitted. All steel rejected for defects or major damage to galvanizing shall be acid stripped, the base metal properly prepared, and completely re-galvanized by the hot-dip process. .

Minor Damage

Slight damage in small localized areas may be classed as minor damage if hare steel is not exposed in the damaged areas. Minor damage, usually resulting from handling, bundling, or shipping hazards, may he characterized by two types, namely crushed or chipped-off zinc and worn spots caused by abrasion.

Small area of crushed or chipped-off zinc not exceeding 1.55 in^2 (1000 sq mm) in area may be repaired provided that, the surface of any damaged area shows clearly the presence of the inner amalgam coating of steel and zinc, and the damaged area shows no evidence of rusting or non-adherence of the original coating.

Worn spots caused by abrasion or rubbing in which the zinc coating has been thinned, but not rubbed through to bare steel may be repaired

An excessive number of damaged areas on any one piece of steel shall be cause to require the piece to he re-galvanized.

Repair to minor damage, except complete re-galvanizing, will not be permitted at the galvanizing plant before shipment. Repairing of minor damage by painting the affected area with 3 coats of zinc-rich paint will be permitted at the site of the work only on the types of minor damage noted above. The materials and methods used in the repairing of minor damage by painting shall be subject to approval by the Engineer. The Contractor shall not proceed with any painting without permission by the Engineer, The latitude extended to the Contractor in permitting the repair of minor damage by painting as herein specified shall in no way relieve the Contractor of his responsibility for exercising every reasonable precaution to eliminate defects and keep damage of all kinds at a minimum.

Steel with defective or major damaged galvanizing found at the site of the Work shall be segregated and marked “Re-galvanize" and kept separate from minor damaged galvanized steel marked Repair.

Painting

Painting shall conform to the applicable requirements of Painting Specifications.

Shop Assembly

For shop assembled metalwork, the tolerances shall not exceed those shown on the Drawings and each unit assembled shall be closely checked to ensure that all necessary clearances have been provided and that binding does not occur in any moving part.

Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match marked so that they can be reassembled in the same position The parts shall not be interchanged. Diagrams showing such match marks shall be placed on record.

Reaming or drilling full size of assembled parts or members shall be done after the parts or

members are so firmly bolted or clamped together as to bring the surfaces in close contact.

Splices.

Splices shall develop the full strength of the section where the splice is made.

Field Erection Methods

Prior to commencing field erection, all material to be installed shall be cleaned thoroughly to remove rust, dirt, grit, packing compounds and other foreign matter, and the Contractor shall inform the Engineer of the method of erection, welding, bolting sequence and the type of equipment he proposes to use. He shall also submit, for the approval of the Engineer, a detailed description of the method of handling and installation sequence of major subassemblies. The description shall also include the location and procedure of field assembly, the erection sequence and the type of support he is intending to use. Where erection drawings have not already been supplied to the Engineer, explanatory sketches or drawings shall be included showing lifting brackets, temporary erection connections and holding supports.

Materials used during Erection

The Contractor shall furnish all welding rods required for field welds and all anchors, temporary bracing, tie rods, shims, clamps, erection bolts and other miscellaneous i materials required to place metalwork in position and hold it in proper alignment during erection and concreting and/or grouting. Material and workmanship shall conform to the applicable requirements .stated herein except as otherwise specified. Any proposed departures due to field conditions shall be submitted to the Engineer for approval and no changes shall be made without prior written approval.

Steel Stairs and Ladders

Structural steel stairs and ladders, complete with channel stringers, grating treads and landings, structural steel supports, handrail supports and other fastenings, shall be furnished and installed in accordance with, the details, sizes and dimensions and at the locations shown on the Drawings. Safety cages shall be provided on ladders as shown. All material shall be galvanized after fabrication.

The stairs and ladders shall be' installed in a first class, workmanlike manner. Stair and ladder units shall be shop assembled arid fabricated in sub-assemblies for convenient installation. Field connections shall be made by welding and bolting as indicated on the Drawings.

Connections to adjacent concrete structures shall be made with cinch anchors or an approved equivalent. Anchor bolts, grating fasteners, washers and all parts of devices necessary for proper installation, whether or not fully detailed on the Drawings, shall be furnished and installed by the Contractor. All nuts, screws .and other fastening devices shall be tight. Galvanized lock washers shall be used under all nuts. Steel stair handrails shall be shop assembled, welded .and. galvanized, and delivered in convenient lengths for field installation. Field welding and cutting of handrails will not be permitted. If zinc coatings are damaged, the parts affected shall be repaired, re-galvanized or replaced by the Contractor as specified in the Specifications at no additional cost to the Employer.

Steel Pipe or GI Pipe Handrail.

Steel pipe or GI pipe handrail shall be furnished and installed in the manner -and at the locations shown on the Drawings.' Fixed and removable handrails and safety chains shall be, furnished and installed in the locations indicated on the Drawings. Pipe for handrail and posts shall be of the weight and sizes indicated on the Drawings and shall be securely supported. All shop connections shall be welded unless otherwise indicated on the Drawings. All handrails shall be galvanized after fabrication. Handrails shall be carefully adjusted prior to fixing in place to ensure proper matching at abutting joints and correct alignment and level throughout their length.

(Chain-link Fence)

The installed fence shall conform to the alignment and grade shown on the Drawings with posts plumb and wire and fabric stretched taut. Excavation for posts and other concrete embedded items shall be carried to the depths shown on the Drawings. Line posts shall be spaced at not more than 10 ft (3.0 m) on centers. All posts shall extend at least 3.0 ft (900mm) into footings, and the footings shall extend at least 8 inches (200 mm) below the post i (bottom. The concrete footings shall have a diameter of not less than 6 inches (150 mm) for line posts and not less than 1.5 ft (450 mm) for terminal and gate posts. The concrete shall be thoroughly compacted and shall be finished convex. The concrete shall be cured a minimum of 7 days in accordance with Section 8, Concrete Works, before any further work is done on the posts.

Post tops shall be installed as recommended by the manufacturer.

Top rails and accessories shall be installed prior to the installation of chain-link fabric. The top rails shall have sleeve couplers spaced at a maximum of 15' on centers. An expansion, contraction coupler, standard with the manufacturer, shall be provided every 100’ or fraction thereof. End clamps shall be used for attaching top rails to end posts, gate posts and pull posts and for attaching braces to line posts and gate posts. Corner clamps shall be used for attaching

top rails and braces at corner posts. Braces shall be installed at the mid-height of the fabric and two truss wires shall be provided at each gate, corner, pull or end post.

The bottom wire shall be installed prior to the installation of chain-link fabric. Each end, gate, corner, or pull post shall have a wire-stretching band.

Fabric shall be attached to the top rat! and bottom wire at intervals of not more than 2.0 ft) on centers and to the intermediate posts at intervals of not more than 1.0 ft to 2.0 ft (300 mm) on centers with fabric bands of 6 US gauge steel wire. The fabric shall be attached to end, corner, pull or gate posts with stretcher-bars and stretcher-bar bands. The bands shall be equally spaced on the stretcher bar and not over 300 mm on centers.

Gate frames shall be constructed of tubular members. Gate leaves more than 8' wide shall have intermediate members and/or diagonal truss rods, as necessary, to provide a rigid construction free from sag or twist. The end members of gate frames shall be extended vertically above the top member to carry three strands of barbed wire at the same heights as the strands of barbed wire on the fence. Clips or other approved fasteners shall be furnished for securely fastening the barbed wire to the extended members. All joints between tubular members shall be made by welding. Connections shall be rigid and weather-tight. Truss rods shall be 10 mm minimum diameter. Intermediate brace members shall be of the same section and weight as the main gate-frame members. Plunger bars shall be provided on double gates. Plunger bars shall have top, bottom and middle locking points with the middle point arranged for padlocking. The padlock shall be accessible from both sides of the gate.

Gate fabric shall be the same chain-link fabric as is used in the fence. The fabric shall be attached to the gate frame ends by use of bolt hooks, stretcher bar bands and stretcher bars, or other method standard with the manufacturer, except that welding the fabric to the gate frame will not be permitted. The fabric top and bottom shall be attached with standard wire clips at intervals not exceeding 1 foot on centres.

Padlocks shall be furbished for all gate openings; the locks shall have chains that are securely attached to the gates or gate posts. All the padlocks shall be of similar type, and three keys shall be provided for each padlock.

Bridge Deck Scupper Drains

General

Bridge deck scuppers shall be furnished and installed at locations as shown on the Drawings or as directed by the Engineer. Each scupper shall be supplied with a steel pipe .stub of proper length including straps and the miscellaneous hardware required for proper installation.

Construction Methods

Each scupper shall be placed and properly positioned in accordance with the details and to the lines and grades shown on the Drawings. After erection, all exposed steel pipe and all miscellaneous hardware shall be cleaned and painted with one field coat of paint, before embedment in concrete.

TESTING

General

Inspection of welds in all steel shall begin immediately after the welds are completed. In addition to inspection as required by AWS D1.1 and as specified below, all welds shall be visually examined. Procedures, techniques and standards of acceptance shall be in accordance with AWS D1.1.

Radiographic Testing

Butt welds in main members shall be tested radio-graphically as follows:-

- All butt splices shall be tested in full length by radiographic examination.
- All tension splices and all splices subject to reversal of stress shall be tested in full length by radiographic examination, except that on girder webs, only 17% of the web depth, beginning at the point or points of maximum tension, and 25% of the remainder of the web depth need be radio-graphed.
- 25% of each compression and shear splice shall be tested. Maximum spacing of the radiographs shall be four times the length of the radiographs. Alternatively, 25% of the compression and shear splices selected by the Engineer shall be radio-graphed. If unacceptable defects are found in more than 10% of the radiographs of the compression and shear splices, of a member, all compression and shear splices of that and succeeding members shall be radio-graphed until the accumulated rejection level falls to 10% or less, at which time the radio-graphing shall revert to the 25% level specified above.
- Should a radiograph indicate reject able defects, the areas on each side of the defect shall be radio-graphed to determine the extent of the defective area before repair.
- Defective welds shall be radio-graphed after repair.

► The Engineer reserves the right to view the making of the radiographs, examine and interpret the radiographs and technician's reports, review methods proposed by the

Contractor for repairing disapproved welds and inspect the preparation and re-welding of disapproved welds. The locations and findings of all radiographic inspections, together with descriptions of any repairs made, shall be recorded on proper testing sheets and a copy of each provided to the Engineer the day after the test/repair is carried out

Tests and Analysis

Genera!

The Contractor shall, at no additional cost to the Employer, perform analyses and tests to demonstrate that all materials furnished by him conform to these Specifications, except where such tests are waived in writing by the Engineer. Should the Contractor desire to use stock materials, not specifically manufactured for the work covered by these Specifications, he shall submit evidence satisfactory to the Engineer that such materials conform to the requirements of these Specifications and detailed tests of these materials will not be required, if so approved by the Engineer. Tests, except where modified, shall be made as ^indicated in these Specifications or on the Drawings and in the presence of the Engineer.

The Contractor shall furnish to the Engineer certified reports in duplicate of all required analyses and tests. The Contractor shall furnish to the Engineer, upon request, specimens and samples for independent analyses and tests, all properly labeled and prepared for shipment.

Analysis of Materials

If required by the Engineer, the Contractor shall furnish to the Engineer certificates listing the heat numbers and the chemical and physical properties of the metal from which articles or materials furnished by him were made. When required by the, Engineer, the Contractor shall also furnish two lists; one from the shop showing which pieces or members are to be madp from the material ordered, and the other from the mills showing which pieces or members are furnished from each heat or melt,

Tests of Welded Steel

General

Inspection of welds in all steel fabrications including pipes shall start immediately after the welds

are completed. All welds shall be visually examined. Except where otherwise specified below, procedures, techniques and standards of acceptance shall be in accordance with AWS D1.1

Non-destructive Testing

All welds in fabricated steelwork which in normal service are not subjected to high stresses shall be subjected to dye penetrant tests to check for the presence of cracks. Any cracks detected shall be cut out and repaired, and retested ultrasonically. Such steelwork shall include:

- chain link fence and gates;
- steel crash barriers;
- steel pipe handrail, and
- Welding pads.

All weids in fabricated steelwork which in normal service are subjected to high stresses shall be subjected to dye penetrant tests as specified above. In addition, the following tests shall be carried out:

Welds of structural steel members shall be ultrasonically tested for the presence and sizing of planar defects such as lamination, cracks and lack of fusion, and 10% of such welds shall be tested by radiography for the presence and sizing of cavities, solid inclusions, and incomplete penetration where a gap exists.

Such steelwork welds shall include:

- joints in load-bearing structural steelwork subject to bending and/or tension;
- welds in longitudinal members of steel ladders, ship ladders and safety cages, and
- Joints in track rails.

Repair of Defective Welds

If any test shows a defect in the welding or adjacent steel, the location of the defect shall be clearly marked. The extent of the defect shall then be determined by ultrasonic and/or radiographic testing, as appropriate, and the defect cut out and repaired, all subject to the approval of the Engineer. The repair shall then be tested.

The Contractor shall maintain a record of the results of all tests as well as the details of each

repair on suitable, test record sheets. A copy of each sheet shall be provided to the Engineer the day after the test or repair is carried out. The Engineer reserves the right to view the making of radiographs and to carry out his own ultrasonic tests.

Test of Galvanizing

Galvanizing shall be tested in accordance with the provisions of ASTM A90.

MEASUREMENT AND PAYMENT

General

Earthing of ferrous metal shall be measured and paid for in accordance with the applicable provisions of Mechanical and Electrical works.

Chain Link Fence and Gates

Measurement

Measurement shall be made of the areas in sq. feet of chain-link fabric fence and chain-link fabric gates acceptably installed in the Permanent Works. The area of fence shall be computed in square feet by multiplying the total length of fence measured from centre to centre of end of terminal posts by the nominal height of the fencing fabric.

The area occupied by pedestrian and vehicular gates shall be deducted. The gate area to be deducted shall be computed by multiplying the length between gate posts for each gate by the nominal height of the gate leaf.

Payment

Payment will be made for the number of square feet measured as above at the unit price for the respective Item.

The unit prices shall be deemed to cover all costs for furnishing and installing the chain-link fencing' and gates including foundations, concrete work, fence and gate posts, all accessories, coatings, padlocks and all other work related to the Item.

No separate payment shall be made for excavation of post holes, and the cost thereof shall be deemed to be included in the applicable unit prices for chain-link fence and for chain-link gates.

No separate payment shall be made for concrete and cement used in the base of fence and

posts and the cost thereof shall be deemed to be included in the applicable unit prices for chain-link fence and chain-link gates.

Steel Crash Barrier

Measurement

Measurement shall be made of the length in feet of steel crash barrier acceptably installed in the Permanent Works. Each separate run of steel crash barrier shall be measured between the centres of the two respective end posts.

Payment

Payment will be made for the number of feet measured as above at the unit price for the Item.

The unit price shall be deemed to cover all costs for furnishing and installing the steel crash parrier including the rail, wing terminals, posts, hardwood pads, bolts and other accessories, excavation, concrete including cement and all other work related to the Item.

Miscellaneous Ferrous Metalwork

Measurement*

Measurement shall be made of the weight of miscellaneous ferrous metal in the acceptably installed in the Permanent Works. Miscellaneous ferrous metalwork shall include all the miscellaneous ferrous metalwork, excluding pipes and fittings for grout and check holes and including any other approved ferrous metalwork of a generally similar kind that is not included for payment under another Item.

Measurement shall be computed from the approved shop drawings. Erection bolts, washers, driving nuts, shipping bolts and fitting-up material -not incorporated in the final work shall Not be measured for payment. The weight shall be computed by the Contractor and checked by the Engineer from the approved shop drawings, as follows:

- The weights of rolled steel shapes, plates and corrugated steel sheet shall be computed on the basis of their nominal weights as shown in the current edition of the American Institute of Steel Construction Manual Weights shall be computed on the ’ basis of the unit weights per cubic meter.
- Iron 445 Ib/cft (7,127 kg i m3)
- Steel 490 Ib/cft (7,848 kg/m3)

- Structural shapes shall be measured on the basis of nominal weights, for overall lengths, with no allowance for overrun, and with no deduction for cuts, copes and holes. An allowance of 0.25 inches (6 mm) in the- length shall be made for each milled or finished end of each shape.

- Plates shall be measured on the basis of nominal weights, for overall rectangular dimensions, with no deduction for cuts, copes and holes. To these nominal weights there shall be added one half of the percentage of overrun allowed by ASTM A6, except that no allowance shall be made for overrun in the weight of flat steel bars, 6 inch or less in width. The nominal thickness of plates, as shown on the Drawings, shall be used in measuring the weight of plates milled or finished to an unspecified thickness.

- Weight of castings shall be computed from the finished dimensions shown on the Drawings. In computing the volume, deductions shall be made for cored holes, and dimensions to finished surfaces shall be increased by 3/8 inch. To the weight' computed from the volume, an. additional allowance of 5 % shall be made for fillets and overrun. Alternatively, small castings may be weighed.

- No allowance shall be made for any excess diameter required for finishing rollers and pins. The weight of segmental rollers shall be measured using the finished width between the two parallel sides, and no deduction shall be made if the sides are concave.

- Weight of welds, either shop or field, shall not be considered in measuring quantities

- Nominal weight shall be increased by 3.5 % when' computing the weight of galvanized material.

- No allowance shall be made for paint, or for erection equipment

- Weight of high-strength bolts, nuts and rivets incorporated in the final work shall be included in the computed weight.

Shop lists of weight computations showing all material included for payment in the Works shall be submitted to the Engineer with the shop drawings.

Payment

Payment will be made for the number of tons measured as above at the unit price for the respective Item.

The unit prices shall be deemed to cover all costs of miscellaneous ferrous metalwork, including furnishing, fabricating, galvanizing (when specified), shop painting, transporting and installing the miscellaneous metal and all other work related to the Item. Field painting of miscellaneous metalwork, shall be included in the rates.

Steel or Gl Pipe Handrail

Measurement

Measurement shall be made of the length of Gl pipe handrail acceptably installed in the Permanent Works and computer from approved shop drawings.

Payment

Payment will be made for the number running feet measured as above at the unit price for the item.

The unit prices shall be deemed to cover all costs of furnishing, fabricating, galvanizing and installing the steel pipe handrail, including furnishing and installation of bolts, nuts, washers, lead, oakum, gaskets, sealing compounds, coatings, fastenings for holding pipe in place during installation wail plates and all other work related to the Item.

Gl Sheet for Roofing

Measurement

The measurement of corrugated iron sheet roofing shall be done by the superficial area of the roofing. The unit rate shall be square ft.

Payment

Payment shall be made for square feet measured as above for the unit price of the item. The unit rate shall include:

- Hoisting and fixing of corrugated iron sheet in position with the specified fixing accessories.
- Punching or drilling holes and cutting of sheets.

Providing, using, erecting and removing of scaffolding, benching ladders, templates and use of other tools and plants required for carrying out the work in accordance with the above specification.

The unit rate shall include the cost of galvanized corrugated steel sheets with all the specified overlaps, all bolts, nuts hook bolts, screws and washers required for properly fixing sheets as per above specifications, and labour rate for fixing.

SECTION 10

BRICK WORKS

SECTION 10 BRICKWORK ii

10.1 SCOPE OF WORK ii
10.2 PORTLAND CEMENT ii
10.3 MORTAR SAND ii
10.4 WATER ii
10.5 BRICKS ii

BRICKWORK

SCOPE OF WORK

All brick masonry required to be constructed under these Specifications and for all related purposes, including Brick masonry profiles under canal lining and other structures as directed by the Engineer, shall consist of the materials herein specified and cement sand mortar shall be proportioned, mixed, and bricks placed in accordance with the requirements stated herein. The requirements set forth herein shall apply to all brickwork, except when such requirements are specifically modified by the Engineer for any particular item of work.

PORTLAND CEMENT **Portland cement shall conform to the requirements set forth in Section 5 - Concrete - Cement.**

MORTAR SAND **Sand for mortar used in the construction of brick paving and brick masonry required under these Specifications shall be furnished by the Contractor in accordance with provisions of and in complete conformity with the requirements for sand specified in the Section -5 Concret- "Fine and Coarse Aggregates".**

WATER

The water used in the manufacture of bricks and in the preparation of mortar shall be potable and in complete conformity with the requirements of section - 5 "Concrete, General".

BRICKS

For all brickwork only first class bricks shall be used. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges, parallel faces and of deep red or copper colour. The bricks shall be free from flaws, cracks, chips, stones, nodules of lime or kankar or any other blemishes. Bricks over-burnt, under-burnt, vitrified and irregular shall not be used.

A first class brick in an oven-dried condition shall not absorb more than one sixth of its weight when soaked for one hour in water at 70 to 80 degrees Fahrenheit and shall show no efflorescence on subsequent drying. The average compressive strength of five (5) representative bricks shall be not less than 2,000 lb/in^2 when tested in accordance with ASTM Designation: C67. Such testing shall be carried out regularly for each lot of bricks or as directed/approved by the Engineer.

All bricks shall be manufactured by the Trench Kiln Method or other standard methods approved by the Engineer. Each finished brick shall be of standard size (9”x4.5”x3”) first class, and weigh between seven (7) and nine (9) pounds. All bricks shall have a “frog” 1/4 of an inch deep on upper face.

Each finished brick for tile lining shall have standard size (12”x6”x2”) first class.

The bricks shall be sorted and arranged in stacks of 2,000 bricks each. Each stack shall be ten (10) courses high and two (2) bricks thick so that at least one end of every brick is visible for inspection. Sufficient room shall be allowed between each stack so that all bricks may be inspected by the Engineer.

Mortar Composition

Mortar for all brickwork requiring mortar, shall consist of one part Portland cement to three parts of sand by volume (1:3) and sufficient water to produce the proper consistency for the intended use as specified in these Specifications or on Drawings

Where directed by the Engineer for increased workability, hydrated lime putty, approved by the Engineer shall be added to the mortar, but shall not exceed 25 percent, by volume, of the dry cement.

Mortar Batching

Methods and equipment used for mixing mortar shall be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer. If a mixer is used, it shall be of approved design and the mixing time, after all the ingredients are in the mixer, except for the full amount of water, shall be not less than two minutes.

Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within thirty (30) minutes after addition of the water to the mix shall be wasted. Retempering of mortar will not be allowed. Mixing troughs and pans shall be thoroughly cleaned and washed at the end of each day’s work.

Construction

The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the bricks nor delay the use of mixed mortar.

All brickwork shall be placed only after the foundation surfaces have been prepared satisfactorily in accordance with these Specifications and the Engineer’s instruction.

Bricks shall not be placed during heavy or prolonged rain which may wash the mortar from the bricks. Mortar already spread which becomes diluted by rain shall be removed and replaced before continuing with the work. Workmen shall

not be allowed to walk on the brickwork before it is fully set.

All bricks to be used in brickwork with mortar joints shall be moistened with water for three to four hours before they are used, by a method which will ensure that each brick is thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brickwork.

All bricks shall be skillfully laid with level courses, uniform joints, square corners, plumb vertical and true surfaces, except otherwise shown on Drawings or directed by the Engineer. Brickwork constructed for a waterway will be of the best standard of workmanship obtainable, and objectionable offsets in the brick work shall be removed by and at the expense of the Contractor. The smoothest practicable finished surface of the brickwork will be required whenever it is a part of waterway.

Curing

All brickwork requiring mortar shall be cured by water curing or other acceptable methods. All methods and operations of the Contractor in curing the different portions of the work shall be subject to the Engineer's approval.

When curing by water, the brickwork shall be kept wet for at least 10 days, unless specified elsewhere in these Specifications, by covering with water saturated material, or by a system of perforated pipes, mechanical sprinklers, porous hose, ponding, or by any other approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the Specifications for water used in the manufacture of bricks.

Repairing Brickwork

If after the completion of any brickwork, any bricks are found to be out of alignment or level, or do not conform to the lines and grades shown on the Drawings, or show a defective surface, they shall be removed and replaced by the Contractor at his expense unless the Engineer grants permission, in writing, to patch or replace the defective area.

Dry Brick Pitching

(1) General: Dry brick pitching shall consist of a double layer of bricks laid without mortar joints on a plain cement concrete class "C" foundation, all placed in accordance with the stipulations and requirements herein set forth and the details shown in the Drawings or directed by the Engineer.

All materials and operations of the Contractor for placing dry brick pitching under these Specifications shall be in accordance with the provisions of, and in complete conformity with the stipulations and requirements for "Brickwork" and "Concrete General" setforth in these Specifications.

(2) Dry Brick Pitching: Bricks shall be placed upon the plain cement concrete class

"C" foundation to the lines and grades shown in the Drawings or established by the Engineer. The first layer of bricks shall be laid flat (9-inch by 4-1/2 inch side) in such a manner that a smooth and even surface is obtained upon which the second layer of bricks may be laid. The second or top layer of bricks shall be laid on edge (9-inch by 3-inch side) and in zig-zag pattern. All bricks shall be closely fitted together so that all edges of the bricks are in contact with each other.

(3) Brick Masonry Profile: The dry brick pitching shall be divided into bays by brick masonry profiles (pacca brickwork) by means of bricks laid with cement-sand mortar (ratio 1:3) and as shown on the Drawing. Proper curing shall be provided as directed by the Engineer.

Brick Masonry

(1) General: Brick masonry (pacca brickwork) shall consist of bricks laid with mortar joints, cement pointing and cement plaster, all placed in accordance with the stipulations and requirements herein set forth and the details shown in the Drawings or directed by the Engineer.

All materials and operations of the Contractor for constructing brick masonry, cement pointing and cement plaster under these Specifications shall be in accordance with the provisions of, and in complete conformity with the stipulations and requirements for "Brickwork setforth in these specifications".

(2) Construction: All brick masonry (pacca brickwork) shall be constructed in accordance with the Engineer's instructions and the stipulations and requirements set forth herein, as follows:

i. The exterior and interior facing of all brick masonry shall be of first class bricks laid with mortar joints and the English bond unless otherwise shown in the Drawings or directed by the Engineer. Brick masonry shall be laid where possible from one face only and each brick shall be set with both bed and vertical joints filled with mortar and the bricks shall be bedded-in by firmly tapping with the handle of the trowel. Brick courses shall be carried up as neatly as possible in a uniform manner during construction.

ii. The exposed face of all brick masonry shall have the smoothest practicable finish and be kept clean and free from streaks of mortar. Whenever such streaks are formed they shall be washed off immediately and not allowed to harden.

iii. Horizontal joints shall be parallel and vertical joints in alternate courses shall be directly over one another. The thickness of the joints shall be 1/4 of an inch and the height of four (4) courses as laid shall not exceed by more than one inch the height of four dry bricks stacked one upon the other. Excess mortar at the other edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

iv. When fresh brick masonry is to join the existing brick masonry or new brick masonry that has partially or fully set, the exposed joining surface of the existing or

set brick masonry shall be cleaned, roughened and wetted so as to effect the best possible bond with the new work. All loose bricks and mortar shall be removed.

v. The joints of brick masonry, which are to be pointed or plastered, shall be raked out with a hook to a depth of half an inch. The raking shall be done before the mortar sets each day.

vi. Bricks shall be cut, dressed or grooved, as required for shaping, fittings and for other purposes. Corners shall be made with cut bricks, five bricks shall be used for each corner.

(3) Pointing of Brick Masonry

i. Striking Joint

All unplastered faces of brick masonry at locations shown in the Drawings or as directed by the Engineer shall be finished by striking joints in accordance with the stipulations and requirements set forth herein, as follows:

ii. Cement Mortar

The cement-sand mortar for pointing of brick masonry will have a mix ratio 1:3.

iii. Preparation of Surface

Before pointing brick masonry, the joints shall be raked out with a hook (not hammer or tessi) to a depth of half an inch. If, for any reason, the joints are not struck as the work proceeds, they shall be raked out before the mortar sets.

All mortar dust coming out of the joints as a result of raking shall be washed off and the brick masonry watered for 24 hours. The face shall once again be washed just before starting pointing.

The surface prepared in the manner described above shall be inspected by the Engineer and shall be approved before actual pointing begins.

iv. Method of Pointing

The mortar shall be filled in the joints flush with brick masonry with a pointing trowel and then pressed in with proper pointing tools. Lining with a spike on a mass of mortar shall not be allowed.

The pointing tools for horizontal joint shall be such as to form weathered and struck joints; and for vertical joint, triangles, so as to make a (v) notch in the joint. Care shall be taken not to develop a cutting edge in the tools since the idea is to compress the green mortar into the joints and not to cut it away.

The mortar shall not be spread irregularly over the edges and corners of the

bricks, which shall be left clearly visible. The practice of smearing mortar over defects in bricks, to hide them, shall not be allowed and shall render the whole brick masonry liable to be rejected.

v. Washing after Pointing

After pointing, the face of the brick masonry shall be cleared off all surplus mortar sticking to the face. No washing shall be done till the pointing has set.

vi. Curing

Cement pointed brick masonry shall be kept wet for ten (10) days after completion. The work shall be protected during that period from extreme fluctuations of weather.

(4) Cement Plaster for Brick Masonry

i. Composition

The cement sand plaster for brick masonry will have 1:3 mix ratios for various work items as shown in the Drawings or as directed by the Engineer.

ii. Plaster Thickness

The cement plaster will have the thickness of ¾" as shown in the Drawings or as directed by the Engineer.

iii. Preparation of Surface

Before plastering, the joints of brick masonry shall be raked out with a hook (not hammer or tessi) to a depth of half an inch. The joints shall be raked out before the mortar sets each day.

All mortar dust coming out of the joints as a result of raking shall be washed off, and the brick masonry watered for 24 hours before plaster is applied. The face shall once again be washed just before starting plastering.

All putlog holes shall be filled up before starting plastering.

The surface prepared in the manner described above shall be inspected by the Engineer and shall be approved before the actual plastering begins.

iv. Method of Plastering

Unless otherwise specified or directed by the Engineer, wooden screeds three inches wide and having a thickness equal to the plaster thickness shall be fixed vertically 8 feet to 10 feet apart to act as gauges and guides in applying the

plaster.
The arises shall be plastered for a space of four inches on each side and up to the ceiling, except in case of openings where it shall run around them. This plaster shall also serve as a guide for thickness etc. Unless otherwise specified or directed by the Engineer all corners and arises shall be rounded off to a radius of 3/4 inch.

The mortar shall be laid on the wall between the screeds, using a plastering float and pressing mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight-edge reaching across the screeds. The straight-edge shall be worked on the screeds with an upward and sideways motion, two (2) inches or three (3) inches at a time. Finally the surface shall be finished off with a plastering wooden float. Metal floats shall not be used.

The plaster shall be laid to a true and plumb surface and tested frequently with a straight-edge and plumb-bob. The straight-edge shall not be less than ten (10) feet in length. As the work proceeds, all horizontal lines and surfaces shall be tested with a level, and all jambs and corners with a plumb-bob.

v. Curing

Plastering shall be kept wet for ten (10) days after completion.

(5) Brick flooring

i. The work covered by this item consists of furnishing and laying 4 inch sand over prepared earth to required slope and grade and 4.5 inch thick brick on edge in 1:5 cement sand mortar. These joints of these bricks are struck at the top of flush pointing.

ii. The method consists of placing bricks on edge for flooring in 1:5 cement sand mortar over 4 inch sand and striking the joints of bricks with flush pointing laid over thoroughly consolidated bottom by ramming and watering before laying this floor.

iii. The concrete flooring properly laid shall be cured for 7 days.

(6) White or Colour Washing

The whitewash shall be made from pure fat lime brought to site of work in the form of un-slaked lime. Water shall be added to this lime in a container until the mixture is of consistency cream and allowed to rest until cracks shall appear on its surface (48-72 hours). After screening through coarse cloth, gum at the rate of 4 oz. boiled with 10 oz. of rice shall be added to each cubic feet of whitewash. The colour pigment if required shall be added and mixed with white wash and stirred to give the required shade. Enough quantity shall be prepared in one go so as to meet the requirement of one complete room.

Measurement and Payment

Measurement and payment for all brickwork required under these Specifications will be made at the unit rate per hundred cubic foot tendered in the Bill of Quantities for the appropriate item in which such brickwork is incorporated. The unit rates tendered for such work shall include, but not be limited to, the cost of procuring bricks, water, sand, cement; the cost of all operations of batching, mixing, classification, transportation, preparation for placing, curing, protection, finishing and repairing brick surfaces; and of all other operations, procedures and requirements necessary to complete the brickwork in accordance with the Specifications.

(2) Dry Brick Pitching: (Not used)

(3) Brick Masonry (Pacca Brickwork)

i. Measurement: Measurement for brick masonry (pacca brickwork) in the wing walls for canal structures and outlets flared walls shall be in hundred (%) cubic feet to the outlines, thickness and grades as shown in the Drawings or determined by the Engineer.

ii. Payment: Payment for brick masonry (pacca brickwork) measured as above shall be made at the unit rates tendered for respective BOQ items in hundred (%) cubic feet. Payment shall include full compensation for providing materials, equipment, tools, laying of brick masonry in cement-sand mortar, soaking of bricks, dressing, flaring, curing and labour including all incidentals necessary to complete the work as per Specifications.

(4) Cement Plaster for Brick Masonry

i. Measurement: Measurement for cement-sand plaster for brick masonry, up to 20 feet height, shall be in 100 square feet to the outlines, thickness and grades shown in the Drawings or determined by the Engineer.

ii. Payment: Payment for cement-sand plaster for brick masonry, up to 20 feet height, shall be made at the unit tender rates per 100 square feet. Payment shall include full compensation for providing materials, equipment, tools, plastering, curing and labour including all incidentals necessary to complete the work as per Specifications.

(5) Pointing of Brick Masonry

i. Measurement: Measurement for pointing of brick masonry up to 20 feet height shall be in 100 square feet to the surface outlines shown in the Drawings or determined by the Engineer.

ii. Payment: Payment for pointing of brick masonry up to 20 feet height, shall be made at the unit tender rate per 100 square feet. Payment shall include full compensation for providing materials, equipment, tools, pointing, curing and labour including incidentals necessary to complete the work as per

Specifications.

SECTION 11
GATE EQUIPMENT

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GATE EQUIPMENT

GENERAL

Introduction

The Gate Equipment Specified hereinafter shall be installed on seventeen (17) Head Regulator for Distributaries on all three rivers Nari, Talli and Lehri alongwith Radial gates on every dispersal structure. The installation of gate equipment on these structures is necessary to regulate the flow in Rivers and offtaking inundation canals.

This section specifies general requirements for the design, manufacture, delivery to Site, installation, testing and commissioning of gate equipment to be furnished and installed in accordance with the provisions in these documents. The Contractor shall provide all labour, material, equipment, and transportation for the satisfactory completion of work and maintain the equipment during defect liability period.

Works to be Done

The Contractor shall:

A. Design, detail, manufacture, furnish, deliver to the Site, install, test and commission the Radial Gates equipment in accordance with specifications and as shown on the Tender Drawings.

Nari River	Jalal khan
	Khatoor
	Sharkal
Talli River	Saafi
	Chandia
	Chachar
Lehri	D.S Point # 5

B. Furnish a complete set of maintenance tools needed for the lubrication, adjustment and

normal maintenance of each item of the Equipment. These tools shall be properly mounted in heavy-duty steel cabinets provided with locks, suitable for wall mounting. The price for each set of maintenance tools shall be included in the quoted price of the respective B.O.Q item.

C. Furnish a complete set of erection supplies. The price for erection supplies shall be included in the quoted price of the equipment to which it belongs. Erection supplies shall consist of the following quantities in excess of the total quantity required for site assembly for each type of the Equipment.

D.

Erection Supplies	**Excess Quantity (Percentage)**
1. Bolts, screws, studs, nuts, washers and similar parts that are to be placed and/or removed during field installations	2
2. Electrodes for field welding	5
3. Expansion anchors or other anchors	3
4. Lubricating grease or oil	5

E. Furnish the basic spare parts for each Equipment. The cost of the following basic spare parts shall be included in the corresponding Equipment cost:

Description Item/Unit		**Fixed Wheel Gates**	**Radial/Slide Gates**	**Stoplogs**
a.	J-type seal (ft.)	130	300	24
b.	Wedge type seal (ft.)	90	24	60
c.	Self-Lubricating bushes and washers (one set contains one bush & two washers) (set)	18	18	-
d.	Rubber block (Nos)			
	- for lower corners	9	-	5
	- for upper corners	-	-	-

Description Item/Unit		Fixed Wheel Gates	Radial/Slide Gates	Stoplogs
e.	Bearing of all types	25% of each size	25% of each size	25% of each size
f.	Wire ropes alongwith sockets and turn buckles	For 4 gates sets 25% of each size	25 % for each dispersal structure	-

All spare parts shall be interchangeable with and of the same material and quality as the original parts. All spare parts shall be treated and boxed as required to preserve them against deterioration during storage. Boxes shall be clearly marked for identification of the parts they contain.

F. The Contractor shall submit drawings, data and perform all other work specified hereinafter.

Drawings Furnished by the Engineer

The general arrangement of the Equipment shall conform to the Tender Drawings. The Tender Drawings are not intended to define the detailed design of the Equipment to be furnished and installed but are merely illustrative to show the general layout of the Equipment except where limiting or mandatory dimensions, elevations, tolerances and similar features are indicated. Alternative details and arrangements will be considered if, in the judgment of the Engineer, those are not inferior to the details and arrangement shown on the Tender Drawings

Contractor's Drawings and Data

A. General

1. The Contractor shall submit drawings and instructions as outlined hereunder. The sequence of submission to the Engineer for review shall be such that information is available for review of each drawing when it is received. Contractor's drawings and design data, submitted formally shall have certification by an authorized representative of the Contractor to the effect that information shown thereon has been checked by the Contractor and is correct for use in the Project, except for drawings of a preliminary

nature furnished for information which shall be clearly identified as such. Before submitting any drawing for review, the Contractor shall submit a list of drawings he proposes to submit, showing sequence of submittal and submittal dates to meet the requirements of the Contract Documents.

2. The applicable parts of the requirements of all paragraphs with reference to the drawings shall apply equally to design data, calculations, catalog pages, illustrations, descriptions, printed specifications, draft reports or any other similar data submitted for review.

B. Outline Drawings

The Contractor shall submit outline drawings of the Equipment together with data, to permit final design of the structures into which the Equipment is to be incorporated. Outline drawings and/or data shall be submitted in accordance with a schedule mutually agreed upon between the Contractor and the Engineer.

C. Detailed Drawings and Data

1. General

Before proceeding with the manufacture of Equipment, the Contractor shall submit general assembly drawings, subassembly drawings, detail drawings, calculations, design criteria, design data, catalog pages, specifications and similar engineering documents required to demonstrate fully that all parts will conform to the provisions and intent of these Specifications and to the requirements of their installation, operation, and maintenance. The drawings shall show all necessary dimensions and fabrication details, including the design of welded and bolted joint connections, tolerances on fits and clearances, and all field joints and subassemblies in which the Contractor proposes to transport the Equipment.

2. Detailed Drawings

Detailed Drawings shall include the following wherever applicable:

(a) General arrangement drawings for embedded parts: These drawings shall show all final dimensions, tolerances, and details of field connections.

(b) General arrangement drawings for gates and stoplogs: These drawings shall show all final dimensions and tolerances, surface finishes, details of field connections and final weights.

(c) General arrangement drawings of the hoists for the Gate Equipment: These drawings shall show all final dimensions and tolerances, details of field connections, final weights, and loads on foundation bolts.

(d) Slot and sill beam details showing seal contact with the embedded sealing faces.

(e) Typical seal details.

(f) Seal splice and seal corner details.

(g) Structural detail drawings of each gate and Stoplog.

(h) Hoist platform and access ladder details.

(i) Details of the hoist gear box, hoist drum and couplings.

(j) Assembly match mark sheets.

(k) Other drawings not specifically listed but required to develop the detail drawings.

3. Structural Design Data

The calculations and design data, shall include the following:

(a) Structural analysis for fixed wheel gates, slide gates, stoplogs, hoisting arrangement, dogging devices, embedded parts and major structural parts.

(b) Weight and center of gravity calculations.

4. Mechanical Design Data

The calculations, design data, etc shall include the following:

(a) Required hoisting/operating force calculations

(b) Speed reduction and gear box calculations.

D. Review of Drawings

(a) Three (3) copies on durable paper with dark lines on a white background and one durable paper-type reproducible shall be furnished of each drawing submitted. All drawings submitted shall in so far as practicable, be of standard size, measuring approximately 33 in. x 23.5 in. Printed catalogs and data shall be submitted in five (5)

copies.

(b) One copy will be returned to the Contractor marked "Approved", "Approved Except as Noted", or "Not Approved". Review will not relieve the Contractor of responsibility for conformity with Specified requirements and correct detail and fit of parts when installed. No revision affecting the design shall be made after a drawing has been "Approved" without resubmitting the drawing.

When copies of drawings have been marked "Approved Except as Noted", or "Not Approved", the Contractor shall make the necessary corrections and resubmit three (3) copies and one reproducible. Number and date shall show every revision.

E. Record Drawings

Prior to completion of the work under the Contract, the Contractor shall furnish one complete full size set of all Contractor's drawings of equipment as finally built, including any field changes, stamped "As Built Drawings". The drawings shall be accompanied by 2 sets of electronic uneditable copies on compact disks of approved quality.

F. Installation Instruction

1. General

The Installation Instructions shall be prepared in one volume, divided into two sections as referred below, and shall cover instructions for Installation, (hereinafter referred to as the Installation Section), testing and setting to work (hereinafter referred to as the Site Testing Section). The volume shall be strongly bound in a durable cover of approved legend, and shall bear on the spline in bold letters an approved shortened version of the title.

2. Installation Section

This section shall include full and detailed instructions as to all procedures and precautions to be observed in installing, assembling and adjusting the Equipment and as to the use of the Erection and Maintenance Tools. It shall include or be accompanied by drawings clearly showing installation marking and particularly any match-marking and shall embody in particular a full statement as to installation tolerances to be observed.

3. Site Testing Section

This section shall include full detailed directions as to the methods and procedures to be

followed and the quantities to be observed and recorded in checking the accuracy of installation, and the carrying out of Site tests as required by the Specifications. It shall also include a schedule of tests and a description of all instruments to be provided for these tests and of their use.

4. Number of Copies

The Contractor prior to producing the final volumes shall submit two (2) draft copies to the Engineer for approval. After its approval the Contractor shall provide six (6) fair copies for the use of the Employer and the Engineer.

G. Operating and Maintenance Manuals

The Contractor shall submit two (2) draft copies of detailed operating and maintenance manuals for the Equipment for Engineer's review. After Engineer's review, six (6) complete, durable bound copies of the manuals shall be furnished. The operation and maintenance manuals shall include reduced-size copies of applicable drawings, applicable parts' lists, and catalogs covering all equipment furnished or which may be needed in operation, maintenance, repairs, dismantling or assembling, and for repair and identification of parts for ordering replacements.

H. Photographs

The Contractor shall furnish three (3) prints (size 8" x 10") of each view of the progress photographs of the shop & installation works done. Photographs shall be taken at approximately monthly intervals.

Technical Designations

Wherever the following technical terms occur in these Documents, these shall be understood to have the following meanings:

"DRAWINGS" means the drawings furnished by the Engineer or any modifications of such drawings approved in writing by the Engineer.

"GATE EQUIPMENT": All equipment to be furnished under the Contract which includes gates, stoplogs, lifting beam and all accessories, including embedded parts, hoisting/operating system arrangement, platforms, access ladders, spare parts, erection & maintenance tools and all appurtenances including supplementary equipment. The word "Equipment" wherever used instead of "Gate Equipment" shall mean as Gate Equipment.

"GATE UNIT": Completely operational group of equipment parts that are required and are

sufficient to close one opening. A gate unit will normally include one gate, one hoist with hoisting deck, one set of embedded parts, access ladders and all required appurtenances.

"GATE": The movable or moving parts of a gate serving to close one opening.

"HOIST": A device serving to move (open and close) a gate, including all related equipment necessary to assure safety.

"EMBEDDED PARTS": The group of parts of a gate equipment, which is to be embedded in concrete or otherwise permanently attached to the civil work, such as frames, seal-plates, sill beams, bearing plates and rails. All welding pads, erection studs and anchorages to be furnished by the Contractor are also considered embedded parts except as otherwise noted.

"HOISTING/OPERATING DECK": Comprise steel structure consisting of beams, chequered plates, required to install the hoists/operating system and related equipment.

Standards

The standards under which work is to be performed or tested are cited throughout the Tender Documents. Where such standards are cited, it shall be understood that the latest issue or revision in effect at time of submission of Tender shall apply. If it is desired to deviate from the cited or approved standards, a statement of the exact nature of the proposed deviation shall be submitted for approval. Other equivalent standards may be substituted provided approval is obtained from the Engineer. Name of the standards and abbreviations are given below:

Name	Abbreviation
American Gear Manufacturer's Association	AGMA
American Institute of Steel Construction, Inc.	AISC
American National Standards Institute	ANSI
American Iron and Steel Institute	AISI

American Society of Mechanical Engineers	ASME
American Society for Testing and Materials	ASTM
American Welding Society	AWS
Federal Specifications Board	U.S. Fed. Spec.
United States Bureau of Reclamation	USBR
Institute of Electrical and Electronics Engineers	IEEE
International Organization for Standardization	ISO
National Bureau of Standards	NBS
National Electrical Code	NEC
Crane Manufacturers Association of America	CMAA
National Electrical Manufacturer's Association	NEMA
Society of Automotive Engineers	SAE
Steel Structures Painting Council	SSPC
Underwriter's Laboratories, Inc.	UL
Antifriction Bearing Manufacturers Association	AFBMA

A. Or Equal

For convenience certain equipment, articles, materials, or processes are designated by trade name or catalog name and number. Such designation shall be deemed to be followed by the words "or equal".

Shop Assembly and Tests

A. General

Materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections, and of the grades, classes and types listed herein, or their equivalents. However, while selecting the materials the Contractor shall keep in view water analysis results and may propose materials having better qualities to resist the chemicals present in the water.

B. Material specifications

1. Structural Steel

a. for skinplate, main components of gate leaf, stoplogs.	ASTM-A36, "Specification for Structural Steel".
b. for embedded parts (except seal bearing plates and guide plates and rails which will be of CRES) and supports etc.)	ASTM-A36, "Specification for Structural Steel".
2. Corrosion-Resisting (or Corrosion Resistant) Steel (bars, bolts, nuts, and washers, etc.) (Symbol: "GP - CRES").	ASTM-A276, "Specification for Stainless and Heat Resisting Steel Bars and Shapes, "Type: Series 316L.
3. Corrosion-Resisting (or Corrosion Resistant) Steel (pins and rods) (Symbol: "CRES")	ASTM-A276, "Specification for Stainless and Heat Resisting Steel Bars and Shapes," Type: Series 403 or 410.
4. Stainless Steel (plate, sheet and strip).	ASTM-A240, “Specification for Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
5. Corrosion-Resisting Steel Castings	ASTM-A743, "Specification for Corrosion Resisting Iron-Chromium - Nickel Alloy Casting for General Applications" Grade CA-15 and CF-8.
6. Cast Steel Wheels	ASTM-A583, "Specification for Cast Steel Wheels for Railway Service."
7. Carbon Steel Axles	ASTM-A21, "Specification for Carbon Steel Axles, Non-Heat- Treated for Railway use."
8. Steel Shafting	ASTM-A29, "Specification for Steel Bars Carbon and Alloy, Hot Rolled, Cold Finished"
9. Steel Bolts and Nuts	ASTM-A307, "Specification for Low-carbon Steel Externally and Internally Threaded Standard Fasteners," and ASTM-A325. "Specifications for High-Strength Bolts for Structural Steel Joints Including

		Suitable Nuts and Plain Hardened Washers,"
10.	Lock Washers	Spring steel, SAE proportions, regular series.
11.	Forged Steel	ASTM-A668, "Specification for Steel Forgings, Carbon and Alloy, General Industrial Use,".
12.	Cast Steel	ASTM-A27, "Specification for Mild-to-Medium-Strength Carbon- Steel Castings for General Application," Grade 65-35.
13.	Round Wire Rope	ASTM-A492 "Specification for Stainless and Heat Resisting Steel Wire Rope and U.S. Fed. Spec. RR-W-410b. "Wire Rope and Strand,"
14.	Wire Rope Fittings	Contractor's standard fittings for the type of rope used.
15.	Permanent self lubricating bearings and washers with rated coefficient of friction less than 0.15.	"Lubrite" A cast bronze alloy (ASTM-B22, "Specification for Bronze Castings for Bridges and Turntables," Alloy E) with self-lubricating inserts.
16.	Lubricating Fittings	According to manufacturer's published data.
17.	Bronze Bushings, Sleeve type Bearings and other Lubricated Wearing Parts	SAE Standard Specification No. 64 for Phosphor Bronze.
18.	Anti-Friction Bearings	According to manufacturer's published data.
19.	Steel Pipe	ASTM-A53, "Specification for Welded and Seamless Steel Pipe," Welded Grade.
20.	Expansion Anchors	According to manufacturer's published data.
21.	Concrete Anchor Studs	According to manufacturer's published data.
22.	Gears and Speed Reducers.	AGMA Standard.
23.	Rubber Seals.	The rubber seals shall be molded and the material shall be compounded of natural rubber or copolymer of butadiene and styrene or a blend of both. The compound shall contain not less than 70% by volume

		of the basic polymer and the remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, anti-oxidants, vulcanizing agents, and plasticizers.
24	Fluoro-carbon Clad Rubber Seals.	Rubber seals shall be as specified above. A fluoro-carbon sheath shall be bonded to the rubber on the sealing surface. The sheath shall be abrasion resistant. The outside surface of the fluoro-carbon shall be free of adhering or bonded rubber.

Test of Materials

A. General

Unless otherwise directed all materials or parts used in the Gate Equipment shall be tested, in conformity with applicable methods prescribed by the ASTM, or such other organization as may be specifically required, and in general accordance with the best commercial methods. When requested, tests shall be made in the presence of the Engineer. Stocked material may be used, provided evidence is furnished to the Engineer to show that such material meets the requirements specified herein, in which case tests on stocked materials may be waived.

B. Test Certificates

Certified material test reports shall be furnished in triplicate to the Engineer as soon as possible after the tests are made. The test certificate shall identify the component for which the material is to be used and shall contain all information necessary to verify compliance with the Specifications.

C. Rubber Seals

1. All rubber seals shall be tested for and shall have the following physical properties:

a.	Tensile Strength min. 3000 lbf/sq. in.	ASTM-D412, "Tests for Rubber Properties in Tension."
b.	Elongation at Break min. 450%	ASTM-D412
c.	300% Modulus, min. 850 lbf/sq.in.	ASTM-D412

d.	Shore Durometer (Type A) 60 to 70	ASTM-D2240, "Test for Rubber Property-Duro-meter Hardness".
e.	Specific Gravity	1.15 $\pm$ 0.03
f.	Absorption of Water by Weight, max. 5%	ASTM-D471, "Test for Rubber Property-Effect of Liquids,"
g.	Compression set (constant deflection) or Original Deflection max. 30%.	ASTM-D395, "Test for Rubber Property-Compression.
h.	Tensile Strength after Oxygen Bomb Aging 48 hr. 70^{O}C, 48 hr, 158^{O} F, 300 lbf/sq.in., percentage of Tensile Strength before Aging min. 80	ASTM-D572, "Test for Rubber Deterioration byHeat and Oxygen Pressure".

2. On rubber seals with fluoro-carbon cladding, the rubber shall be tested as specified above. The fluoro-carbon shall be tested for and shall possess the following physical properties:

   Tensile strength 2000 lbf/sq.in (min.)

   Elongation 250% (min.)

3. The fluoro-carbon cladding on rubber seals shall be tested for adhesion in accordance with ASTM-D413, "Tests for Rubber Property Adhesion to Flexible Substrate," using either the machine method or the dead-weight method.

4. Except where tolerances for rubber seals are specified on the Tender Drawings, seal dimensions are nominal and slight variations will be acceptable.

Design Criteria and Working Stresses

A. General

The general design criteria covering the design loads, load combinations and maximum unit stresses considered for the design of Equipment are described below.

The design of Equipment will be based on the guidelines of the U.S. Army Corps of Engineers and U.S. Bureau of Reclamation, except as modified and supplemented by the design criteria described in this Section.

B. Design Loads

The Gate Equipment is designed for the applicable loads described hereunder.

1. Dead Loads

The dead load includes the weight of the components, machinery elements, equipment, protective devices and contained fluids. Eccentricity of loading shall be taken into account.

2. Hydrostatic Loads

Components of Equipment subject to water pressure will be designed for hydrostatic loads corresponding to the maximum differential pressure expected during the life of the Project.

3. Friction

The friction forces considered in the design will be based on the applicable coefficients of friction taken from the following table:

	Maximum	**Minimum**
Rubber on steel	1.0	0.3
Rubber on corrosion-resisting steel	0.8	0.2
Fluoro-carbon on corrosion-resisting steel	0.15	0.05
Corrosion-resisting steel on carbon steel, non-lubricated	0.5	0.1
Corrosion-resisting steel on carbon steel, lubricated	0.18	0.08
Corrosion-resisting steel On corrosion-resisting steel	Not acceptable	
Bronze on corrosion-resisting steel, non-lubricated	0.5	0.15
Bronze on corrosion-resisting steel, lubricated	0.2	0.07
"Lubrite" on corrosion-Resisting steel	0.2	0.06

Anti-friction bearings As recommended by bearing manufacturer.

4. Wind Load

- Horizontal wind load of 30 lbs/sq.ft., acting in any direction on the projected area of affected components, will be considered in the design.

5. Seismic Loads

All components of gates will be designed to withstand safely the seismic forces computed by using the following seismic coefficients and design factors:

- OBE: An operating basis earthquake (OBE) equivalent to a horizontal ground acceleration equal to 0.08 g acting simultaneously with a vertical acceleration equal to 1/3 of horizontal acceleration.

- Seismic forces: Seismic forces considered for the design of each gate leaf are taken as the sum of inertia and hydrodynamic forces. The inertia forces are equal to the product of the mass and the effective acceleration of the gate leaf assembly. The hydrodynamic forces are assumed equal to the product of added mass of water acting on the skin plate and the effective acceleration of the skin plate. The seismic forces on all other components of the gates and hoists are taken equal to the product of their mass and effective acceleration.

6. Live Loads

The live loads on walkways and catwalks which are transmitted to the gates and hoists will be taken as uniformly distributed loads (UDL) equal to 105 lbf/sq.ft.. In addition to this UDL, any superimposed concentrated loads likely to be placed on the walkway and catwalks will also be considered.

7. Thermal Loads

The thermal forces will be considered in the design of the components when temperature fluctuations relative to an assumed erection temperature would exceed 10oC. The following temperature variations are assumed:

- For components located above water or periodically exposed and submerged: + 70^{o}C - 0^{o}C.
- For components partly submerged or protected from direct sun: + 50^{o}C - 0^{o}C
- For components permanently submerged in water : + 20^{o}C - 0^{o}C

8. Miscellaneous Loads

Loads due to changes in conditions of support, lifting and raising forces as well as impact will also be considered in the design of components thus affected.

C. Load Combinations and Conditions

The detailed design of Equipment will be based on the most critical loading condition applicable to major components. The Contractor shall be required to investigate the following loading conditions and load combinations for the final design of the Gate Equipment.

1. Erection Conditions

- Normal loading: Equipment in any stage of erection subjected to applicable dead and live loads plus forces resulting from the erection procedures.

- Exceptional loading: Normal loading plus wind loads.

2. Operating Conditions

Normal Loading:

- For vertical fixed wheel and slide gate leaf assembly : Dead weight, friction, thermal, hoisting and maximum hydrostatic loads when the gate is resting on the sill, being lifted, partially opened or being closed, with maximum water pressure.

- For stoplogs: Dead weight, friction, thermal and normal maximum hydrostatic loads when stoplogs are resting on the sill.

- For mechanical hoist/operating system: Dead weight, live, thermal, friction and rated hoist/operating loads.

Exceptional loading:

- For Gate: Loading when the gate is jammed.

- For stoplogs: Loading when the stoplog is jammed.

- For fixed wheel gates, slide gate and hoists operating system: Normal loading plus seismic forces for OBE.

3. Maintenance Conditions

Normal loading.

The Equipment in the normal maintenance position with applicable dead, live, thermal, imposed and support loads.

Exceptional loading :

Normal loading plus wind load plus OBE.

D. Working Stress

1. Factor of Safety - Mechanical Components

A factor of safety not less than 5, based on the ultimate strength of material, will be used under normal loading.

2. Allowable Stresses:

Summary of allowable stresses is given here as under:

Fy = Yield Stress
Fu = Ultimate Stress
Fa = Allowable Stress

a. For structural members			
Type of Stresses	**Load Cases**		
	Normal	**Exceptional**	**Extreme**
Bending	0.6 Fy	0.8 Fy	0.95 Fy
Shear	0.4 Fy	0.5 Fy	0.60 Fy
Tension	0.45 Fy	0.5 Fy	0.60 Fy
Bearing pressure (machined surface)	0.8 Fy	0.85 Fy	0.90 Fy
Combined stresses	0.75 Fy	0.95 Fy	No
Buckling AISC value	1.0 Fa	1.3 Fa	1.4 Fa
Hertzian stresses Lbs/ in^2	755 BHN	850 BHN	925 BHN
(BHN=Brinell Hardness not exceeding 300 BHN)	No.		

Type of Stresses	Load Cases		
	Normal	Exceptional	Extreme
b. For all Mechnical and Electrical Components	0.33 Fy	0.67 Fy	0.90 Fy
	OR	OR	OR
	0.2 Fu	0.4 Fu Whichever is less	0.55 Fu Whichever is less

3. Design Criteria for Gate Hoist

A. Loads

The loads used in hoist /operating system design shall include the following:

- Suspended weight of gate including weight of hoist rope, fittings, side seal friction and wheel friction.

B. Efficiencies

Efficiencies of operating machinery components shall be assumed as no greater than the following:

- Speed reducer with worm gear 70 percent
- Speed reducer (triple reduction) 85 percent
- Gear and pinion 95 percent
- Bearings 96 percent

C. Operating Speed and Force

The hoisting speed for all fixed wheel and slide gates shall not be less than 1/16 in. per revolution for hand operated hoists.

D. Shafting

Shafting shall be designed in accordance with Clause 16.1.9(D) "Working Stresses". A shock or fatigue factor of 1.25 shall be used for shafting, except for speed reducers, which shall conform to applicable AGMA standards.

E. Gears

Gear design shall be in accordance with applicable AGMA standards.

F. Drums (Where Applicable)

The minimum diameter of the drum for winding the rope shall be not less than 20 times the nominal rope diameter. The outside diameter of the drum flanges or spacers shall not be less than the outside diameter of the rope wrapped on the drum. With gate resting on the sill, there shall be at least two complete wraps on each drum.

G. Walkways and Catwalks

Walkway flooring shall be designed for a uniformly distributed live load of 105 lb/sq. ft. plus a superimposed concentrated load of the heaviest piece of hoisting equipment or sub-assembly. Stair treads and their fastenings shall be designed for a concentrated live load of 1000 lbs. The catwalk shall be of clear width as shown on the Drawings and shall be designed for a uniform live load of 50 lb. per sq. ft. plus a single movable concentrated load of 1000 lb. The catwalk structure shall be sufficiently rigid to deflect no more than 0.250 in. under the above maximum live load conditions.

H. Hoist/Operating Platforms

The platforms shall be designed to suit the proposed equipment layout. All mechanical components will be supported directly on the structural members of the platform. The platform gratings shall be all welded construction and shall be fastened to the steel supports by clips or fasteners subject to the approval of the Engineer. Platforms will be tied down to concrete pier by means of anchor bolts designed to resist all possible loading cases. Platforms shall be designed to carry the specified live loads, dead loads, machinery loads, catwalk loads, and normal hoisting/operating loads at the specified basic stress. The platform shall also be designed to resist the loads resulting from stall torque of the operating motors together with dead and machinery loads. Deformation of the hoist platforms shall be limited to the amount, which will limit the maximum gear misalignment to that permitted by AGMA Standards.

Minimum Dimensions

A. Material Thickness

1.	Plate thickness on any structural member except webs of rolled shapes	3/8 in.
2.	Webs of rolled shapes	5/16 in.

3.	Embedded metal with exposed surfaces	1/2 in.
4.	Completely embedded metal	7/16 in.
5.	Diameter of bolts or screws on gate structures	3/8 in.
6.	Diameter of adjusting bolts between frame or embedded part and welding pad	5/8 in.

B. Weld Size

Fillet weld, leg length	1/4 in.

Electrical Features

A. Deleted

Workmanship

A. General

Components and spare parts shall be interchangeable wherever possible. Surface finish of machined parts shall be adequate for their functional requirements. Machining of fits on renewable parts shall be accurate and to specified dimensions so that replacements made to drawings size may be readily installed.

B. Electric Welding

1. General

All welds shall be made continuous and watertight. All butt welds shall be full penetration welds welded from both sides.

2. Preparation of Base Material

Members to be joined by welding shall be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conditions. Design of welded joints and selection of weld filler metal shall allow thorough penetration and good

fusion of the weld with the base metal. The edges of surfaces to be welded shall be sound metal free of visible defects, such as laminations or defects caused by cutting operations and free from rust, oil, grease, and other foreign matter.

3. Welding Qualifications

The qualification of welders for all welding, including weld repairs shall conform to the relevant AWS Standard Specifications. The Contractor shall furnish the facilities, all equipment, materials and other articles required to perform qualification tests of his welders and welding operators.

4. Weld Finish

Welds shall in general display good appearance and a surface suitable for painting. Structural welds shall be ground and blended to avoid stress raisers. All welds, which require nondestructive examinations, shall be dressed by chipping and grinding as required for good interpretation by the selected weld examination methods.

C. Steel Castings

Castings shall be free from injurious defects and shall be satisfactorily cleaned for their intended use. Surfaces of castings, which do not undergo machining, shall be dressed for good appearance and painting. The location of existing defects shall be determined, and all defects, which impair the strength or utility of the casting, shall be removed. The structure of the castings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a casting shall make it liable for rejection.

D. Nondestructive Testing

1. General

Unless otherwise indicated, all nondestructive tests shall be in accordance with ASTM Standards.

2. Examination of Welds

(a) Main Welds

All butt welds on skinplates and beam flanges, and all welds on other main components shall be given complete nondestructive examination by ultrasonic, dye penetrant, or magnetic particle methods, supplemented by radiographic examination. Supplemental radiographic examinations shall include examination of areas where interpretations by other methods is unclear or where the integrity of the weld is doubtful.

(b) Secondary Welds

The Engineer shall have the right to request random spot-check examination of welds, including radiographic examination, as part of the Equipment inspection.

(c) Technique and Acceptance Standard

Examination of welds shall be in accordance with the technique and acceptance standards of "AWS Code D-1.1 welding in Building Construction".

3. Examination of Castings

All major castings shall be given a complete ultrasonic examination and a radiographic examination insofar as practicable. Where radiographic examination is not practicable due to configuration or accessibility, the castings shall be examined by dye penetrant or magnetic particle methods in addition to the ultrasonic method.

4. Examination of Forgings

Major forgings shall be given ultrasonic examination with liberal overlap and other applicable nondestructive tests, to determine that they are sound. The structure of forgings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a forging will be cause for its rejection.

E. Structural Work:

Design and fabrication of structural parts shall conform to the applicable provisions of the AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings," of the AISC "Code of Standard Practice for Steel Buildings and Bridges."

F. Machine Work

1. General

All tolerances, allowances, and gauges for metal fits between plain (nonthreaded) cylindrical parts shall conform to ANSI-B4.1. "Preferred Limits and Fits for Cylindrical Parts," for the class of fit as shown or otherwise required. All drilled holes for bolts, which are intended to match other drilled holes, shall be accurately located and drilled from templates. No machining shall be done on working surfaces of "Lubrite" bushings or washers.

2. Finished Surfaces

All surfaces that are indicated on the drawings or those that require machining for their intended function, or those that are usually machined according to good shop practice shall be

machined. Surface finish qualities shall be adequate for the intended use and shall be indicated on the Contractor's drawings and shall be in accordance with ANSI-B46.1. "Surface Texture". Compliance with specified surface will be determined by sense of feel and by visual inspection of the work compared to standard roughness specimens, in accordance with the provisions of ANSI B-46.1.

3. Unfinished Surfaces

So far as practicable, all work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the Drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner. Corrosion resistant steel seal plates shall have all surfaces thoroughly cleaned and those in contact with seals shall have a surface finish of 63 RMS or finer.

4. Pins and Pin Holes

Pin holes shall be bored true to gauges, straight, and at right angles to the axis of the member. Pinholes shall have a surface finish of 125 RMS or finer. The boring shall be done after the member is securely fastened in position.

5. Protection of Machined Surfaces

(a) Machine-finished surfaces shall be thoroughly cleaned of foreign matter. Finished surfaces of large parts and other delicate surfaces shall be protected with wooden pads or other suitable means. Unassembled pins and bolts shall be oiled and wrapped with moisture- resistant paper or protected by other approved means.

(b) Finished surfaces of ferrous metals to be in bolted contact shall be washed with a rust inhibitor and given one thin coat of white or blue lead and tung oil.

G. Lubrication

Before assembly all bearing surfaces, journals, and grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. After assembly, each lubricating system shall be filled with an approved lubricant. "Lubrite" bearings shall not be greased and shall be assembled dry according to the manufacturer's instructions. Solvents shall not be used on "Lubrite" bearings.

H. Tolerances

1. General

All tolerances shall be selected by the Contractor to correspond to the accuracy required for the proper operation of the equipment considering the nature and function of the part. All tolerances shall be indicated on the Contractor's drawings and submitted for review. The tolerances specified in the Tender Documents are maximum tolerances applicable to the equipment when it is installed. It shall be the Contractor's responsibility to establish finer shop tolerances, if necessary to meet the specified design or operational requirements or for interchangeability of spare parts. All tolerances shall be selected with due consideration to the nature and function of the parts and to the corresponding accuracy required to secure proper operation, but shall not exceed the tolerances specified in these Documents.

2. Fixed Wheel Gates, Slide Gates, Stoplogs and Embedded Parts

(a) Skin plate:

The bottom and top edge of each skin plate shall be parallel within + 0.002 in. per 10 in. height. The length of the two diagonals connecting the skin plate corners shall be within + 0.030 in. for any 10 ft. of skin plate perimeter or within + 0.125 in. maximum, whichever is smaller.

(b) Sealing Surfaces

The plane formed by side and sill seals shall be true within + 0.060 in.

(c) Sill Seal Backing Bars

Sill seal backing bars shall be within + 0.060 in. of a plane surface formed by the top of sill beam.

(d) Embedded Parts

Seal Bearing Plates for Gates and Stoplogs:

Each bearing plate shall be within + 0.060 in. of the design plane along its length and + 0.008 in. along its width. Bearing plates shall be checked by means of 10 ft. and 5 ft. straight edges and feeler gauges. The maximum deviation from 10 ft. straight edge shall not exceed 0.080 in. and 0.02 in. from the 5 ft. straight edge.

Track Plates

Track plates for gates shall be within + 0.040 in. of design plane along their entire length and + 0.004 in. across their width. Tracks shall be checked by means of 10 ft. and 5 ft. straight edges and feeler gauges and shall be straight within + 0.008 in. over any 10 ft. length or + 0.002 in over any 5 ft. length.

Sealing Surfaces

- Side and top seal bearing plates shall be in the same plane within + 0.030 in.

- Sill beams shall be square with the centerline of side seal bearing plates and shall have a maximum camber of not more than 0.060 in. for the entire length.

Guides

All guiding surfaces of each guide shall be straight within + 0.04 in. over any 10 ft. length. All guides shall be parallel with their opposite guide across the opening within + 0.125 in.

Structures and Embedded Parts

A. Structures

1. The structure of each item of the Equipment and embedded parts shall basically be of welded steel construction. All welding shall be done in the shop, except welded field splices.

2. Field Splices

   (a) Field splices (or field connections) shall be provided wherever required for compliance with the size of weight limits for transportation.

   (b) Permanent field splices shall be made either with fitted bolts or with high-strength bolts, or by field welding. Semi-permanent (disconnectable) field connections shall be made with pins or bolts. Fitted pins or bolts shall be used if exact positioning is required.

   (c) The location and arrangement of field splices shall be such that they do not affect the integrity, rigidity, function or alignment of the structure. Field splices shall be located, as far as possible, away from highly stressed areas, and shall not be made in main girders.

   (d) Field welded splices shall not be used where distortions due to welding might affect finished tolerance requirements. Chamfering and other preparation for field welding shall be completed in the shop. Backing cover plates shall be provided for temporary connection during shop assembly and field welding.

   (e) Exact relative position and alignment of members to be connected by field

splicing shall be established by shop-reamed dowels, fitted bolts or closely fitted shear lugs, so that no field alignment work is required at the connection. The strength, quality and arrangement of such dowels, bolts or lugs shall be proportional to the member size and adequate for their purpose.

(f) No field or shop welded splicing shall be used on members heat treated in the shop.

3. Stress Relieving

The Contractor shall stress relieve all parts which are to be heat-treated. In addition, the Contractor shall stress relieve any part where stress relieving is required to obtain the specified tolerances or other required features.

4. Drain Holes

Drain holes or other openings of suitable size, quantity and location shall be provided to ensure effective drainage of all water accumulated from submergence or weather conditions.

B. Sealing System

1. General

(a) Each Gate Unit shall be provided with a sealing system consisting of seals mounted on the gate and seal plates embedded in the concrete structures. Seals shall not be mounted on embedded parts.

(b) The sealing system for slide gates shall consist of side, bottom and top seals. The sealing system shall be continuous providing a tight closed sealing line without gaps when the gate is closed.

(c) The sealing system for fixed wheel gates and stoplogs shall consist of side and bottom seals. The sealing system shall ensure a tight closed sealing without gaps when the gate is closed.

2. Seal Plates

(a) The sealing surface of the seal plates shall be arranged as shown on the Tender Drawings.

(b) Seal plates shall be of an adequate width to ensure that seals remain on seal plates under all possible working conditions. These working conditions shall cater for the most unfavorable combinations of all factors causing relative position change, including the following:

- the contact width of the expanded rubber seal when compressed by maximum load.

- the extreme lateral positions of the gate as limited by actual clearances.

- the most unfavorable manufacturing and erection tolerances.

- deformation or deflection of structures.

- thermal expansion effects.

3. Seal Profiles

Seals shall be of one of the following profiles, as specified.

(a) Wedge Type Seal

Wedge type seals shall be without cladding and shall have a rectangular profile with chamfers as required.

(b) J-Type Seals

J-type (music note type) seals shall be with fluoro-carbon cladding as shown on the Drawings.

(c) Bronze Bars

Bronze Bars shall have rectangular profile as shown on the Drawings.

(d) Gaskets

Gaskets shall be flat or of some other profile suitable for their function.

4. Seal Arrangement and Mounting

(a) J-Type Seals

- J-type seals shall be arranged to have a positive initial pre-compression when the gate is closed and to have water admitted to the reverse side of the seal so that water pressure increases seal compression. Mountings shall provide adequate freedom of movement for seal deflection.

- Seals shall be seated on seal seating bars and held in place by clamp bars bolted to the gate.

- Seal seating bars shall be continuous within each section.

- Clamp bars shall be arranged in sections ending at corners.

- Clamp bars shall be fastened with CRES bolts, nuts and washers.

- The splices of clamp bars shall overlap all seal splices by at least 4 in.

(b) Wedge Type Seals

- Wedge type seals shall seal by expansion of the edge of their profile when the seal is compressed due to the gate weight or water load.

- Wedge type seals shall be seated on the gate skinplates or seal seating bars, and clamped as specified for J-type seals.

(c) Seal Corners

- Corners where seals of the same type of profile are connected shall be molded in one piece.

- Corners where wedge type seals are connected to J-type seals shall be overlapped and cemented.

- At corners where the sealing plane is shifted, corner blocks shall be provided. Corner blocks shall be compressible.

5. Seal Splices

(a) Seal lengths

Seals shall be furnished in sections as long as feasible. Each section shall have minimum 6 in. of excess length for field splices and for trimming the seal end in the field.

(b) Shop Splices

All splices other than those specified herein as field splices shall be connected in Contractor's shop.

(c) Field Splices

Connections between a lower corner block and either a side seal or a bottom seal, shall be field spliced.

C. Guiding System

1. General

Guiding system shall perform one or more of the following functions:

- When the gate is handled above the working area, the guiding system shall ensure that the gate is in the required position and shall correctly engage the frame when lowered.

- When the gate is handled in its working area the guiding system shall ensure that the gate remains engaged with the frame.

2. Guide Plates and Guide Rails

(a) Guide plates shall be used for restricting the gate in one or two directions per plate. Guide rails shall be used for restricting the gate in two or three directions per rail. Guide rails and guide plates shall be part of the embedded parts.

(b) Geometry, clearances and contact areas in the guiding system shall be established according to the requirements shown on the drawings.

(c) When defining the extreme positions of the gate for geometric layouts, the most unfavorable combination of all possible effects, such as shifts in clearances, tolerances, deformations and expansions shall be considered.

D. Gate Accessories

1. Lifting Lugs

Two lifting lugs shall be provided on each gate for making connection to hoisting means, as shown on the Drawings.

2. Handling Eyes

Permanent handling eyes shall be provided on gates for attachment to lift the gates for handling during manufacture, erection and maintenance.

3. Dogging Devices

Gates shall be provided with dogging devices to hold them in maintenance position at the top of the slots.

4. Ballast

Ballast, if necessary, shall be confined within the structure, without protrusions.

5. Counter Weight

Fixed wheel gates, if necessary, shall be provided with appropriate counter weight to minimize the hoisting effort. It shall have to be checked by Contractor for each fixed wheel gate.

6. Access Ladders, Hoisting Deck and Railing

Access ladders, hoisting deck and railing shall be provided as shown on drawings.

E. System for Alignment and Anchorage of Embedded Parts

1. All embedded parts shall be set in blockouts and aligned with studs field welded to welding pads embedded in first stage concrete where required.

2. The embedded parts shall be reasonably smooth, true to form and free from twists, warps and kinks, so that they may readily be brought within erection tolerance and straightness requirements.

3. The system for alignment and anchorage shall include the following:

(a) Alignment studs with two nuts and two oversized washers.

(b) Erection brackets shall be shop welded to the embedded parts or frames wherever required. The brackets shall be arranged to provide the following:

- Ease of placing the embedded part on studs already welded to welding pads.
- Convenient access for adjusting and tightening of all nuts.
- Strong and rigid holding in position during placement of second stage concrete.

4. Welding pads embedded in first stage concrete shall be located so as to provide a minimum 4 in. distance between a construction joint and the nearest edge of the welding pad.

F. Hoisting / Operating Machinery

1. Fixed Wheel Gates

Manually/electrically operated wire rope and drum type hoist shall be installed at all the fixed wheel gates.

2. Slide Gates

Manually operated stem type hoist shall be installed at all the slide gates.

3. Stoplogs

Mobile crane shall be used to handle stoplogs.

G. Embedded Parts for Gate Equipment

1. General

Embedded parts of the Equipment shall include all the metal parts, which are to be embedded in first stage or second stage concrete or otherwise permanently attached to the civil structure.

Each set of embedded parts supplied and installed by the Contractor in first and second stage concrete shall include the following:

(a) Frame

A complete frame shall include one sill beam, two side seal plates (including side seal bearing plates and guide rails). The frame shall also include slot corner protection angles and welding pads.

(b) Appurtenances

Appurtenances shall include embedded bearing plates, seating plates for installing hoisting machinery, platforms, dogging devices etc.

2. Seal Bearing Plates, Guide Plates and Rails

(a) The side and sill seal bearing plates, guide plates and rails shall be of CRES.

(b) Splices shall be avoided on side seal bearing plates, if possible. If splices cannot be avoided because of transportation limitations, the seal bearing plates shall be spliced by field welding and grinding. Field splices on corners between different seal bearing plates shall also be spliced by field welding and grinding.

(c) The side seal bearing plates shall extend from the sill beam to the top of the gate.

(d) The top of the side seal bearing plates, guide plates and rails shall be tapered to ensure safe and correct engagement of the seals and guide blocks when the gate is lowered

Name Plates

The Equipment items shall be provided with nameplates, written in English, suitably engraved, weather resistant, containing operating instructions, warnings, or other information essential to the proper use of the Equipment. Information on these nameplates shall include rated capacity of lifting hooks and lifting lugs or pins, required for lowering and raising the gate.

All nameplates shall be permanently attached to the respective parts, components or equipment items in clearly visible locations.

Miscellaneous Equipment Details

The following stipulations referring to miscellaneous design details shall be applied to all Equipment covered by these Specifications.

A. Locking of Bolted connections

All screws, bolts and nuts shall be provided with a locking device.

B. Handling Provision

All parts components and assemblies which are heavier than 33 lbs shall be provided with suitable provisions for handling, such as eyebolts, lugs, hooks, tapped holes for eyebolts or holes with rounded corners for passing slings.

Painting

A. Scope

The Contractor shall furnish and apply all paints as specified herein, before packing and transportation, with the exception of those parts or surfaces that are expressly designated as unpainted. Surfaces to be painted shall receive the preparatory treatment and number of coats prescribed in the painting schedule. The applicable provisions of the SSPC shall apply unless specifically covered otherwise in this clause.

B. Standard Products

All materials, supplies, and articles furnished shall be the standard products of recognized and

reputed manufacturers.

C. Surface Preparation:

1. Cleaning and preparation of surfaces shall be as specified in Clause 16.1.16. “Painting Schedule".

2. Surfaces to be painted shall be cleaned before applying paint or surface treatment. All oil, grease, dirt, rust, loose mill scale, weld spatter, slag or flux deposit, old weathered paint, and other foreign substances shall be removed as hereinafter specified. The removal of oil and grease shall, in general, be accomplished before mechanical cleaning is started. Where specified, blast cleaning shall be done in accordance with SSPC-SP-10. "Near White Blast Cleaning". Clean cloths and clean fluids shall be used to avoid leaving a thin film of greasy residue on the surfaces being cleaned. Cleaning and painting shall be so programmed that dust or spray from the cleaning process will not fall on wet, newly painted surfaces. Where required, imperfections and holes in surfaces and open joints between matching surfaces shall be filled or obliterated in an approved manner. Any required wash treatment shall be done in accordance with the paint manufacturer's instructions. Extreme care shall be exercised when blast cleaning machinery components to prevent blasting materials from entering or damaging bearings, machined surfaces and similar precision parts.

3. Surface preparation and paint application shall be done after the parts are completely finished and checked in shop assembly. The parts shall be disassembled to the extent necessary to enable cleaning and painting those surfaces, which are inaccessible when assembled. After finish painting and drying, parts shall be reassembled as required for transportation and paint. Bolts and other connections that will not be removed in erection shall be painted by touch-up.

D. Colors

Colors shall be as directed. Alternate coats of paints having the same color shall be tinted in order to insure that all surfaces are properly coated with the specified number of paint coats. Unless otherwise specified, the color of all undercoats shall match the color of the finish paint.

E. Painting Schedule:

Surface	Method of Surfaces Preparation	Coats
1. Ferrous Metal Subject to Continuous Immersion in Water.	SSPC-SP10, Near White Blast Cleaning	Two coats in workshop of epoxy Zinc Rich Primer paint with total dry film thickness 75 microns.Two workshop applied coats of low

Surface	Method of Surfaces Preparation	Coats
		VOC (Volatile Organic Compound) , two components hig build high solid's surface tolerant epoxy, each coat minimum 150 micron dry film thickness.
2. Ferrous Metal subject to intermittent immersion and splash, exposed to favorable atmosphere or humid environment.	SSPC-SP10, Near White Blast.	Two coats in workshop of Pigmented Epoxy Paint with total dry film thickness of 50 micron. Two coats at Site of Epoxy Paint, each coat minimum 200 micron dry film thickness
3. Ferrous Metal Expected not to Come in Contact with Water.	SSPC-SP10, Near White Blast Cleaning except galvanized surfaces.	Two coats of Silicone Aluminum Paint, total dry film thickness not less than 50 micron.
4. Ferrous Metal Embedded in Concrete, Welding (erection) pads, erection studs: embedded parts surfaces in contact with concrete.	Clean	None
5. Corrosion Resistant Steel Surfaces.		
a. Seal Plates	Clean thoroughly, and grind smooth if required	None
b. Other	Clean	None
6 Galvanized Surfaces	ASTM A 123 & A 153	Galvanize per ASTM A 123 & A 153

4. Mating Machined Surfaces

Mating machine-finished surfaces including bored and reamed holes, shall be thoroughly cleaned of foreign matter, and coated with a suitable rust- resisting compound which can be easily removed by a commercially available petroleum solvent. Finished surfaces of large parts shall be further protected with wooden pads or by other suitable means. Unassembled fittings, pins, bolts and nuts shall be oiled and wrapped with moisture-resistant paper or protected by other approved means.

F. Paint Materials

1. Zinc Rich Epoxy Primer

Zinc rich epoxy primer shall conform to Permobel Protective Primer, manufactured by ICI, Pakistan, or equivalent.

2. Etch/Wash Primer

Etch/Wash Primer manufactured by ICI, Pakistan, or equivalent.

3. Pigmented Epoxy Paint

Pigmented Epoxy Paint shall conform to M10 Aluminum Epoxy finish manufactured by ICI, Pakistan or equivalent.

4. Low VOC Epoxy Paint

Low VOC, two components high build solids surface tolerant (linter Seal 670 HS) or equivalent.

5. Silicone Aluminum Paint

Silicone Aluminum paint shall conform to Dual Pack H/R Silicon Aluminum Paint manufactured by ICI, Pakistan, or equivalent.

G. Paint Materials for Field Touch-Up

The Contractor shall furnish paint for the field touch-up painting, of the same quality and color as used in shop painting.

Shop Assembly and Tests

(a) General

1. All shop assemblies and tests specified below for the various items of equipment will be witnessed by the Engineer and completed shop inspection reports shall be signed by him or his authorized representative. Copies of all shop inspection records shall be furnished to the Engineer. No equipment shall be transported to Site until it has been inspected. Prior to major shop assemblies and tests the Contractor shall submit an outline of the procedures and tests he plans to perform to demonstrate fulfillment of the requirements of the drawings and Specifications.

2. While assembled, each item of Equipment shall be checked for dimensions, tolerances and accuracy of alignment. Any errors and misalignments discovered shall be corrected.

3. Before disassembling and after installation of dowels and fitting bolts between bolted subassemblies, all parts shall be clearly match marked.

(b) Gates and Stoplogs

4. Each finished and painted gate & stoplog including seals, wheels, hoists and all other applicable accessories shall be completely shop assembled. All field splices shall be assembled. Welded field splices shall be temporarily bolted for shop assembly.

5. All seals shall be fitted to their supports during the shop assembly and proper allowances shall be made for shrinkage after aging. Seal sections, which are furnished in excessive lengths for field splicing, shall be mounted successively.

Installation

A. Installation of Embedded Parts

(a) General

Each set of embedded parts shall be assembled in its blockout, brought to line and grade within the applicable tolerances and firmly secured in place on the alignment studs. The alignment studs shall be located with care so that no subsequent bending or forcing is required to match them with the corresponding holes in the frame and guide members. The alignment studs shall then be welded to the embedded welding pads. Alignment studs shall be adjusted and firmly tightened to hold the frames and guides securely in position while concrete is being placed in the blockouts. Additional bracing shall be provided where necessary to ensure the required alignment. Extreme care shall be taken to ensure that the guiding, bearing and sealing surfaces are within the tolerances specified throughout their entire length. Placement of concrete in blockouts shall not proceed until the frames and guides have been completely assembled, cleaned of dirt, aligned, and secured at least throughout the height of the openings. The use of the gates as a support or brace for the guides during placement of concrete shall not be permitted. Caution shall be exercised in placing the concrete to avoid distortion and displacement of the frames and guides. Before placing the concrete in any one lift, and between placement of successive lifts, alignment tolerances shall be checked and remedial action shall be taken. Suitable windows shall be provided in the concrete forms to facilitate concrete placement and inspection. After all blockout concrete has been placed and forms removed the blockout concrete will be inspected and the embedded parts will be sounded to detect any voids. All voids shall be filled by pressure grouting. No grout holes shall be drilled in the sealing or bearing surfaces.

The tolerances specified in Clause 16.1.12 (H2) shall be met during installation of embedded parts for gates and stoplogs.

(b) Installation of Gates

The gates shall be installed as shown on the approved drawings. The bottom of the gate when erected shall be in true alignment to ensure a tight even bearing of the rubber seal on the embedded sill beams. The sides of the gate shall be in true alignment so that the seal when installed will have a tight and even bearing on the embedded sealing surfaces. The rubber seals shall be installed after the gate has been painted. The wheels on fixed wheel gates shall be properly and truly aligned keeping in view the proper deflection of the side seals.

(c) Installation of Gate Hoists

Each gate hoisting equipment complete with all accessories shall be assembled and installed as per approved drawings.

(d) Installation of Hoist Platform, Deck and Access Step Ladder

All hoist platform parts shall be accurately assembled and erected as shown on the approved drawings, and all match-marks of the fabricator shall be accurately followed. All of the material shall be handled carefully so that no part will be bent, broken or otherwise damaged. Hammering which will injure or distort the members will not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned carefully before the members are assembled or erected. At bolted connections, the bolts shall be drawn tight, and where required, the threads shall be burred or spot-welded so that nuts cannot become loosened. Where required, bolt holes shall be reamed in the field to provide a light-driving fit.

Inspection and Testing

A. General

1 All equipment, apparatus, material and supplies forming part of the Equipment shall be subjected to inspection and tests at the plant of the Contractor at the discretion of the Engineer in the presence of a representative of the Engineer for conformity to the requirements of the Specifications. For field-testing of the Equipment, the method and procedure of the tests and inspection shall be as specified for the particular items or in conformity with one of the applicable recognized standards for making such tests and inspections or as approved by the Engineer. After being assembled by the Contractor in place at site, each complete machine or structural unit shall be operated through a sufficient number of complete cycles to demonstrate to the satisfaction of the Engineer that it meets specification requirements in all respects and is suitable for performing the work intended. Field tests shall be conducted under the supervision of the Engineer. The Contractor shall submit a schedule of the specified testing programme to the Engineer for his approval. Testing of related equipment shall be coordinated so that testing may proceed with a minimum of delay. Field tests shall start, proceed, stop and be resumed

in accordance with the approved schedule and as directed by the Engineer.

2 Remedy of Defects

Defects disclosed during trial operations and tests shall be remedied. The Contractor shall stop work and shall notify the Engineer immediately when any defect is disclosed so that an assessment may be made as to where the responsibility for the defect lies, and so as to permit the recording of necessary data as to the extent of delay and the additional costs of work, labour and material required for remedying of the defect. After defects in Equipment have been remedied, the Equipment shall be subjected to such retesting as may be necessary to demonstrate satisfactory operation.

3 Commissioning Tests

After the installation of each system or item of the Equipment and the system in which it operates, including testing and adjusting as outlined above, has been completed, the Equipment and system shall be given commissioning tests as specified for the respective item of the Equipment. During the final test, the Equipment shall be placed in service under normal operating conditions, and fully loaded where possible.

Commissioning tests will be witnessed by the Engineer and the Employer.

4 Records and Reports

Records of all tests shall be kept by the Contractor. All test reports shall be signed by the Contractor and shall be in the format approved by the Engineer. When approved by the Engineer, five (5) copies of the test reports shall be submitted by the Contractor to the Engineer. All site test reports will be combined into one comprehensive report to be prepared by the Contractor.

5 Test Equipment, Materials and Labour

Except as otherwise specified, all plant, testing equipment, materials and labour required for the performance of tests shall be furnished by the Contractor.

B. Field Stage Tests

From time to time at various stages of installation, tests of sub-assemblies of the Equipment as instructed by the Engineer, will be carried out by the Contractor. The Contractor will conduct such tests, make records of all measurements, and instruct and advise as to any corrections or adjustments he considers desirable. A record of all stage tests shall be embodied in a report.

C. Performance Tests

1 Commissioning Tests

After each, Equipment has been installed, commissioning tests shall be conducted to prove that all parts have been accurately assembled and are operating correctly.

(a) Testing of Fixed Wheel and Slide Gates

Each gate shall be operated in its respective guide slot through a sufficient number of complete cycles to ensure that it is suitable for performing its intended function. Minor adjustments necessary to achieve the above shall be made where required. All joints and connections in the gate and sealing surfaces, which are field welded and where leakage may occur, shall be tested for water tightness prior to field painting. The gates and their embedded parts shall be thoroughly cleaned for all foreign material, with particular attention being paid to bearing and sealing surfaces, and the paint repaired where necessary.

(b) Testing of Gate Hoists

After installation, the hoisting equipment shall be tested for proper operation and adjusted, if required. Each gate shall be operated through a number of complete cycles and, gate position indicators shall be tested for proper operation. Any defects and improper operation discovered during the tests shall be corrected by the Contractor and the appropriate tests repeated. All instrumentation and test equipment required for tests shall be furnished by the Contractor.

(c) Testing of Stoplogs and Lifting Beam

Each section of the stoplog shall be operated with the help of lifting beam and mobile crane through sufficient number of cycles to ensure that it is suitable for performing its intended function. Minor adjustment necessary for smooth operation of stoplogs, and lifting beam shall be made by the Contractor.

2 Final Acceptance Tests

(a) After the entire Equipment of a project feature has been completely assembled at the Site and placed in satisfactory operation, it shall be tested at or near full Head by the Contractor to determine whether or not the requirements of the Specifications have been fulfilled.

(b) The installed Equipment shall be tested to the satisfaction of the Engineer to prove that they meet the design and functional requirements of the Specifications.

FIXED WHEEL GATE EQUIPMENT

General

Fixed wheel gate equipment shall be provided for Cross Regulators of Main Canal at RD 1254+500 to control the downstream flow of water.

A. Scope

This section specifies the detailed requirements for the design and manufacture of the fixed wheel gate equipment to be furnished and installed in accordance with these Specifications. These requirements supplement and/or modify the applicable requirements of Section 16.1 "General".

B. Fixed Wheel Gate Equipment

1 The fixed wheel gate equipment shall be complete with all parts and components required for installation and operation in accordance with the Specifications, except for those parts explicitly specified to be furnished by others.

2 The fixed wheel gate equipment is required to be installed on the Cross Regulators at RD 1254+780.

Four (4) sets for each Cross Regulator structure of the following equipment shall be provided.

- Fixed wheel gates
- Hoists
- Hoisting Platforms, Access ladder and Railings
- Embedded metal parts which shall consist of all embedded parts including seal bearing plates, sill beam, guide rails, welding pads embedded in first stage concrete, alignment studs with nuts and washers.

3 Spare parts as listed in Clause 16.1.2(D) heretofore.

C. Design Loading Conditions

The fixed wheel gates shall be designed for the loading conditions specified in Clause 16.1.9, heretofore.

Fixed Wheel Gate

A. Skin-plate Structure

The gate shall be of welded construction and consist of upstream skin plate strengthened by horizontal and vertical stiffener plates all conforming to ASTM-A36. Wheel axles shall be attached to end vertical stiffener plates by means of locking plates. Wheels shall move on downstream stainless steel/CRES rails. Special care shall be exercised in the fabrication of all parts affecting the strength, rigidity and water tightness of the gate. Unless otherwise specified herein or shown on the Drawings, all connections shall be welded.

Each gate leaf shall be completely assembled in the shop and be free of twists, bends and open joints. Pockets or depressions that may hold water shall be provided with effective drains. Connections between structural members for the gate leaf shall have continuous welds designed to develop full strength of the members. Sections of skinplate shall be connected by continuous welding all around.

B. Wheels

Each gate shall be provided with fixed wheels of material conforming to ASTM-A583. The wheel rims shall be heat-treated to a minimum BHN of 225. Wheel shafts shall conform to the material of ASTM-A276. The rails will have hardness not less than 275 BHN.

Holes for the wheel shafts shall be bored and counterbored in pairs to a common axis after the gate's leaf is fully fabricated. The accuracy of locating and boring holes shall be such that the axis of the completed holes will be perpendicular to the vertical centerline of the gate and lie in a common plane which shall be parallel to the skinplate surface of the gate within a tolerance of plus or minus 0.060 in. Wheels on the same side of the gate shall be in a common plane through the mid-point of the wheel treads within a tolerance of + or - 0.006 in. and such plane shall be parallel to the corresponding plane through the wheels on the other side of the gate.

The bushings of the gate wheels shall be self- lubricating, lubrite bushings, suitable for use in water.

C. Seals

J-type rubber seals with fluoro-carbon cladding shall be attached to gate on upstream side with holding plates and bolts. Sill seal shall be compression type attached to bottom of gate with holding plates and bolts. Side and sill seals shall bear against stainless steel/CRES bearing surfaces. Sill beam steel strip and side seal bearing plates shall have hardness not less than 150 BHN. Joints in rubber seal shall be minimum in number. Holes in seals and gate skin plates will be drilled in workshop. After match marking, the seals will be attached to gates in field. Complete leak proof seal corner blocks shall be provided.

D. Embedded Parts

1 General

The fixed wheel gate shall be provided with one set of embedded parts which shall include sill beam, stainless steel/CRES seal bearing plates, guide rails, welding pads embedded in first stage concrete and alignment studs with nuts and washers. The guide rails shall extend from sill beam to top of the piers and side seal bearing plates shall extend from sill beam to 1 ft. above the top of fixed wheel gate. The top edge of guide rails and side seal bearing plates shall be tapered.

2 Guides

Gate side slots will act as guides for the gate. The width of the slots shall be such that it will provide ample clearance for gate movement and at the same time it will not allow the wheel collars to come out of rails. The rails shall also act as guides for gate wheels and will restrict the lateral movement of the gate.

E. Gate Hoist and Control

1 General

Manually/electrically operated wire rope and drum type hoist shall be provided for the gate operation. Each gate shall have an independent local control panel. The hoisting arrangement shown on the drawings is indicative only. The Contractor shall design the system and shall start fabrication after approval by the Engineer. The hoist shall consist of the following equipment:

(a) Worm-gear Reducers

The worm-gear reducers shall be standard, high-grade reduction units suitable for the service intended, and the proportioning of all parts therein shall be in accordance with the best engineering practice. Either cylindrical or double envelope-type worm-gear reducers will be acceptable. The reducers shall be standard, regularly produced commercial units, manufactured in accordance with standard practice for heavy-duty worm-gear speed reducers. The worm-gear shaft shall extend through the housing on one end for the attachment of flexible coupling and also handle for manual operation of the gate. Keyways shall be cut to suit all flexible couplings. Worm shaft and gear shaft openings shall be provided with seals or packing glands. The gear reduction ratio shall be selected such that one man effort will be required to lift the gate manually. The minimum output torque rating shall be not less than the torque required to lift the gate at a speed of 0.060 in. per revolution of handle.

(b) Drums and Ropes

Drums shall be of fabricated construction or cast steel. Drum diameter shall not be less than 20 times the rope diameter. When assembled, the shafts and drums shall have a common horizontal axis. Each drum shall be supported by grease-lubricated, self-aligning, roller bearings and pillow blocks mounted on a common base plate. Drums shall be accurately machined and keyed properly to the shafts. Drums shall have sufficient grooves to provide two dead-wraps of the rope on them when the gate is fully closed. Drums shall be equipped with integral cable clamps. Rope shall be standard hoisting wire rope made of plow steel, galvanized, non preformed and regular lay. Rope size shall be selected according to the loading given in design criteria. Provision for adjusting the length of one of the two ropes in each hoist shall be made. The ends of the wire rope shall be fitted with wire rope fittings for connection to the gate. Dust covers shall be constructed of 16 gauge sheets steel. One intermediate shaft support containing a split babbitted bearing shall be provided between each drum and gear reduction unit.

(c) Drive Shafts

The lengths of the drive shafts will depend upon the length of the worm-gear output shaft and shall be such that when the hoist is completely assembled with proper clearances between the faces of the halves of the flexible couplings, the distance between the drums will be approximately as shown on the Drawings.

(d) Flexible Couplings

The flexible couplings shall be fully enclosed, dustproof, geared type, and shall be bored for tight fits on the shafts and shall be fitted accurately on the shafts, shall be of the size rated for the shafts they connect and shall have torque ratings suitable for the load transmitted. The flexible couplings shall be designed for oil or grease lubrication, and shall be all metallic except that oil or grease seals may be of suitable non-metallic material.

(e) Lubricating Fittings

Lubricating fittings shall be provided for parts needing lubrication.

(f) Bearings and Bearing Blocks

Bearings and bearing blocks shall be of standard well known manufacturer like SKF or other equivalent known make.

(g) Shafting

Shafting shall have provision for longitudinal movement. Lateral shaft deflections shall not be more than 0.01 in. per foot length of shaft and angular shaft deflection shall not exceed 0.08 deg. per foot.

F. Hoisting Platform

Hoisting platform shall be furnished for the gate to support the gate and all hoist loads. The hoisting platform shall consist of structural steel framework and grating/chequered plate flooring and access step ladder. Before being laid out, all structural steel components shall be straight and free from kinks and bends. All working surfaces shall be finished neatly. Connections between adjoining members shall be welded or bolted. Holes for bolts shall be accurately located and drilled 0.060 in. larger than the nominal size of the bolts. When placed in structure, the length of bolt shall extend at least 0.25 in. beyond the nuts. Washers shall be used with all bolts. Beveled washers shall be used on sloping member.

G. Handrailing

Handrailing of 2 in. dia schedule 40 painted steel pipe shall be provided along the opening side of all the hoist platforms, catwalks, walkways, piers and steps. Bends and turns shall be smooth and accurately formed. Railing and parts shall be shop assembled in convenient sections. Welded sections may be used provided that all welds are ground smooth. Railing shall be painted as specified in Clause 16.1-16 E2 "Ferrous Metal Expected not to come in contact with Water".

H. Gate Position Indicator and Gate Locking Arrangement

A gate position indicator shall be provided and installed with the gate so that the operator, while working on the hoist, can easily see and read the position of the gate. Position indication shall be shown by a pointer on a 12 in. diameter circular graduated scale. The Contractor shall design and provide required mechanism of speed reduction so that total travel of the gate can be calibrated on the scale. The Contractor shall also be required to provide a device to lock the gate at any position.

Shop Painting

The fixed wheel gate shall be painted as specified in Clause 16.1.16E(1) "Ferrous Metal Subject to Continuous and Intermittent Immersion in Water".

Equipment Parameters

(a) Cross Regulator on Main Canal at RD 1254+646

Type of gate	Fixed Wheel
No. of gates	04
No. of embedded metalwork	04 set

Type of construction	welded
Type of hoist	wire rope & drum
Type of hoist operation	Manual/Electrical

Other parameters e.g. width of opening, Elevation of Gate Sill, top of Gate etc. are as per Drawings.

SLIDE GATE EQUIPMENT

General

Vertical slide type gates shall be installed at Six (06) Head Regulators of Distributaries/Minors of Main Canal to regulate the flow of water.

A. Scope

This section specifies the detailed requirements for the design and manufacture of the slide gate equipment to be furnished and installed in accordance with these Documents. These requirements supplement and/or modify the applicable requirements of Section 16.1 "General".

B. Vertical Slide Gate Equipment

1 The slide gate equipment shall be complete with all parts and components required for installation and operation in accordance with these Documents, except for those parts explicitly specified to be furnished by the others.

2 The slide gate equipment shall be installed at the following locations at Main Canal:

D21 Distributary, RD 1254+646

3 Spare parts as listed in Clause 16.1-2(D) heretofore.

C. Design Loading Conditions

The vertical slide gates shall be designed for the loading conditions specified in Clause 16.1.9, heretofore.

Slide Gate

A. Skin-plate Structure

The slide gate shall be of welded construction and consist of upstream skin plate strengthened

by horizontal and vertical stiffener plates all of conforming of ASTM-A36. Special care shall be exercised in the fabrication of all parts affecting the strength, rigidity and water tightness of the gate. Unless otherwise specified herein or shown on the Drawings, all connections shall be welded.

Each gate leaf shall be completely assembled in the shop and be free of twists, bends and open joints. Connections between structural members for the gate leaf shall have continuous welds designed to develop full strength of the members. Sections of skinplate shall be connected by continuous welding.

B. Seals

Bronze bars shall be attached to gate on downstream side serving both as seals as well as load bearing. Wedge type rubber seal installed to the bottom of the gate shall act as sill seal. Side and top seals shall bear against CRES bearing surfaces having hardness not less than 150 BHN.

C. Embedded Parts

Each slide gate shall be provided with one (1) set of embedded parts which shall include sill beam, side channels with CRES seal bearing plates and anchor bolts, nuts & washers embedded in the concrete.

The side channels will act as guides for the gate. The width of the channels shall be such that it will provide ample clearance for gate movement.

D. Gate Hoist

Manually operated hoisting system shall be provided for each gate. Hoisting system shall consist of vertical screw type stems having square/Acme threads and associated worm gears and bevel gears etc. Hoisting arrangement shown on the Tender Drawings is indicative only. The Contractor shall design the system and shall start fabrication after approval by the Engineer.

E. Hoisting/Operating Deck and Platform

Hoisting/operating deck shall be furnished for the gate to support the gate and all hoist loads. The hoisting deck and platform shall consist of structural steel framework and gratings / chequered plate flooring. Before being laid out, all structural steel components shall be straight and free from kinks and bends. All working surfaces shall be finished neatly. Connections between adjoining members shall be welded or bolted. Holes for bolts shall be accurately located and drilled 0.060 in. larger than the nominal size of the bolts. When placed in structure, the length of bolt shall extend at least 0.25 in. beyond the nuts. Washers shall be used with all bolts. Bevelled washers shall be used on sloping member. Steel ladders shall be provided on

both sides of each gate.

F. Handrailing

Handrailing of 2 inch dia. Schedule 40 painted pipe railing and posts shall be provided along the opening side of all the hoisting platforms. Bends and turns shall be smooth and accurately formed. Railing and posts shall be shop assembled in convenient sections. Welded sections may be used provided that all welds are ground smooth.

G. Gate Position Indicator and Gate Locking Arrangement

A gate position indicator shall be provided and installed with the gate so that operator while working on the hoist can easily see and read the position of the gate. Position indication shall be shown by a pointer on a 12 in. diameter circular graduated scale. The Contractor shall design and provide required mechanism of speed reduction so that total travel of the gate can be calibrated on the scale. The Contractor shall also be required to provide a device to lock the gate at any position.

Painting

Painting shall be carried out in accordance with Clause 16.1.16 (1) of these specifications.

Equipment Parameters

Head Regulators for Distributary D-21

Type of gate	Vertical Slide
Type of construction	Welded
Type of hoist	Single/Double Stem
Type of hoist operation	Manual
No. of gates / Disty	01
No. of embedded metalwork / Disty	01 sets

Other parameters e.g. width of opening, Elevation of gate sill etc. are as per Drawings.

STOPLOGS

General

Structural Steel Stoplogs shall be provided at the Cross Regulators Structures of main canal for inspection, maintenance and repair of the waterway and fixed wheel gates of the Canal.

Stoplogs shall be designed to withstand the applicable differential Head at each structure.

Wooden stoplogs of Deodar wood shall be provided at the Head Regulator for inspection and repair of slide gates of the canal Distributary.

A. Scope

This section specifies the detailed requirements for the design and manufacture of the stoplogs to be furnished and installed in accordance with these Documents. These requirements supplement and/or modify the applicable requirements of Section 16.1 "General".

B. Steel Stoplogs

1 The stoplogs shall be complete with all parts and components required for installation and operation in accordance with these Documents.

2 Following steel stoplog equipment will be required for each Cross Regulator:

- Stoplogs Section

- Embedded parts which shall consist of all embedded parts including seal bearing plates, sill beam, guide plates, welding pads embedded in first stage concrete, alignment studs with nuts and washers etc.

- One (1) lifting beam for each structure

- No of wooden stoplogs as mentioned in sub section 16.4.5. here under:

C. Design Loading Conditions

All the stoplogs shall be designed for the loading conditions as specified in Clause 16.1.9.

Steel Stoplogs

A. General

The stoplogs shall comprise two (02) sets each of four (04) sections for upstream and downstream of fixed wheel gates of cross regulators and shall be installed one above the other to form a set of stoplogs for closing the waterway.

B. Stoplogs Structure

The stoplogs shall be of vertical-lift type with downstream skinplate and seals. The structure shall be of welded construction conforming to ASTM-A36. No seismic load shall be considered for the design of stoplogs. The skinplate shall be reinforced by vertical and horizontal members welded to the skinplate. All the stoplog sections shall be numbered.

C. Seals and Clamps

Each stoplog section shall be provided with J-type side and wedge-type bottom rubber seals. The seals shall be fastened to the stoplogs by CRES steel clamp bars.

D. Guide Shoes

Two guide shoes of CRES on each side of each stoplog section shall be arranged to engage with embedded guide plates.

E. Embedded Parts

Each set of embedded parts for stoplogs shall consist of two side-seal bearing and guide plates and one sill beam, all of corrosion-resisting steel. The guide plates shall extend from the sill beam to the top of the waterway. The side seal bearing plates shall extend from sill beam to 1 ft. above the top of stoplog and their top edges shall be tapered to avoid damage to side seals when stoplogs are lowered. The embedded parts shall be installed in the blockouts and adjusted by means of alignment studs attached to welding pads embedded in first stage concrete. After the alignment of the embedded parts, the blockouts shall be filled with concrete.

Lifting Beam

One lifting beam for each size of steel stoplog set shall be provided. The lifting beam shall be of welded construction. The beam shall be equipped with two semi-automatic engaging and disengaging hooks. Two guide rollers on each side of the lifting beam shall engage with the guide plate embedded in concrete for the stoplogs. The semi-automatic hooks and guide rollers shall be mounted on corrosion-resisting steel pins with self-lubricating bushings.

Steel Stoplog Equipment Parameters

(a) Cross Regulator on Main Canal at RD 1254+500

Type of stoplogs	Vertical lift
No. of stoplogs	01 set
No. of sections per set	03
No. of embedded metalwork	04 sets

Other parameters e.g. Elevation of sill of stoplog, FSL, Elevation of top of stoplog etc. are as per drawings.

Wooden Stoplogs

The work under this section covers furnishing wooden stoplog of First Class Deodar wood alongwith embedded metal parts as shown in Drawing No. KC-6B(3R)/MC/TD/CHR/43, for isolating steel slide gates of the Distributaries for maintenance of the gates. The furnishing of stoplogs shall include sawing, planning, wroughting wood and providing and fixing steel parts of stoplogs i.e. end strips and rods etc., as per irrigation practice and/or as directed by the Engineer.

Shop Painting

The stoplogs and lifting beams shall be painted as specified in Clause 16.1.16 E (1) “Ferrous Metal Subject to Continuous and Intermittent Immersion in Water”.

MEASUREMENT AND PAYMENT

Fixed Wheel Gate Equipment

A. Gate Leaf Assembly and Hoisting Machinery

- Measurement for payment will be made for each complete set of gate leaf assembly and hoisting machinery acceptably installed and maintained in accordance with the provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the

contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works and services related to this item.

B. Hoisting Deck, Platform, Access Step Ladder, Railing and Embedded Metal Parts

- Measurement for payment will be made for each set of hoisting deck, platform, access step ladder and embedded metal parts acceptable installed and maintained as a complete set in accordance with provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the Contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works related to this item.

Slide Gate Equipment

A. Gate Leaf Assembly and Hoisting Machinery

- Measurement for payment will be made for each complete set of gate leaf assembly and hoisting machinery acceptably installed and maintained in accordance with the provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works and services related to this item.

B. Hoisting Deck, Platform, Railing and Embedded Metal Parts

- Measurement for payment will be made for each set of hoisting deck, platform, access step ladder and embedded metal parts acceptably installed and maintained as a complete set in accordance with provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the Contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works related to this item.

Steel Stoplog Equipment

A. Stoplog Sections and Embedded Metal Parts

- Measurement for payment will be made for each complete set of stoplog sections and

embedded metal parts acceptably installed and maintained in accordance with the provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works and services related to this item.

B. Lifting Beam

- Measurement for payment will be made for each unit of lifting beam acceptably installed and maintained in accordance with provisions of the Contract.

- Payment will be made for the number of units measured as provided above at the Contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works related to this item.

Wooden Stoplog Equipment

Measurement for payment will be made for each complete set of stoplog sections and embedded metal parts acceptably installed and maintained in accordance with the provisions of the Contract.

Payment will be made for the number of sets measured as provided above at the contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works and services related to this item.

SECTION 12

ROAD WORKS

SECTION 12 ROAD WORKS ii

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ROAD WORKS

GENERAL

Scope

This Section contains requirements for construction of roads, and road safety works.

References

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M180	Standard specifications for corrugated sheet steel beams for highway guardrails
AASHTO T11	
Amount of material finer than 0.075 mm sieve in aggregates	
AASHTO T27	
Sieve analysis of fine and coarse aggregates	
AASHTO T96	Resistance to abrasion of coarse aggregate by use of Los Angeles machine
AASHTO T104	Soundness of aggregates by use of sodium sulphate or magnesium sulphate
AASHTO T112	Clay lumps and friable particles in aggregates
AASHTO T166	Bulk specific gravity of compacted bituminous mixtures**
AASHTO T182	Coating and stripping of bitumen aggregate

	mixtures
AASHTO T209	Maximum specific gravity of bituminous paving mixtures**
AASHTO T90	
Determining the Plastic Limit and Plasticity index of Soils	
AASHTO T176	Method of Test for Sand Equivalent
AASHTO T193	The California Bearing Ratio (CBR)
AASHTO T180	"Moisture Density Relations of Soils"
AASHTO M17	Mineral Filler for Bituminous Paving Mixtures

BRITISH STANDARDS (BS)

BS 340 Precast concrete kerbs, channel, edgings and quadrants

BS 873 Road traffic signs and internally illuminated bollards

** Bituminous mixtures prepared in accordance with Marshall Method of mix design as mentioned in Asphalt Institute Manual series No. 2 (MS-2) Fourth Edition - March 1974;

"Mix Design Methods for Asphalt Concrete and Other Hot-mix Types".

Submittals

The following shall be submitted in accordance with Clause 1-1.4 - Submittal Procedures for Engineer's review and approval:

1 Samples

The Contractor shall provide samples of all materials used in the Permanent Works covered by this Section and as may be required by the Engineer at no additional cost to the Employer. Samples of materials shall be submitted for approval 63 days prior to starting the Permanent Works, and thereafter at regular intervals during production, as required by the Engineer. The samples shall be obtained at the source, from test pits, stockpiles, at the place of use during construction or from other locations designated by the Engineer.

Reference samples shall be kept in suitable containers properly labelled and stored on Site. The Contractor may also be required to furnish certificates from an independent reputable testing

laboratory acceptable to the Engineer certifying that the materials comply with these Specifications or with manufacturers' specifications.

2 Tests Performed by Contractor

The Contractor shall furnish:

- Daily reports and monthly summaries of aggregate plant gradation test results on aggregates produced for roadwork.
- Calibration certificates for the weighing and dispensing devices on bitumen concrete batching plant - once every month with an interval of not less than three weeks between two calibrations.
- Monthly summary of tests conducted on precast concrete pipes, i.e. physical dimensions, 3-point load bearing test and determination of uniformly distributed load-bearing capacity.

3 Certificates

Before delivery of materials to the Site, the Contractor shall submit to the Engineer, for his approval, certificates of origin specifying physical and/or chemical characteristics of each material, and each constituent, which shall conform with those contained in the Specifications or other Standards acceptable to the Engineer. All such certificates of compliance with relevant standards shall accompany each shipment of all materials to be used in the Permanent Works.

Before delivery to the Site, or during the course of work, the Engineer may call for any test considered necessary for acceptance of the materials or for control of their use. All such tests shall be performed at the expense of the Contractor. The materials that will be used in the Permanent Works include:

- Asphalts
- Grade 60-70 penetration for pavement
- Medium Curing (MC) Grade MC-1
- Rapid Curing (RC) Grade RC-2 or RC-4
- Precast concrete pipes
- Unplasticised polyvinyl chloride (uPVC) cable ducts

4 Bituminous Concreting Records

The Contractor shall submit daily returns in respect of bitumen concrete placed during the previous day.

The returns shall detail:

– In respect of each concrete mix design (base coarse or wearing course):

- Number of batches mixed,
- Number of batches wasted or rejected, and
- Total volume of concrete placed.

In respect of location in the Permanent Works:

- The position of placement,
- The concrete mixes placed, and
- Total volume of bitumen concrete placed and number of batches of each mixture used.

In addition, the Contractor shall maintain an accurate and up-to-date record showing dates, times, weather and temperature conditions when each location of road/drainage was completed. These records shall be available for inspection by the Engineer at all times.

PRODUCTS

Roadway Fill

Material for roadway fill shall conform to the requirements specified in Section 5, Excavation and Miscellaneous Earthwork.

The Contractor shall be responsible for carrying out all field and laboratory testing of fill materials in accordance with provisions of Section 5, Excavation and Miscellaneous Earthwork. In addition, the Contractor shall also be responsible for carrying out CBR tests on every 2500 cubic meter of fill or a fraction thereof, and submit these results to the Engineer. CBR tests shall be in accordance with AASHTO T193.

Asphalt

Asphalt for Bituminous Base Course or Bituminous Wearing Course shall be petroleum asphalt, Grade 60-70 penetration, conforming to all applicable standards.

Liquid asphalt for prime coat shall be medium curing cutback asphalt and shall consist of an asphaltic base fluxed with suitable petroleum distillates. The product shall show no separation prior to use and shall conform to standard requirements of Grade MC-1.

Liquid asphalt for tack coat shall be rapid-curing type cutback Grade RC-2 or RC-4, as may be directed by the Engineer.

Aggregate

Aggregate for Aggregate Base Course

Coarse material for aggregates for base course shall consist of clean, tough, durable, sharp angle fragments, free of any excess of thin or elongated pieces, and free of soft, disintegrated or decomposed stone, dirt or other deleterious matter.

Crushed gravel or stone fragments for base course shall consist of the product obtained by crushing gravel that, if directed by the Engineer, has first been screened in such a manner that not less than 90% of the material to be crushed is retained on 5 mm sieve.

All base course aggregates shall conform to the following physical requirements:

- Loss of sodium sulphate soundness
- Test (AASHTO T104) 10% maximum
- Loss of magnesium sulphate soundness
- Test (AASHTO T104) 12% maximum
- Loss by abrasion (AASHTO T96) 40% maximum
- Thin and elongated pieces, by weight,
- (larger than 25 mm thickness less
- than 1/5 length) 5% maximum

- Friable particles (AASHTO T112) 0.25% maximum

Coarse materials for aggregate base course shall be crushed rock or crushed gravel conforming to the following grading requirement:

Sieve Designation		Percent Passing by Weight
63.5 mm	(2.5 inch)	100
50.8 mm	(2 inch)	90-100
38.1 mm	(1.5 inch)	35-70
25.4 mm	(1 inch)	0-15
12.7 mm	(0.5 inch)	0-5

Fine materials for the aggregate base course shall be quarry screenings or natural material and of suitable binding quality as approved by the Engineer. The material shall be free from foreign or organic matter, dirt, shale, clay and clay lumps or other deleterious matter and shall conform to the following requirements when sieved in accordance with AASHTOT27:

Sieve Designation		Percent Passing by Weight
9.52 mm	(0.375 inch)	100
4.76 mm	(No. 4)	85-100
0.148 mm	(No. 100)	10-30

– Plasticity index (AASHTO T90) 6 maximum

– Sand equivalent (AASHTO T176) 30 minimum

The combined material shall consist of a mixture of all aggregate well graded from coarse to fine to conform to the following gradation requirements:

Sieve Designation		Percent Passing by Weight
63.5 mm	(2.5 inch)	100
50.8 mm	(2 inch)	90-100
38.1 mm	(1.5 inch)	60-90

25.4 mm	(1 inch)	45-80
19.1 mm	(0.75 inch)	35-70
12.7 mm	(0.5 inch)	25-60
4.76 mm	(No. 4)	15-40
2.00 mm	(No. 10)	10-25
0.425 mm	(No. 40)	5-15
0.075 mm	(No. 200)	2-10

- Plasticity index (AASHTO T90) 6 maximum
- Sand equivalent (AASHTO T176) 50 minimum

During construction, the following testing shall be carried out:

- When a stationary plant is used, the aggregates shall be tested immediately following mixing based on periodic samples taken from the pugmill.
- When a roadside mix method is used, the aggregates will be accepted after necessary blending and before laying, based on samples taken from the combined windows for each layer of the aggregate base course in case the same is to be constructed in more than one layer.
- When the aggregate is total aggregate, it may be accepted at the crusher plant.

Acceptance of the material by the Engineer does not constitute acceptance of the aggregate base course.

Aggregate for Bituminous Base Course

Mineral aggregates for bituminous base course shall consist of coarse aggregates, fine aggregates, and filler, if required, all complying with the requirements given below.

Coarse aggregate, which is the material retained on a 5 mm sieve, shall consist of crushed rock or crushed gravel. It shall be clean, hard, tough, durable and sound, and shall be of uniform quality and free from decomposed stone, organic matter, shale, clay, lumps and other deleterious substances.

The coarse aggregate shall be free from excess of flat elongated pieces, in no case more than 10%, and shall be of such character that when coated with asphalt shall pass a stripping test performed in accordance with AASHTO T182.

Fine aggregate material shall be that material which passes a 5 mm sieve. Fine aggregate shall be obtained by crushing gravel. The Engineer may allow use of natural material passing a 5 mm sieve provided this material is fed separately to the drier and the amount used shall be so limited that the mixture of the fine aggregate will contain not less than 25% by weight of the crushed aggregate.

The combined mineral aggregates shall meet the quality requirements specified for material for aggregate base course and, in addition, shall conform to the following physical requirements:

- Sand equivalent (AASHTO T176) determined after all processing except for addition of asphalt binder — 45 minimum
- Plasticity index (AASHTO T90) — 6 maximum
- Loss of Marshall Stability by submerging specimens in water at 60øC (140øF) for 24 hours as compared to stability measured in water at 60øC (140øF) for 30 to 40 minutes — 25% maximum

The Contractor shall determine the absorption of asphalt by the aggregates by measuring the maximum specific gravity of the loose paving mixture (AASHTO T209) and then calculating the effective specific gravity.

When tested according to AASHTO T11 and AASHTO T27, the combined mineral aggregates shall conform to the following gradings:

Sieve Designation		Percent Passing by Weight
38.1 mm	(1.5 inch)	100
25.4 mm	(1 inch)	80-100
19.1 mm	(0.75 inch)	70-90
9.5 mm	(0.375 inch)	55-75

4.76 mm	(No. 4)	45-60
2.00 mm	(No. 10)	35-50
0.425 mm	(No. 40)	15-25
0.075 mm	(No. 200)	3-10

The grading limits specified are based on materials having uniform specific gravity and shall be adjusted for any variations in specific gravity of the individual sizes. Also the gradings may be revised by the Engineer on the basis of Marshall tests to obtain optimum stability and life of the bitumen base course mix.

When the combined grading of coarse and fine aggregates is found deficient in material passing a 0.063 mm sieve, approved mineral filler may be added to make up the deficiency. This mineral filler shall consist of rock dust, limestone dust, slag dust, hydrated lime, hydraulic cement or other approved material. It shall be dry and free from agglomerations at the time of its use. This filler material shall conform to the requirements of AASHTO M17 gradation as follows:

Sieve Designation		Percent Passing by Weight
0.60 mm	(No. 30)	100
0.30 mm	(No. 50)	95-100
0.075 mm	(No. 200)	70-100

Aggregate for Bitumen Wearing Course

Mineral aggregate for bitumen wearing course shall consist of coarse aggregate, fine aggregate, and mineral filler, if required, all complying with the requirements given below.

Coarse aggregate shall be the same as specified in Sub-Clause 12-2.3.2 - Aggregate for Bituminous Base Coarse.

Fine aggregate shall be the same as specified in Sub-Clause 12-2.3.2 - Aggregate for Bituminous Base Coarse.

The combined mineral aggregate shall have physical requirements as specified in Sub-Clause 12-2.3.2 - Aggregate for Bituminous Base Coarse

– The plasticity index shall be maximum 3.

– When tested according to AASHTO T11 and AASHTO T27, the combined mineral aggregates shall conform to the following requirements:

Sieve Designation		Percent Passing by Weight
19.1 mm	(0.75 inch)	100
12.7 mm	(0.5 inch)	80-100
4.76 mm	(No. 4)	50-70
2.00 mm	(No. 10)	30-45
0.425 mm	(No. 40)	15-25
0.177 mm	(No. 80)	10-20
0.075 mm	(No. 200)	4-10

Road Safety Works

Corrugated Guard Rails

Steel Guard Rails shall be manufactured from rolled steel as shown on the Drawings or as directed by the Engineer.

Pre-cast Concrete Kerb Stone

Pre-cast concrete kerb stones shall comply with BS 340 and shall be hydraulically pressed or machine extruded in situ. They shall be manufactured in accordance with all applicable requirements specified in Section 8, Concrete Work.

Road Signs

Road signs shall be in accordance with BS 873.

Road-Marking Paint

Road- marking paint shall be chlorinated rubber, one-pack epoxy, or alkyd based, and shall be supplied by an approved manufacturer. It shall be suitable for applying by brush or mechanical means to concrete or bituminous pavement and to concrete block paving so as to give a

chemically stable film of uniform thickness.

White paint shall contain not less than 6% by mass of titanium dioxide as a pigment, conforming to type A (anatase) or type R (rutile) specified in BS 1851. Yellow paint shall be standard colour BS 381C No. 355, and shall contain not less than 6% by mass of a suitable yellow pigment.

The paint shall be supplied fresh and ready for use in sealed containers.

Right of Way (ROW) Markers and Delineators

The markers and delineators shall conform to the details shown on the plans drawings.

(a) Concrete Post

The Concrete post markers and delineators shall conform to the material requirements as indicated in Section 8, Concrete work.

(b) Reflectorization

The white part of a delineator shall be illuminated with white retroreflecting material and the red part may be illuminated with red retroreflecting material.

Reflex reflectors or retroreflective sheeting may be used for object markers and delineators with rigid posts. Retroreflective sheeting shall be used for delineators with concrete posts.

The instrumental method of determining color shall conform to the requirements of Yemeni Standards. In the event of any dispute concerning the test results of instrumental testing, the visual test shall prevail.

A significant difference between day and night reflective color shall be grounds for rejection.

Equipment

General

Plant and equipment shall be sufficient to meet the requirements of both the Specifications and the Construction Program. This chapter describes special requirements for plant and equipment for roadway construction. Alternative equipment capable of producing the specified results may be proposed by the Contractor for the approval by the Engineer.

Two-Axle Tandem Steel Rollers

The two-axle tandem steel rollers shall be self-propelled and shall not weigh less than 7 tons nor more than 11 tons. The power mechanism shall be capable of propelling the roller smoothly and without jerking when starting, stopping or reversing, free from backlash, loose link motions, faulty steering mechanism and worn king bolts. The steering mechanism shall not have any lost motion, shall operate readily and permit the roller to be directed on the alignment desired.

The faces of all drums shall be smooth and free from defects which mar the finished road surface. The roller shall be equipped with water tanks and sprinkling devices which shall be used for wetting the drums to prevent adherence of placed material.

The equipment shall be equipped with independent vibratory mechanism capable of producing 1500 to 2000 vibrations per minute in three different amplitudes to act as an additional tamping force.

Heavy-Weight Self-Propelled Pneumatic-Tired Rollers

Heavy self-propelled pneumatic-tired rollers shall be so constructed that they can be loaded to provide a gross weight of not less than 15 tons and up to 23 tons. The tires of the front and rear axle shall have wide smooth treads and shall be staggered to provide complete coverage of the entire area over which the rollers travels. The tires shall be inflated to a pressure that has been approved by the Engineer and the pressure shall be uniform in all tires.

Aggregate Mixing Plant

The mixing plant shall be capable of mixing the specified grades of the aggregate and water into a mixture of uniform consistency and of discharging the mix directly through a hopper into the transporting equipment without segregation.

Self-Propelled Aggregate Spreader

The aggregate spreader shall be a self-propelled, self-contained unit provided with manually controlled screed and capable of spreading the mixed aggregates uniformly in lane width and thickness as shown on the Drawings.

The equipment shall have mechanical devices capable of guiding the spreader along the route and adjustable device to maintain the design grade of the aggregate base course and confine the edges of the mixture to true lines without use of stationary side forms.

The screed shall effectively produce a finished surface of the required evenness and texture without tearing or shoving the material. The spreader must be capable of paving the desired width and thickness of the aggregate base course without segregation and defects in workmanship. The Engineer can order the Contractor to remove any equipment that fails to produce work within specified limits and acceptable workmanship.

Bitumen Distributor

This equipment shall be used to spray bituminous materials, Prime Coat Grade MC-1 and Tack Coat Grade RC-2 or RC-4, on prepared and approved surfaces at approved rates of spraying and in accordance with the requirements of these Specifications.

Hot-Mix Plant for Bitumen Mixes

The plant shall be capable of producing asphalt concrete for bituminous base course and bituminous wearing course in accordance with the requirements of these Specifications and in such a quantity that can meet the demands of the construction program.

Self-Propelled Bituminous Paver

The bituminous paver shall be a self-contained, power-propelled unit provided with automatically controlled activated screed or strike-off assembly, capable of spreading and finishing courses of bituminous plant- mixed material in lane widths to the specified sections and thickness shown on the Drawings. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mixed material in widths as shown on the Drawings.

The machine shall employ mechanical devices such as equalizing runners, straight-edge runners, evener arms or other compensating devices to adjust the grades and confine the edges of the mixture to true lines without the use of stationary side forms.

The screed or the strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

The controls for the paver shall be an automatic linkage arrangement so that through the process of adjusting the screed thickness controls, asphalt mixture can be placed and finished to a predetermined grade and a uniform transverse slope.

Broom Drags

Broom drags shall consist of brooms mounted on a frame in such manner as to spread the aggregate uniformly over the surface of the area to be treated. The drags shall be equipped with tow plates. Towing equipment shall be equipped with pneumatic tires.

Power Brooms and Power Blowers

Power brooms and power blowers shall be suitable for cleaning the surfaces to be treated.

EXECUTION

Control of Work

Construction Stakes, Lines and Grades

The Engineer will furnish the Contractor with the locations of beginning point and end point of each road, the points of horizontal intersection of tangents and primary bench marks. The Drawings will indicate the properties of horizontal and vertical curves, together with rates of super elevation where required and elevations of the top of the finished road surface. The Contractor shall set construction stakes establishing lines, slopes and continuous profile grade in road work, and centre lines and bench marks for drainage and culvert works and embankment slope protection works. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall establish other necessary controls and perform the work.

The Contractor shall, prior to any stake-out work, submit to the Engineer, for his approval, a planned method of staking-out of the roads, covering accuracy, the position of the various types of stakes, the method of marking stakes, the method to be used for protecting stakes, etc. No staking shall proceed prior to the Engineer's approval of the Contractor's staking plan.

At least twenty-four hours before he intends to stake-out any portion of the work, the Contractor shall submit written notice to the Engineer. Such notice shall include the time, location and type of work to be staked.

The Contractor shall stake-out the work and secure the Engineer's approval of his stake-out before proceeding with construction. If, in the opinion of the Engineer, modification of the line or grade is advisable, before or after stake-out, the Engineer will issue instructions to the

Contractor for such modification and the Contractor shall revise the stake-out for further approval at no extra cost to the Employer.

Templates and Straightedges

The Contractor shall provide a sufficient number of metal templates to be used by the Contractor and the Engineer to control and check the correct shaping of finished surfaces of the work.

In addition, the Contractor shall provide sufficient number of metal straight edges, as required by the Specifications and the Engineer, for control of the longitudinal dimensions of work.

Samples of templates and straight edges shall be submitted to the Engineer for approval.

No separate payment for templates and straightedges will be made. The cost of these items is deemed to be included in other items in the Bill of Quantities.

Tolerances

All slopes, lines and grades shall be true, correct, and accurate and according to those shown on the Drawings or as directed and approved by the Engineer. The subgrade and the finished surface of unpaved shoulders shall be accurate to the authorised levels plus or minus 25 mm, with a maximum deviation from a 3 m straightedge of 25 mm. Where discrepancies are found in the work, the Contractor shall make the necessary corrections.

Earthwork

Clearing and Grubbing

Clearing and grubbing shall conform to the requirements of Section 5, ‘Excavation and Miscellaneous Earthwork’, except that tree stumps and roots less than 75 mm in diameter, which will be more than 600 mm below the bottom of the subgrade and more than 600 mm away from the lateral extent of the roadway subgrade need not be removed.

Excavations

All excavations including borrow excavation, if any, for roadways, road drainage culverts, berm drains and stream channels adjacent to drainage culverts shall conform to the requirements of Section 2, Excavation and Miscellaneous Earthwork.

Roadway Fill

The work of constructing roadway fill including preparation of the areas upon which they are to be placed; placing and compacting of approved materials within roadway areas where unsuitable material has been removed ; and placing and compacting of fill material in pits and other depressions within the roadway area shall be carried out in accordance with Section 2, Excavation and Miscellaneous Earthwork, and in conformity with the lines, grades, thickness and typical cross sections shown on the Drawings or established by the Engineer.

The work shall comply with Section 2, Excavation and Miscellaneous Earthwork, except that:

- The subgrade shall be compacted so that the dry density of the upper 150 mm is nowhere less then 95% of the maximum density as determined in accordance with AASHTO T180 method D or AASHTO T181.
- Pieces of rock projecting more than 75 mm from the surface of the foundation shall be cut down.
- In order that the roadway embankment, subbase and/or base course may not be subject to standing water, during or after construction, the Contractor shall at all times provide adequate drainage so as to prevent standing water. The Contractor shall clean and trim all such drainage ditches from time to time during the work and/or when directed by the Engineer. Damage to the work attributable to wetting through failure to provide such adequate drainage shall be immediately repaired by the Contractor at no additional cost to the Employer. No separate payment will be made for cleaning and trimming drainage.

Compaction of Roadway Fill

Compaction of roadway fill shall be in accordance with the requirements of Section 5, Excavation and Miscellaneous Earthwork.

Aggregate Base Course

Description

This work shall consist of furnishing and placing a layer of aggregate, including additive if required, on a prepared surface in accordance with these Specifications and in conformity with the lines, grades, thickness and typical cross sections shown on the Drawings or as established by the Engineer.

Prior to placing the aggregate base course, the Contractor shall provide adequate edge kerbs

on both edges of the roadway width to be paved. Edge kerbs shall be subject to the approval of the Engineer.

Maintenance of Subgrade

The roadway fill and subgrade shall be maintained true to cross section and grade until the aggregate base course is completed. The Contractor shall make all the necessary arrangements to prevent ponding of water on or along the roadway fill. It shall be the sole responsibility of the Contractor to maintain the subgrade as prepared and approved, and any defects which may develop shall be corrected at no additional cost to the Employer.

Combining Aggregates and Water

Aggregate for the base course shall be combined into a uniform mixture and water added in a central mixing plant. When a binder is to be added, it shall also be combined in the central mixing plant.

Placing Combined Aggregates

Aggregates for aggregate base course shall be delivered to the Site as a uniform mixture and shall be placed in a single layer of uniform thickness as shown on the Drawings. Aggregates shall be placed using a mechanical spreader capable of working to control guide wires.

The material shall be so handled as to avoid segregation. If the spreader causes segregation, or leaves ridges or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the spreader operation, the use of such spreader shall be discontinued and it shall be replaced. All segregated material shall be removed and replaced with properly graded material. Surface patching shall not be permitted after compaction has commenced. Local pockets or depressions may be patched up with aggregates before compaction commences.

Hauling and placement of material will not be permitted when, in the opinion of the Engineer, the weather or the road conditions are such that hauling operations will cause damage to the road surface or contamination of the aggregates.

Compaction

Immediately after placing the material shall be compacted to 100% of the maximum density as determined according to AASHTO T180 method D or determined in accordance with ASTM

D2049. The field determination of density shall be made in accordance with AASHTO T 181. The percent of maximum density may be adjusted by the Engineer if, in his opinion, the weight and volume of the aggregate is larger than the aggregate used in the compaction control test.

Rolling shall be done with self-propelled steel drum rollers to insure a smooth surface free from ruts or ridges and having the proper cross slope and longitudinal grade.

The surface of the finished aggregate base course will be tested with a 3 m straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall not exceed 6 mm when placed parallel or perpendicular to the center line of the roadway. The base course shall be compacted to the thickness and cross section as shown on the Drawings and shall not vary more than 6 mm from the required elevation. All humps shall be cut down to correct elevations within permissible tolerance limits mentioned before and compacted as specified. Skin patching shall not be allowed to make good thickness deficiencies. If the thickness deficiencies are more than the specified tolerances, these deficiencies shall be corrected by removing the defective work or by adding new material as directed by the Engineer.

Maintenance of Aggregate Base Course

The approved aggregate base course shall be maintained by the Contractor at his expense until such time as the bitumen base course (the upper layer) or the prime coat Grade MC-1 is allowed to be placed.

The Engineer shall determine when the surface of the base course is in the proper condition to permit the bituminous prime coat to be applied. When such a permission is extended to the Contractor who chooses not to apply the prime coat or is not in a position to apply the prime coat, he must continue to maintain the approved surface of the aggregate base course, including necessary application of water, brooming, etc at his expense until such time as the bituminous prime coat is applied.

Bituminous Prime Coat

Description

This work shall consist of applying a liquid asphalt prime coat on previously constructed aggregate base course in accordance with these Specifications and in conformity with the lines shown on the Drawings or established by the Engineer.

Preparation of Surface

It shall be the sole responsibility of the Contractor to maintain the surface in an approved condition conforming to required grades and sections. Any and all defects that may have developed shall be corrected at no extra cost to the Employer.

Prior to the application of the bituminous prime coat, all loose material shall be removed by mechanical sweepers, hand brooms or power blowers until the surface is as free from dust as is deemed practicable. If permitted by the Engineer, the cleaned surface shall be given a light spray of water and allowed to dry to surface-dry condition before the prime coat is applied. No traffic shall be permitted on the surface after it has been prepared to receive the prime coat.

Temperature of Bituminous Prime Coat Application

Cutback medium-curing asphalt of Grade MC-1, shall be heated to a temperature range of 50 ºC to 80 ºC. Material heated to temperatures higher than 80 ºC shall be considered as overheated and shall not be applied. Over- heated material shall be retested before it may be allowed to be used as bituminous prime coat. The reacceptance or final rejection will be made by the Engineer on the same requirements under which the material was originally tested.

Areas to be Primed

The top of aggregate base course from a point 200 mm outside the edge of the pavement line to the like point on the opposite side of the pavement.

- The top of the shoulders from the intersection of the embankment slope and top of subgrade to the edge of the pavement line.
- The bridge deck surface from kerb to kerb and end to end of the bridge wearing surface.
- Other surfaces as shown on the Drawings or as directed by the Engineer.

Application of the Prime Coat

Medium-curing cutback asphalt of Grade MC-1 shall be applied mechanically. The spray nozzles and the spray bar shall be adjusted and frequently checked so that uniform distribution is ensured. Spraying shall cease immediately upon any clogging or interference of any nozzle, and corrective measures taken before spraying is resumed. Hand sprays will be approved only for priming small patches or areas inaccessible to the normal distributor. Care shall be taken to avoid excessive overlapping of earlier spreads to avoid exceeding the specified amount. Any

such excess shall be blotted from the surface when directed by the Engineer. Any missed areas or recognized deficiencies shall be corrected by means approved by the Engineer.

Test Section and Rate of Application

The rate of application shall be approved by the Engineer within the limits shown below as determined from field trials conducted on a test section. The Contractor shall prepare a test section for determination of the rate of application for the prime coat for a given type of soil.

The test methods shall be determined by the Engineer and performed by the Contractor in his presence.

The Engineer may order subsequent test sections and/or alter the previously established rate of application when he deems it necessary.

Application Rates

Type of Surface	Grade MC-1	
	Minimum	Maximum
Earth surface, shoulders, aggregate base course	0.50	1.40
Bridge decks	0.075	0.25
Other surfaces	As determined from field tests	

Protection of Adjacent Structures

When bituminous materials are being applied, the surfaces of all structures, wheel guards, guard rails, kerbs, gutters, and other roadway appurtenances shall be protected from being splattered with bituminous material or marred by construction equipment. In the event any appurtenances become splattered or marred, the Contractor shall remove all traces of bituminous materials and repair all damage at no extra cost to the Employer.

Blotting

If the bituminous prime coat has been applied for 48 hours and has not dried under favourable conditions, the Engineer either may allow blotting of undried bitumen by clean fine sand or any other approved material or may extend extra time for drying out of the bituminous prime coat.

Care shall be taken to protect the surface during stripping and removal of bitumen- mixed blotting sand.

Protection of Prime Coat

The Contractor shall maintain the prime-coated surface until it has been covered by the subsequent layer. Any area where the prime-coated surface has been damaged shall be cleaned of all loose material, the defective aggregate base course or subgrade repaired to the satisfaction of the Engineer and the prime coat reapplied. The maintenance and repairs to defective areas shall be done at no extra cost to the Employer.

Weather and Temperature Limitations

Application of the prime coat shall be performed only when the surface is dry, when the atmospheric temperature is above 15 ºC and when the weather is not foggy or rainy.

Bituminous Base Course (BBC)

Description

This work shall consist of aggregates and bituminous material mixed in a central plant and spread and compacted on an approved and primed aggregate base course in accordance with these Specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the Drawings or established by the Engineer.

BBC Mixture Proportions

At least 28 days prior to the date the Contractor intends to begin production of plant-mix bituminous base course and after receiving approval of the aggregate and after the delivery on Site of the asphalt specified for the bituminous base course, the Contractor shall submit, for approval by the Engineer, the job-mix formula for bituminous base course prepared by the Contractor. The job-mix formula, prepared in accordance with the Marshall Method of Mix Design, shall combine the mineral aggregates and asphalt in such proportions as to produce a mixture conforming to the following composition limits by weight:

Total mineral aggregates 96-93%

Asphalt binder 4-7%

When tested according to the Marshall Method (75 blows), the bituminous mixture shall conform to the following requirements:

Stability (kg) 800 minimum

Flow (mm) 2-5

Voids in total mix (percent) 4-7

Voids filled with asphalt (percent) 60-75

All mixes to be used in the Works shall be prepared by the Contractor and submitted to the Engineer for his approval.

The mix will be densely graded and on the high side in fine materials. The mix formula shall have as high asphalt content as possible. The formula shall also take into consideration the absorption of asphalt into the aggregates. Thus for calculations for voids, the bulk specific gravity of the Marshall specimens, adjusted for the portion of asphalt lost by absorption, shall be used.

The gradation of the combined aggregate, including the mineral filler, shall be within the limits specified in Sub-Clause 12-2.3.1 – Aggregate for Aggregate Base Coarse. The Engineer may vary the specified limits where he deems it necessary, on the basis of the Marshall Method, to obtain optimum stability and life of the completed mix.

Upon receiving approval for the Bitumen Base Course mix by the Engineer, the Contractor shall adjust his plant to proportion the individual aggregates, mineral filler and asphalt to produce a final mix that, when compared to the job-mix formula, shall be within the following limits:

Maximum Variations of Percentage of Materials

Retained on sieve No. 4	5%
Passing sieve No. 4 and retained on sieve No. 200	5%
Passing sieve No. 200	1.5%
Asphalt content	0.3%

The Engineer will test the mix periodically and, if necessary, direct the Contractor to readjust the plant to maintain conformity with the design proportions of all ingredients of the mix.

Construction Requirements

Asphalt shall be heated within a temperature range of 135 ºC to 165 ºC at the time of mixing with heated aggregates. Asphalt heated more than 40 ºC above the maximum shown shall be considered overheated and shall be rejected until the material can be resampled and tested.

Each aggregate ingredient shall be heated and dried so that the temperature when recorded in the bins for hot fines after screening does not exceed 165 ºC. If the aggregates contain sufficient hot water vapours to cause foaming in the mix or their temperature is in excess of 165 ºC, they shall be removed from the bins and returned to their respective stockpiles for reprocessing.

Immediately after heating, the aggregates shall be screened into at least 3 sizes and conveyed into separate bins ready for batching and mixing with asphalt. The efficiency of the screening operations shall be sufficient to produce, at plant operating capacity, gradations in each of the sizes of heated and dried aggregates which when mixed shall result in production of a mixture complying with the limits specified for the aggregates.

Dried and heated aggregates and bitumen shall be combined in the plant in the approved proportions.

The mixing time shall be enough to obtain a homogeneous mixture and satisfactory coating of each and every particle of the aggregates.

Placing of the Mixture

The bituminous mixture shall be spread and finished true to crown and grade by an automatically-controlled paver. Where pavers cannot be used, the Engineer may allow manual operations or other means.

The automatically-controlled paver shall spread the bituminous mixtures without tearing the surface and shall strike a finish which is smooth, uniform in density and texture and free from hollows, transverse corrugations and other physical irregularities.

The paver shall be operated at a speed which will give the best results for the type of paver being used and which coordinates satisfactorily with the rate of delivery of the mixture to the paver so as to provide a uniform rate of placement without intermittent operations of the paver. The delivery of the mixture to the paver shall be arranged to allow the paver enough time to complete spreading, finishing and compaction.

All mixtures shall be delivered to the paver at a temperature between 140øC and 165øC.

Mixtures delivered at lower temperatures shall be discarded.

If the Contractor paves for the full width of each carriageway in two or more operations, he shall take all care to minimise the effects of cold joints as mentioned hereinafter.

The inner edge of the previously paved lane shall be blown clean of all loose material, and the improperly compacted bituminous mixture shall be removed by means approved by the Engineer. The final surface shall then be heated and a thin coat of Grade RC-2 asphalt applied using a brush before the new pavement is laid against it.

The use of an automatically controlled paver to provide both longitudinal and transverse control shall include the furnishing and maintaining of a reference string line, whether it be erected or mobile, by the Contractor. The reference string line shall be taut and free from sags.

After spreading and strike-off, and as soon as the mix conditions permit the rolling to be performed without excessive shoving or tearing, the mixture shall be uniformly compacted, without the appearance of any cracks due to over-rolling.

Compaction shall be done by steel wheel and pneumatic rollers which shall be in good condition, capable of reversing without backlash and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture uniformly and to the specified density while it is still in a workable condition. A minimum of three rollers, two steel wheel type and one pneumatic-tyre type, shall be used with each spreading operation.

Initial or break-down rolling shall be done by a tandem power steel roller and shall begin when the mixture will bear the roller without undue displacement. Rolling shall be longitudinal, beginning at the low side of the spread of material and proceeding toward the high side, overlapping on successive trips by at least a half width of the rear wheel.

To prevent adhesion of the mixture to the roller, the wheels shall be kept constantly moistened with water but an excess of water will not be allowed.

The initial or breakdown rolling shall be followed by rolling with a pneumatic-tyre roller for kneading action to effect maximum compaction. Final compaction and finish rolling shall be done by tandem power steel rollers. The Contractor shall protect all sections of the newly-compacted mixture from traffic until the surface has hardened properly.

The road compaction density requirement shall be equal to or greater than 96% of the Marshall Density of each day's production.

Joints between old and new pavement or between successive day's work shall be made so as

to ensure thorough and continuous bond between old and new mixtures. Transverse joints in previously laid material shall be constructed by cutting the material vertically with a power saw for the full depth of pavement so as to expose a fresh contact surface.

Before placing the fresh mixture against a cut joint or against an old pavement, the contact surfaces shall be painted with a thin uniform coat of Grade RC-2 asphalt. Where a finishing machine is used, the longitudinal joint shall be made by overlapping the screed on the previously laid material for a width of at least 20 mm and depositing a sufficient amount of mixture so that the joint formed shall be smooth and tight.

Thickness Cores

The depth of the compacted base course shall be measured in two separate operations by extracting a minimum of two cores per lane per km at locations designated by the Engineer. The first core shall be taken when the layer has been laid and cooled. The second core will be taken when the wearing course is laid and at a location adjacent to the first core.

The Contractor shall furnish and operate an approved core drill for cutting samples from the compacted mixture. The equipment shall be capable of cutting the mixture without shattering the edges of the specimen. The core shall have a nominal diameter of 100 mm.

Unless otherwise permitted, core extracted for thickness measurement shall not be used for density determination and density samples shall not be used for thickness measurements.

Tolerances in Construction

The surface will be tested with a 4 meter long straightedge by the Engineer at selected locations. The variations of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed 6 mm when placed parallel or perpendicular to the center line of the roadway. The top of the base course shall not vary from the required elevation by more than 6 mm.

The thickness of the base course shall be determined by average caliper measurement of cores.

When a core is deficient by less than 6mm, the thickness of the base course will be acceptable. When such measurement is deficient by more than 10mm, the Contractor shall remove such deficient areas and replace them. When such measurement is deficient by more than 6mm but less than 10mm, two additional cores at intervals of not less than 100m, at locations directed by the Engineer, shall be taken and used in determining the average thickness. If the average of

the three cores is deficient by less than 6mm, Engineer will accept the work in the area represented by these cores.

In calculating the average thickness of the bituminous base course, measurements which are in excess of the specified thickness will be considered as specified thickness. When the measurement of any pavement is shown to be deficient but within the acceptable limits given above, the Contractor shall make up the deficiency while paving the bituminous wearing course.

Compaction, Sampling and Testing

The field density of the paved layer of bitumen base course shall be determined in accordance with AASHTO T166. The briquettes used in this ascertainment shall be made of the material used in construction, taken from samples of freshly mixed bituminous mixture at the plant. Reheating of the sample mixture will not be permitted.

The density of the mixture as placed and as compacted on the road shall be determined from samples cut from the compacted course on the road at locations specified by the Engineer. Samples shall be taken in sets of two cut from the same location on the road. The frequency of testing shall be one set of samples per traffic lane every 500 linear meter per layer or a minimum of one set per day for shorter runs, as well as additional tests to determine limits of areas deficient in density or for rechecking.

The Contractor shall cut the samples with an approved saw or core drill in the presence of the Engineer. The equipment shall be capable of cutting the mixture without shattering the edges of the specimen. Samples shall be 100 mm square or 100 mm in diameter (nominal).

Weather Limitations

Hot asphalt mixtures shall be placed only when the air temperature is 5øC or above and when the weather is not windy or rainy and when the surface is not affected by moisture.

Bituminous Tack Coat

Prior to placing a bituminous layer on the approved bituminous base course, a tack coat, as specified in Clause 12-2.2 - Asphalt, shall be applied to the base course at a rate of application not exceeding 0.2 liters per sq m or as otherwise directed by the Engineer.

Before application of the tack coat, the surface of the bitumen base course shall be thoroughly cleaned of all loose materials and all mud sticking to the base course shall be washed and the surface allowed to dry naturally.

The application of the tack coat shall be uniform throughout and as specified or directed by the Engineer. If any area is left uncoated, the Contractor shall not apply a second coat throughout but will be allowed to do hand-coating.

The Contractor shall protect the tack-coated surface from traffic and if any damage does occur, the damaged surface shall be recoated at no extra cost to the Employer.

The bituminous wearing course shall be placed as soon as possible after the surface dries.

Bituminous Wearing Course (BWC)

Description

This work shall consist of construction of one course of hot-mixed and hot- laid bituminous mixture conforming to the requirements of this Section, spread and compacted on a layer of existing bituminous base course in conformity with the lines, grades and typical cross sections shown on the Drawings.

BWC Mixture Proportions

The requirements for the BWC mixture shall be the same as given in Sub-Clause 12-3.5.2 – BBC Mixture Proportion except that, when tested according to the Marshall Method (75 blows), the bituminous mixture shall conform to the following requirements:

Stability (kg) 900

Flow (mm) 2.4-4

Voids in total mix (percent) 3-5

Voids filled with asphalt (percent) 70-80

Construction Requirements

The requirements for preparation of the asphalt, the mineral aggregates and the bituminous mixture shall be the same as specified in contract documents.

Placing of the Mixture

The requirements for placing of the mixture shall be the same as specified in Sub-Clause 12-

3.5.4 Placing of the Mixture.

Thickness Cores

The requirements for thickness cores shall be the same as specified in Sub-Clause 12-3.5.5 – Thickness Cores

Tolerance in Construction

The requirements for tolerance shall be the same as specified in Sub-Clause 12-3.5.6 - Tolerance in Construction, except that, when the measurement of any unit of pavement is shown to be deficient, the bituminous wearing course shall be rejected and the Contractor shall replace it with a layer of acceptable thickness.

Compaction Sampling and Testing

The requirements for compaction sampling and testing shall be the same as specified in Sub-Clause 12-3.5.7 - Compaction Sampling and Testing.

Weather Limitations

The requirements for weather limitations shall be the same as specified for BBC in Sub-Clause 12-3.5.8 - Weather Limitations.

Road Safety Works

Steel Crash Barriers

Rails shall be made in standard lengths of 3200 mm effective centre-to-centre of post fixing bolts. They shall be formed from 3 mm (nominal) sheet steel to AASHTO M180, at least 300 mm in depth and corrugated in cross-section to produce a central trough having a depth of at least 75 mm.

They shall be shaped so as to produce no sharp edges to traffic and except where otherwise required shall be straight and of uniform cross-section.

A single length, when freely supported on knife edges placed 3000 mm apart, shall be capable of supporting a load of 1 tonne when applied vertically to the traffic face, without deflecting more than 40 mm. The tensile strength of any rail and its lap joint shall be not less than 330 kN.

Adjacent rails shall be connected by lap joints each using 8 No. M 16 bolts. Lap joints shall be made in the direction of the adjacent flow of traffic.

Curved rails shall be supplied as necessary without any lessening of the strength of the barrier, for radii up to 45 m internal or external. For radii greater than 45 m, the individual rails shall not be curved.

Rails shall be mounted on steel posts of 150x75 mm channel section with hardwood pads 150x150x350 mm setting the rail clear of the post. The connection of the rail to the post, through the pad, shall be with a single M16 bolt with a lock nut and two washers. Each post shall be 1800 mm long and set in concrete minimum 350 mm diameter in plan and 1300 mm deep.

The end of each length of railing shall end in a standard wing terminal as shown on the Drawings.

The upper edge of the rail shall be 700 mm above the edge of the carriageway or hard surface.

All steel parts shall be galvanised after fabrication.

Pre-cast Concrete Kerbs

Pre-cast concrete kerbs shall be provided at locations shown on the Drawings or as directed by the Engineer. Kerbs shall be laid on a foundation 400 mm wide and 150 mm thick of 21 MPa concrete mixed with only enough water to hydrate the cement, and shall be backed up with additional concrete finishing 50 m below the top of the kerb. Thereafter, the gap between kerb units shall be pointed with cement/sand mortar.

Kerbs shall be laid true to line and level, with no more than 3 mm steps between adjacent units. Curved kerbs shall be used to form radii of 8 m or less.

Row Markers and Delineators

Posts may be cast in place. Posts shall be cast in the ground to the depth shown on the plans. After the posts have been set in position, any space around them shall be filled with earth free from rock. The filling material shall be thoroughly watered and tamped into place in such a manner as to hold the post securely in position.

Surplus excavated material remaining after the posts have been installed shall be disposed of in a uniform manner along the adjacent roadway as directed by the Engineer.

Testing

Testing shall be carried out in accordance with the applicable provisions given earlier in this Section.

MEASUREMENT AND PAYMENT

General

Excavation for roadway shall be measured and paid for in accordance with the provisions of Section 5, Excavation and Miscellaneous Earthwork.

Roadway fills shall be measured and paid in accordance with the provisions of Section 5, Excavation and Miscellaneous Earthwork.

Edge kerbs shall be measured under Section 5, Concrete work.

Steel Guard Rails shall conform with Section 14, Miscellaneous Metalwork but shall be paid as item of work under this Section.

Provision and application/installation of road- marking paint and road signs shall be paid as items of work under this Section.

Aggregate Base Course

Measurement

The volume of aggregate base course acceptably constructed as shown on the Drawings or directed by the Engineer shall be measured as the product of its nominal width, its nominal thickness and its length measured along the center line of the roadway at the finished roadway surface.

Payment

Payment will be made for the number of cubic meter measured as above at the unit price for the Item.

The unit price shall be deemed to cover all costs of constructing the aggregate base course including furnishing, mixing, spreading, compacting, maintaining as specified, testing and

reporting and all other work related to the Item.

Unit of Measure

Unit of measure: Cubic Meter

Bituminous Prime Coat, Grade MC-1 and Bituminous Tack Coat Grade RC-2

Measurement

The volume of bituminous coating material applied shall be measured in liters as the product of the area in square meters acceptably coated at the application rate in Kilogram per square meter as directed by the Engineer.

Payment

Payment will be made for the number of liters measured as above at the corresponding rate for the respective item.

The rate shall be deemed to cover all costs of furnishing, applying and protecting the bituminous coat, including the cost of field trials to determine appropriate rates of application, protection of adjacent structures, blotting, testing and reporting and all other work related to the Item.

Unit of Measure

Unit of measure: Liter

Bituminous Wearing Course

Measurement

The volume of bituminous wearing course acceptably placed shall be measured as the product of the nominal width of wearing course, its length measured along the center line of the roadway and the compacted nominal thickness of the finished wearing course.

Payment

Payment will be made for the number of cubic meter measured as above at the unit rate

tendered in the priced Bill of Quantities. The unit rate shall be deemed to include cost of furnishing, mixing, spreading, compacting, testing and reporting and maintaining as specified and all other associated works related to the Item.

Unit of Measure

Unit of measure: Cubic Meter

Corrugated Galvanized Steel Guard Rails

Measurement

The measurement of Guard Rail in linear meter will be made from end to end length of the Guard Rail acceptably installed.

Payment

Payment will be made at the rate quoted on the priced Bill of Quantities. The rate includes cost of providing installing, maintaining as specified and cost of all associated works related to the item.

Unit of Measure

Unit of measure: Linear meter

Delineators

Measurement

Quantities of Delineators to be paid for will be determined as units from actual count in place.

A delineator post equipped with reflectorized red & white paint will be considered a single delineator.

Payment

Payment for measurement will be paid at the tendered rate for delineators of the designated class.

The above rate shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in installing delineators, complete in place, as specified and shown on the drawings and as directed by the Engineer.

Unit of Measure

Unit of measure: Each

Road Marking

Measurement

Measurement for payment shall be made for full lengths

Payment

Payment shall be made at the rate per linear meter tendered in the Bill of Quantities for the lengths measured.

Unit of Measure

Unit of measure: Linear Meter

Arrow Marking

Measurement

Measurement for payment shall be made for the numbers of Arrows Marked of different types

Payment

Payment shall be made at the rate per number tendered in the Bill of Quantities for different types for the total numbers of each type.

Unit of Measure

Unit of measure: Number

Regulatory, Warning and Guide Signs

Measurement

Measurement for payment shall be made for the numbers of each type of sign installed

Payment

Payment shall be made at the rate per number tendered in the Bill of Quantities for each type of sign installed for the total numbers of each type.

Unit of Measure

Unit of measure: Number

Kilometer Post

Measurement

Measurement for payment shall be made for the numbers of Kilometer Posts installed

Payment

Payment shall be made at the rate per post tendered in the Bill of Quantities for the total number of posts installed.

Unit of Measure

Unit of measure: Number

Convex Mirror Post

Measurement

Measurement for payment shall be made for the numbers of Convex Mirror Posts installed

Payment

Payment shall be made at the rate per number tendered in the Bill of Quantities for the total number of Convex Mirror Posts installed.

Unit of Measure

Unit of measure: Number

SECTION 13

RBUILDING/ARCHIECTURAL WORKS

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BUILDING / ARCHITECTURAL WORKS

SCOPE OF WORK

This section covers General Technical Specifications for the followings item of Building Works, but not limited to these items:

(a) Brick work

(b) Plaster work

(c) Cement rendering - special surfaces

(d) Structural steel and aluminum work

(e) Steel doors and windows

(f) Flooring

(g) Roofing and water proofing

(h) Painting and polishing

(i) Distempering and white washing

(j) Wood work

(k) Water supply and sanitation

(l) Sanitary works

(m) Building drainage works

SUBMISSION BY CONTRACTOR

(a) Methods to execute different items of work

(b) Materials detail

(c) Samples of material

(d) Shop drawings

(e) Test reports of materials

APPLICABLE STANDARDS

Following codes will be applicable unless otherwise specified with the different materials:-

Standard	Subject
ASTM A167	Corrosion-resisting chromiurn-nickel steel plate, sheet and strip
ASTM A307	Low-carbon steel externally and internally threaded standard fasteners
ASTM C5	Quicklime for structural purposes
ASTM C28	Gypsum plaster
ASTM C62	Building brick (solid masonry units made from clay or shale)
ASTM C67	Brick
ASTM C90	Hollow load-bearing concrete masonry units
ASTM C144	Aggregate for masonry mortar
ASTM C150	Portland cement
ASTM C207	Hydrated lime for masonry purposes
ASTM C426	Drying shrinkage of concrete blocks
ASTM C476	Mortar for common brick and concrete masonry
ASTM C578	Preformed, cellular polystyrene thermal insulation
ASTM C635	Metal suspension systems for acoustical tile and lay panel ceilings
ASTM C636	Installation of metal ceiling suspension systems for acoustical tile and lay-in panels
ASTM D226	Roofing felt
ASTM D312	Roofing asphalt
BSS 455	Locks and latches for doors
BSS 1227	Hinges
BSS 1228	Door bolts
BSS 1331	Builders hardware
BSS 2088	Performance tests for locks
Acoustical and Insulating Materials Association (AIMA)	installation and workmanship bulletin

Standard	Subject
National Terrazzo and Mosaic Association Inc.	Standard terrazzo specifications
West Coast Lumber Inspection Bureau	Grading and dressing rules for west coast lumber No. 16.
Western Wood Products Association	Standard grading rules
BS: 486	Asbestos, Cement Pressure pipes:
BS: 582	Asbestos cement soil, waste, ventilating pipes and fittings:
BS: 437	Cast iron spigot and socket drain pipes:
BS: 416	Cast iron spigot and socket soil, waste and ventilating pipes fittings and accessories:
BS: 1211	Centrifugally cast (Spun) iron pipes
BS:1130	Schedule of cast iron drain fittings spigot and socket type:
BS: 1740	Wrought pipe fittings; iron and steel screwed B.S.P. thread:
BS:1494	Fixing accessories for building purposes:
BS: 1184	Copper and copper-alloy traps and wastes:
BS:1291	Ferrous traps for baths:
BS:1212	Ball valves (Portsmouth Type):
BS: 1255'	Brackets and. supports for lavatory basins and sinks (dimensions and workmanship):
BS:1189	Cast iron paths for domestic purposes (dimensions and workmanship):
BS:1182	Cast non-ferrous thimbles (spigot and socket) and ferrules (sleeve):
BS:1188	Ceramic lavatory basin; (dimensions and workmanship):
BS: 1184	Copper and copper alloy traps and waster:
BS: 1226	Draining boards:
BS: 1291	Ferrous traps for baths:
BS: 1206	Fireclay sinks (dimensions and workmanship)
BS: 1229	Fireclay wash tube and tube and sink sets (dimensions and workmanship):
BS:1244	Metal Sinks:

Standard	Subject
BS: 1415	Mixing valves (manually operate) for ablutionary and domestic purposes:
BS: 910	Draw-off taps and stop -valves for water services:
BS: 1125	W. C. Flushing Cisterns:
BS: 1254	W. C. Seats (Plastics):
BS: 2089	W.C. Seats (wooden):
B.S.S. 78	Cast Iron Pipes (vertically cast) for water, gas and sewage and special castings for use therewith:
B.S.S. 437	Cast iron spigot and socket drain pipes:
B.S.S. 556	Centrifugal Cast ('spun') iron pipes:
B.S.S. 1130	Schedule of Cast Iron drain fittings spigot and socket type:
B.S.S. 3656	Asbestos cement pipes and fittings for sewerage and
B.S.S. 915	High alumina cement:
B.S.S. 12	Portland cement (ordinary and rapid hardening):
B.S.S. 146	Portland blast furnace cement:
B.S.S. 882	Coarse and fine aggregates from natural sources:
B.S.S. 1199	Natural sand and crushed natural stone sands for external rendering
B.S.S. 1200	Natural sands and crushed natural stone sands for brick work and masonry
B.S.S1301	Clay Engineering Bricks:
B.S.S. 497	Cast iron manhole covers road gully grating and frames:
B.S.S. 1247	Manhole step irons:
B.S.S. 1377	Methods of test for soil classification and compaction:
B.S.S. 1130	Schedule of cast iron drain fittings spigot and socket type:

MATERIALS

The materials such as cement, sand, aggregate water will be as per details given in Section-6

Concrete Works. Details for the other material have been given below in the relevant items.

BRICKWORK

All brickwork masonry required to be constructed under these Specifications and for all related purposes, including brick masonry profiles under canal lining and other structures as directed by the Engineer, shall consist of the materials herein specified. Cement sand mortar shall be proportioned, mixed, and bricks placed in accordance with the requirements stated herein. The requirements set forth herein shall apply to all brickwork, except when such requirements are specifically modified by the Engineer for any particular item of work.

Cement Sand Mortar

Cement mortar for brickwork masonry, rendering, screening, pitching and jointing concrete pipes shall consist of Ordinary Portland cement and natural sand mixed by hand or approved mechanical mixer in the proportions by volume of 1 part cement to 3 parts sand except joints between precast slabs which shall be with 1:2 cement sand mortar. The cement, and sand shall first be mixed dry until the cement color can no longer be distinguished from the sand in any part of the mass and the whole shall then be uniformly wetted by approved means while undergoing further mixing. The water content shall be just sufficient to ensure a dense mortar of stiff consistency and adequate workability to permit trowelling or floating into place. The workability of cement mortar to be used for rendering may be improved by adding an approved plasticizer in the proportions recommended by the supplier of the plasticizer.

Mortar shall be prepared and used in such quantities that no more than 20 minutes shall elapse between first wetting and its completed use. Under no circumstances shall any mortar that has stiffened before commencing to set, be made. Fresh mortar shall not be mixed with mortar prepared earlier and all batches shall be used entirely separately.

Sand for cement mortar to be used for rendering shall comply with specification details given in Section 8 "Concrete Works."

In any continuous face of the wall the finishing coat shall be applied continuously so that breaks due to cessation of work are not visible. Work shall be planned in such a way that the finishing coat can be stopped when architectural features are reached.

Bricks

Bricks will be having minimum strength of 2200 - 2500 psi. Bricks for use in the works shall be first quality clay bricks of standard size and shall either be pressed bricks, hard, properly burnt,

regular and uniform in color or machine-made wire cut bricks. Before commencing brickwork the contractor shall submit samples of the bricks he proposes to use for the approval of the Engineer. Deliveries shall be kept strictly to the approved samples.

On delivery to the site, bricks shall be stacked to the approval of the Engineer. Facing bricks shall not be offloaded by tipping but by hand and no bricks with damaged exposed faces shall be used in the works.

Brickwork shall conform to the requirements of bending codes being used in Pakistan and to the various Standards referred to therein.

Bricks shall be well soaked in water before being laid so that undue absorption of moisture from the mortar is avoided, but bricks shall not be left standing in water or be brought otherwise to a saturated condition. Each brick shall be “floated" and "rubbed in" or "hammered down” upon such sufficiency of mortar that the mortar shall be squeezed up into the joints, but if such joints are not filled up with mortar by this process they shall be flushed up with the mortar from the next succeeding bed. Joints shall not exceed 3/8” in thickness. Joints in brickwork to be plastered or rendered shall be raked out to a depth of 54” and any loose portions of mortar removed to provide a good key. The courses shall be laid truly level and at the time of bedding all joints shall be neatly struck with a trowel.

All propends shall be kept strictly plumb and square and no damaged bricks shall be used in their formation. Brickwork shall be built English bond for walls one brick thick and over and stretcher bond for walls half a brick thick and shall be reinforced with expand metal or other approved brick reinforcement every sixth course.

The open ends of walls shall be raked up and not toothed during construction and no part of the brickwork shall be raised more than 3 ft above adjacent work at any time.

The top of walls where work has been discontinued shall be well wetted before the work recommences.

Brickwork shall be cleaned down after each day's work and newly laid brickwork shall be protected by sacks or other suitable material.

If brickwork becomes damaged by sun or rain, the brickwork so damaged shall be removed by the Contractor and rebuilt at no extra cost to the Employer.

Brickwork in building shall be set in mortar in the proportions by volume of 1 part cement to 1 part lime to 3 parts sand. Brickwork in manholes and elsewhere shall be set in mortar in the proportions by volume of 1 part to 3 parts sand.

Mortar Batching

Methods and equipment used for mixing mortar shall be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer. If a mixer is used, if shall be of approved design and the mixing time, after all the ingredients are in the mixer, except for the full amount of water, shall be not less than two minutes.

Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within thirty (30) minutes after addition of the water to the mix shall be wasted. Tempering of mortar will not be allowed. Mixing troughs and pans shall be thoroughly cleaned and washed at the end of each day's work.

Brickwork Placing

The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the bricks and nor delay the use of mixed mortar.

All brickwork shall be placed only after the foundation surfaces have been prepared satisfactory in accordance with these Specifications and the Engineer's instruction.

Bricks shall not be placed during heavy or prolonged rain, which may wash the mortar from the bricks. Mortar already spread, which becomes diluted by rain, shall be removed and replaced before continuing with the work. Workmen shall not be allowed to walk on the brickwork before it is fully set.

All bricks to be used in brickwork with mortar joints shall be soaked into water for three to four hours before they are used, by a method, which will ensure that each brick is thoroughly, and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brickwork.

All bricks shall be skillfully laid with level courses, uniform joints, square corners, plumb vertical and true surfaces, except otherwise shown on Drawings or directed by the Engineer. Brickwork constructed fora waterway will be of the best standard of workmanship obtainable, and objectionable offsets in the brick work shall be removed by and at the expense of the Contractor. The smoothest practicable finished surface of the brickwork will be required whenever it is a part of waterway.

Curing

All brickwork requiring mortar shall be cured by water curing or other acceptable methods. All

methods and operations of the Contractor in curing the different portions of the work shall be subject to the Engineer's approval.

When curing by water, the brickwork, shall be kept wet for.at least 7 days, unless specified elsewhere in these Specifications, by covering with water saturated material, or by a system of perforated pipes, mechanical sprinklers, porous hose, ponding, or by any other approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the Specifications for water used in the manufacture of bricks.

Repairing Brickwork

If after the completion of any brickwork, any bricks are found to be out of alignment or level, or do not conform to the lines and grades shown on the Drawings, or show a defective surface, they shall be removed and replaced by the Contractor at his expense unless the Engineer grants permission, in writing, to patch or replace the defective area.

PLASTER WORK

Preparation of Surface: The surface on which plaster is to be applied should be in case of brick walls properly raked and wetted before application of plaster. In case of concrete face to receive plaster, all surfaces shall be properly roughened by dragging wire brushes while the concrete surface is still raw or by raking, if the surface had hardened so that 40 % of the surface is roughened to approval.

Plastering

Piaster works should be done in conformity with B.S. Code of Practice 211 "Internal Plastering" and B.S. Code of Practice 221 “External Rendered Finishes". Ail tools should be cleaned by scraping and. washing at the end of each day’s work, or before use. Metal tools should be cleaned after each operation. All tools should be examined and thoroughly cleaned before plastering is begun.

Straightness

All corners and arises shall be rounded if required while plastering and the rate of plastering is inclusive of this provision. The plaster shall be laid to a true and plumb surface and - tested frequently with plumb bob and straight edge not less than 10 ft. in length. Ail horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds. All mouldings shall be worked true to template and shall be neat and clean, level and parallel, or truly plumb. Allowable tolerance in 10 feet run will be 1/8 inch.

Thickness

Whenever a thickness of more than ¾" is specified, it shall be applied in 2 coats, rendering coat and a final coat. The rendering coat shall be carried to full length of walls or natural breaking points. No vertical or horizontal joints shall be permissible. The rendering coat shall be roughened with waving lines drawn by wire brushes when wet to provide bond for final coat applied and the rendering coat shall be properly wetted. The final coat shall then be applied and finished with wooden cleats to present smooth and uniform surface.

All putlog holes shall be filled up in advance of the plastering as the scaffolding is being taken down. The plaster shall be kept wet for 7 days after completion.

Patching

Plaster containing cracks, blisters, pits, etc. or discoloration will not be acceptable. Such plaster shall be removed and replaced, with plaster conforming to this specification and approved by the Engineer. Patching of defective work will be permitted only as per approval of the Engineer and such patching shall match the existing work in texture and color.

Floating Coat

Plaster coat of moist cement as specified shall be carried out as follows:

► Immediately, after the surface has been plastered and while the plaster is still green a floating .coat of moist cement shall be applied on it and the surface rubbed smooth with steel trowel. No trowel marks to be visible after the surface has been finished, or it may be required to be dismantled and redone.

Mortar

The mortar mix for plaster works shall be as specified in the Bill of Quantities and prepared in manner laid down for preparation of mortar described under Section 10 'Brick Work'.

CEMENT RENDERING - SPECIAL SURFACES

The special treatment in surface rendering may be any of the following finishes as specified or indicated on the drawings or as directed by the Engineer.

i) Plaster on metal lathing.

ii) Plaster with stretched mortar.

iii) Terrazzo plaster with stone, marble, colored marble chipping etc.

iv) Roughcast (throw) plaster

v) Pebble dash

vi) Fair Face Finish with Special Motif Formwork.

Surface Rendering of Facade

Special reusable formwork with motifs shall be used for casting fair-faced concrete on external surface of the building facade. The formwork and motifs shall be of the design approved by the Engineer.

Preparation of Surface

The surface shall be prepared in the same manner as described for plasterwork and if the joints are not properly struck as the work proceeded they shall be raked out before the mortar sets. The surface prepared shall be inspected and approved by the Engineer before actual rendering work is started.

Mortar

The mortar mix shall be as specified in the Bill of Quantities and prepared in the manner laid down hereinbefore for preparation of mortar as directed by the Engineer.

Workmanship

Each type of special rendering of surface, or final finish shall be carried out by skilled workers using proper tools and equipment in workmanlike manner and care shall be taken to finish the surface to a uniform appearance.

Samples

The Contractor shall produce samples of work for each type of special surface rendering for approval of the Engineer. The Engineer may order for testing of these samples and the Contractor shall get them tested at his own cost from the laboratory approved by the Engineer.

Curing

All treated work shall be kept wet for 7 days after its completion. The work shall be protected during that period from extreme fluctuation of weather.

Protection

All the plastered and cement rendered surfaces shall be protected by the Contractor. Any damage done to the same shall be made good by him at his own cost.

STRUCTURAL STEEL AND ALUMINUM WORK

Scope

The work covered by this Section consists of providing the following items of work as shown in the drawings and approved by the Engineer.

i) Providing and fixing in position structural steel, such as angle iron, tee iron, M. S. rounds, flats, sq. bars, .M.S. plates including jointing-welding fixing in position painting.

ii) Manufacturing of holdfasts, anchorages and embedded pieces and fixing the same in position as shown in the drawings or as directed by the Engineer.

iii) Providing and fixing in position Iron fencing grill, steel grating and steel railings as shown in the drawings.

iv) Providing and fixing in position Aluminum T-Sections in expansion joints, Aluminum Window Sections, and L-Shaped Sections as nosing on steps in stairs as shown on the drawings, as specified and as directed by the Engineer.

Materials

Steel Angles: shall conform to the requirements of B.S.S. 15 "Structural Steel".

Steel Plates: shall conform to the requirements of B.S.S. 1449, "Steel Plates Sheets and Strips'1.

Steel Sections: shall conform to B.S.S. 15 "Structural Steel".

Pipes: The pipes shall be galvanized iron or black steel pipe as indicated on the drawings and shall conform to the applicable requirement, of B.S.S. 1387 for steel tubes.

Wrought Iron: shall conform to B.S.S. 51 "Wrought Iron for General Engineering Purposes" and B.S.S. 858 as best suited for the purpose.

Aluminium Sections: Extruded Aluminium sections shall be in Aluminium alloy with tamper F22 (DIN Specifications) free from die marks and other imperfections, with a minimum thickness of 1/8". The sections shall be anodized in approved color and minimum thickness of anodization layer shall be 15 microns (.0006").

Paints: shall be high-grade products of approved manufacturers and shall be delivered on the work in original packing.

Welding Electrodes: shall conform to ASTM-233 or equivalent specifications. '

Bolts and Nuts: shall conform to ASTM-320 or equivalent B.S.S. Specification

Samples

All samples of the material used for the work under this Section shall be approved by the Engineer and same type of material shall be used throughout the work.

Workmanship

All steel and Aluminium members shall be sound and free from cracks, scales, blisters, surface flaws, laminations cracked edges and defects of any kind. If any structural member is later discovered to be having any such defects, the Contractor shall at his own cost replace such components to conform to the specifications. The structure shall be shop- fabricated in convenient number of pieces and. these pieces shall be reunited, welded, riveted or field bolted to the architectural details and structural drawings at site prior to their being lifted in position.

All points will be cut truly square so as to butt properly together and will be made only in such positions as shown on drawings or as directed by the Engineer. All fieldwork of fabrication riveting, bolting and welding would be in the best workmanlike manner. During erection, bending, straining or pounding with sledges shall not be allowed.

The steel structure will be given one coat of suitable red lead primer. All connections, meeting surfaces of structural steel work shall be covered with sufficient red lead to ensure that it squeezes out all round in riveting or bolting up. The structure will be fixed as shown on the

drawings by bolts and bedplates embedded in masonry or concrete. The show plates shall be fabricated along with the member and the slotted sides shall be correctly aligned and fixed according to the position shown on the drawings. Finally it shall be coated with two coats of approved rust proof paint as specified.

Fencing Grill, Steel Grating, Frames and Pipe Railings

The work of iron fencing grill, steel grating, frames and pipe railing shall be carried out after the approval of shop drawings to be prepared by the Contractor. The railings grill and fencing shall be painted as directed by the Engineer. '

Embedded Pieces

The embedded pieces, anchorages, hold-fast shall be either of proprietary make or shall be made from proper steel sections or forged in accordance with the drawings and site requirement. These shall be structured in the manners specified on the drawings. Anchor bolts or steel raw plugs shall be protected from damage during the construction and erection operation.

STEEL DOORS AND WINDOWS

Scope

The work covered under this section consists of providing and fixing Steel Doors, Windows, Ventilators and Gates as shown in the Drawings and described in the Bill of Quantities and

Material

Steel Angles: shall conform to the requirements of B.S.S. 15 "Structural Steel".

Steel Plates: shall conform to the requirements of B.S.S.1449 "Steel Plates Sheets and Strips".

Steel Sections: shall conform to B.S.S. 15 "Structural Steel".

Glazing: shall be of clear or tinted glass .02 inches (5 mm) thick, as specified in the Bill of Quantities or as directed by the Engineer.

Wrought Iron: shall conform to B.S.S. 51 "Wrought Iron for General Engineering Purposes" and B.S.S. 858 as best suited for the purpose.

Metal Casement Windows and Casement Doors: shall conform to B.S.S. 990 "Metal

Casement Windows and Casement Doors for domestic buildings, or as shown on the Drawings and specified in the Schedule of Quantities in case of locally rolled window sections.

Wire Gauze 12 x 24: Steel Wire with hot dipped coating of Zinc.

Samples

All samples of the material used for the work under this Section shall be approved by the Engineer and same type of material shall be used throughout the work. If the Engineer desires to get the material tested, this shall be got done by the Contractor at his own cost from a Laboratory approved by the Engineer.

FLOORING

Concrete Floor

Scope of Work

The work to be done under this item consists of placing approximately (1.50 inches) 1 ½" inch thick grade 300 concrete in panels over the concrete floor bedding constructed in accordance with applicable provisions of Section 5 'Concrete Works'.

Batching and Placement

The production and placement of concrete shall conform in all respects with the applicable provisions of Section 5, 'Concrete Works.

The placement will be in areas whose sizes shall be determined before proceeding with the work. The concrete after laying shall be thoroughly rammed-and mortar worked up to top with wooden trowels to achieve non-slip finish prior to floating.

Workmanship

i) Cement shall be laid in accordance with British Standard Code of Practice 204 'In-Situ Flooring Part 2. Concrete Flooring'. Surface shall be truly leveled or shall be pitched to drain where required. The concrete after laying shall be finished by tamping the concrete with special tools to force the coarse aggregate away from the surface, then screening and floating with straight edges to bring the surface to the require finished level. While the concrete is still green, but sufficiently hardened to bear a man's weight without deep

imprint, it shall be wood floated to a true even plane with no coarse aggregate visible. Sufficient pressure shall be used on the wood floats to bring moisture to the surface. After the surface moisture has disappeared surface shall be trowelled to a smooth, even impervious finish, free from trowel marks. After the cement has set enough the surface shall be given a second trowel ling.

ii) Concrete shall be left un-disturbed for 24 hours after pouring. During the process of laying as well as for a subsequent period of 14 days, the concrete shall be protected by suitable covering from the weather and the extremes of temperature. The concrete shall be kept continuously wet for 14 days.

R.C.C. Floor

Materials method of mixing and finishing R.C.C, sub-floor is specified under Section 5 ‘Concrete Works'. ‘Expansion Joints' if shown on the drawings or specified in Bill of Quantities shall be 3A inch thick and filled with approved bitumastic filler.

Terrazzo Flooring

Scope of Work

The work under this item consists of providing terrazzo flooring at locations shown on the drawings or as directed by the Engineer.

Standards

Unless otherwise specified, terrazzo work shall be performed' in conformity with British Standard Code of Practice 204 'In Situ Flooring Part-1, In Situ Flooring-General Part-III and Terrazzo Flooring' as applicable to the work shown on the drawings and given in the Specifications.

Materials

i) Cement.

Cement shall conform to specification given in Section-6 "Concrete Works”.

ii) Sand

Sand shall conform to requirements for sand given in Clause 10 'Brickwork'.

iii) Marble Aggregate

Marble aggregate shall be sound and hard crushed marble chips. Marble and the size of the chips shall be subject to the approval of the Engineer.

iv) Aggregate for Bed Concrete

Aggregate for bed concrete shall be as specified under Section - 5 'Concrete Works'.

v) Dividing Strips

Dividing strips" shall be of marble with a thickness of 3/8 inch or as shown on the drawings and as directed by the Engineer.

vi) Water

Water shall meet the requirements given in Section .5 'Concrete Works'.

vii) Angle for Stair Nosing

Angle for stair nosing shall be cold rolled aluminium angles of the size specified in the drawings and the Bill of Quantities.

Samples

Samples for all materials for terrazzo flooring shall be got approved from the Engineer and same type of material shall be used throughout the work. Testing of materials required by the Engineer shall be performed or arranged by the Contractor at his own cost from a Laboratory approved by the Engineer.

In-Situ Terrazzo Flooring

i) Material and Proportions: Grey cement or .white cement with approved color additive shall be used as specified. The floor shall consist of terrazzo topping 1.50 inch thick after grinding and polishing of topping, laid over a layer of grade 200 concrete 1 inch thick shall be mixed and laid in the manner specified for cement concrete floor, * except that only such quantity if water will be used as would enable the mix to ball in hand when squeezed. Cement concrete shall be laid over the structural slab or over sub-floor screed of specified thickness.

ii) Laying: The cement concrete shall be leveled with a trowel and straight edge and at - once consolidated with flat head rammers and finished with steel trowel to an even but

rough surface, so that the top marble chipping layer bonds with cement concrete. Over this layer of cement concrete the top layer of cement marble chips and marble powder mixed in the proportion of 1:2:½ (1 cement, 2 marble chips and ½ marble powder) mixed dry in such quantities as are sufficient for the whole area of one specified shade. After dry mixing, great care must be taken to protect the mixed material from harmful effects of moisture. The water shall be added to only such quantities as can be consumed in less than 30 minutes, the quantity of water being the minimum required for workability. Mixing must be done on watertight platform. A layer of cement and marble chips mixture shall be well trowelled into the surface of the base concrete before filling to the top level of the screeds. The layer shall be well compacted and all voids filled in with further material. A layer of neat cement, of the required color is then to be well trowelled into the surface leaving a plain smooth surface. The marble chips and cement mixture must be laid on the cement concrete while the latter is sufficiently green so that the two bond and harden together.

iii) Panel size and dividing strips: Floors shall be laid in panels of about 5 feet x 5 feet or as shown on the drawings or of size as directed by the Engineer. Dividing strips of Marble or Metal shall be used as directed by the Engineer. Marble strips shall not be less than 3/8 inch thick and of width 1 ¼ inch.

iv) Finishing: After an interval of 48 to 72 hours, the top layer shall be evenly and smoothly rubbed with carborundum blocks of coarse, medium and fine grades so as to ensure that the marble chips are evenly exposed all over the surface. Great care must be taken to see that the rubbing is adequate. Any resulting imperfections in the surface shall be made good with neat cement the required color. If marble chips are not evenly exposed, the surface shall be removed and new surface laid at no additional cost to the Employer. The surface, after all chips have been evenly exposed, will be left un-disturbed for 2 or 3 weeks. After this period the surface shall be cleaned of dirt and dust by rubbing gently with pumpice stone with sufficient water. If the surface has become dirty, it must be washed with washing soda. Three days after the surface has been cleaned, it will be rubbed hard with oxalic acid (1:10 solution) using felt or an old blanket. After this the surface is to be cleaned and thoroughly washed with water. After the surface has dried, wax polish shall be applied to the surface to the satisfaction of the Engineer.

Terrazzo in Dado and Skirting

i) The marble chips, cement and mixing shall conform to the specifications for floor. The surface over which the dado/skirting is to be laid shall be well roughened and watered. Cement mortar of 1:3 ratio shall be plastered over this well roughened surface so that the finished thickness is ½ inch as indicated in Bill of Quantities. Before the base course

has set, the layer of marble chip mixture shall be well trowelled to produce a thickness of ½ inch after grinding. The cement and marble chip mixture shall be applied with a wooden trowel. A layer of neat cement of the required color is then to be well trowlled into the surface leaving a plain smooth surface.

ii) After 48 hours the Contractor shall finish as for floor specified above. Marble skirting shall be provided in all places where terrazzo floors are laid unless otherwise shown. Skirting and dado shall be straight, level and in plumb, neatly mitered at corners and returned on themselves at openings. Intersections at floors shall be straight and flush. Coves with a radius of 1 inch (2.5 cm) shall be provided at floor unless otherwise shown. Vertical brass strips shall be in continuation of those in the floor. If precast terrazzo tiles are specified in the Bill of Quantities, these shall be of the size, shape and thickness shown on the Drawings.

Terrazzo in Stairs

The stair risers and treads shall be finished according to exact sizes including the terrazzo topping. Where shown on the drawings the nosing shall be flush with the terrazzo topping and shall be protected by extruded Aluminium angle which shall be firmly secured by means of counter sunk screws cast together with the step. If precast terrazzo tiles are specified in the Bill of Quantities for staircase treads, these shall be of the size, shape and thickness as shown on the Drawings.

Terrazzo / Mosaic Tiles Flooring and Skirting

i) Flooring and Skirting

This shall consist of laying 1 inch thick precast terrazzo tiles over ¾ inch thick 1:2 cement sand bedding mortar over plain cement concrete sub grade in floor and Marble Tiles for skirting over ½ inch thick as shown on the drawings and/or directed by the Engineer.

ii) Materials

Precast terrazzo/mosaic tiles shall comprise ½ inch thick topping in 1:2 grey cement/colored cement and marble chips mixture of approved quality laid over ½ inch thick cement grit mortar of identical strength. The tiles shall be machine pressed and manufactured to the neat lines of finished size. 1:2 cement sand mortar shall be used for laying tiles, which shall be mixed in accordance with applicable stipulations of these Specifications.

iii) Sub-Grade

The surface over which the tiles are to be laid shall be thoroughly washed and scrubbed with wire brushes. The floor shall be roughened with wire brushes when it is green.

iv) Laying

Tiles shall be laid to the required pattern and design over the bedding mortar evenly spread on the base. The joints shall not be more than 1/16 inch thick. The entire floor area shall be rubbed with carborundum stone of approved grade so as to produce uniform and smooth finish. The floor and skirting on walls shall be wax polished as instructed by the Engineer.

Ceramic Tiles

Scope of Work

The work to be done under this item consists of providing and laying glazed ceramic tiles on walls and floors as shown on the Drawings or as directed by the Engineer.

Material

The glazed ceramic tiles shall be of the best quality manufactured in Pakistan conforming to BS 1281. Glazed Tiles shall be used on walls whereas matt finish ceramic tiles shall be used in floors wherever required. The cement mortar shall be prepared in accordance with the applicable requirements of Section 10 'Brick Work' of the Specifications.

Workmanship

i) The ceramic tiles shall be laid to the required surface and elevation over a setting bed of cement sand screed comprising of one part cement to 3 parts of sand by volume. The thickness of the screed shall not be less than at any place or as specified in the Bill of Quantities. The setting bed shall be protected as directed by the Engineer.

ii) Tiles shall be laid out with symmetrical pattern and minimum number of cut tiles and shall be laid to straight edges. Tiles shall be cut with approved cutting tool and rough edges shall be rubbed smooth. Joints between tiles shall be of uniform width. The joints shall be raked and grouted full with a plastic mix of neat white cement immediately after a suitable area of tile has been set. Before placing ceramic tiles on screed bed, a slurry bond coat of neat cement shall be applied to the back of each tile just prior to placing on bed. Ceramic tiles shall be placed before the slurry' coat dries out. Uniformity of joints

shall be maintained throughout. After each piece is laid, it shall be firmly pressed in to place so as to embed it and to even the surface before the mortar takes its initial set. Excess mortar shall be lean from the surface with water and damp sponge as the work progresses, while mortar is fresh and before it hardens.

iii) The tile work shall be kept moist for 72 hours and protected.

Marble Tiles

Tiles shall be 1 inch thick, cut from marble obtained from local quarries free from defects with smooth, matt or polished surface and similar to samples approved by the Engineer and laid to pattern as shown on the drawings.

Water Proofing Mortar

The work under this item covers provide and lay water proof mortar consisting of one part of Portland cement or sulphate resisting cement and three parts of sand as required mixed with water proofing material as approved by the Engineer.

ROOFING AND WATER PROOFING

Conformity to Codes.

All roofing and waterproofing works shall conform to relevant standard as applicable to the work as specified, except otherwise specified, the work of waterproofing shall comply with British Standard Code of Practice CP-144, roofer covering, as applicable to the work as specified.

Materials

Materials shall be delivered to the site in manufacturer's original brand container with manufacturer’s label bearing type, grade and name of quality etc. clearly marked thereon. A copy of printed instructions of manufacturers shall be supplied to the Engineer.

i) Cement: shall conform to specifications described under Section 5 "Concrete Works".

ii) Water: shall be as described under Section-5 "Concrete Works".

iii) Bitumen: shall conform to B.S.S. 1310 having a softening point not less than 160°F

iv) Sand: shall be as specified under Section "Surface Rendering - Plaster".

v) Polythene Sheet: polythene sheet of 500 gauge (0.005 inch or 0.13 mm thick) and as approved, by the Engineer.

Samples

The Contractor shall get samples of all the materials used for the items under this section approved by the Engineer and the same type of materials shall be used throughout the work. Any materials required by the Engineer be tested, shall be got done by the Contractor at his own cost from the Laboratory approved by the Engineer.

General

Membrane water proofing shall consist of the number of layers indicated in the Bill of Quantities. It shall not be carried out when temperature is below 40o F.

Surface Preparation

All surfaces to receive waterproofing shall be cleaned and perfectly dry. All pits, holes shall be filled up-with mastic and all high spots chipped off and ground smooth and the surface carefully swept clean to the satisfaction of the Engineer Concrete surface receiving water proofing shall be dry to the satisfaction of the Engineer.

Water Proofing of the Basement

Water proofing of the basement shall be carried out horizontally as well as vertically. Horizontal water proofing shall be executed as per drawings and shall consist of polythene sheets (500 gauge '0.005 inch or 0.13 mm thick') over two flood coats of hot bitumen 80/100 at the rate of 0.5 Ibs./square feet overlaid with bituminized felt paper and protected by polythene layer, over first layer of concrete (1:4:8) (as per respective items of BOQ) and subsequently covered up by the second layer of concrete (1:4:8) (as per relevant items of BOQ). Final coat of bitumen will be blinded with dry sand before placement of polythene. Vertical water proofing will consist of ¾ inch thick plaster (1:3) with chips aggregates trowelled directly onto 4 ½ inch thick wall, which will be subsequently rendered with two coats of hot bitumen 80/100 at the rate of 0.15 Ibs./square feet and a layer of polythene sheet (best quality) with standard overlaps concrete will be casted against this wall.

Roofing

Roof slope shall be developed as per details shown in the drawings. This shall be achieved by

varying thickness of top horizontal member as per drawings. Water proofing shall consist of a primer coat followed immediately by two flood coats of 80/100 hot bitumen @ 0.5 Ibs/sq. feet of top surface of slab overlaid by Bituminized felt paper of approved quality and protected by a polythene layer. Average 2 inch thick Granolithic concrete shall be laid over top of water proofing membrane in panels and with water stop in each joint as for drawings and specifications.

PAINTING AND POLISHING

Scope of Work

The work under this section includes the following items:

i) Painting of exposed concrete and plastered surfaces.

ii) Painting of wood and steel work.

iii) Polishing of marble and terrazzo works.

iv) Polishing of wood work

Conformity to Code of Practice

Except as otherwise specified, all painting shall be applied in conformity with C.P. 231 "Painting" as applicable to the work.

Polishing of marble and terrazzo works shall be carried out as directed and approved by Engineer.

Wax and French polishing of wood shall be carried out by expert craftsmen of these trades.

Materials

Paints for exposed concrete and plastered surfaces shall be plastic paints of the Acrylic group suitable for exterior and interior painting. These shall be the products of the highest quality manufactured by well-known and approved Manufacturers.

The material shall be brought to Site .in original unbroken packages bearing the Maker's Name and Brand. Materials shall conform to the applicable British Specifications and shall be used in accordance with the Manufacturer's printed directions.

i) Paint for Steel Work: shall be of high grade rust proof lead based products of reputed manufacturers.

ii) Paint for Wood Work: paint for Wood Work shall be of high grade enamelled product of approved manufacturers.

iii) Cement Based Paints: shall be obtained in sealed tins from approved manufacturers. It shall be delivered on the work in original and sealed packages bearing the Maker's Name, etc.

iv) Wax Polish: shall be as approved by the Engineer.

v) Spirit Polish: shall be of an approved quality.

Samples and Detailed Application Specification

Certified data, test samples and detailed application specifications shall be submitted for approval of the Engineer. The detailed application specifications, when approved by the Engineer, will become the approved application specifications.

Preparation of Surface

All surfaces shall be clean, dry and free from dust at the time any coating is applied. Base coats applied shall be in good conditions surfaces well covered by touching up any base or abraded spots. Base coats shall be rubbed smooth.

Wood works shall be smooth and free from raised grain or other surface imperfections. Knots and pitch steaks shall be shellacked before polishing. Nail holes, cracks and similar blemishes shall be neatly puttied and sanded smooth after priming and before body or finish coats are applied.

Concrete surface shall be cleaned until free of all loose and foreign material .and excess mortar, using metal scrapers .and. wire brushes if necessary. Grease and oil spots shall be removed by suitable cleaning compound and then rinsed with clean water to remove all traces of alkali. Efflorescence (alkali salts) shall be removed by washing with a 5 to 10 percent solution of muriatic acid, allowed to remain until effervescence ceases, then rinsing with clean water to remove all traces of acid. Interior concrete surfaces shall be washed with zinc sulphate solution. Treated surfaces shall be allowed to dry thoroughly before any paint is applied.

Plaster work shall dry for a minimum of 60 (sixty) days prior to distempering or applying any cement based paint. Surfaces shall be clean and free from grit, loose plaster and surface

irregularities before distemper or cement based is applied.

Ferrous surfaces that have not been shop-coated shall be cleaned and painted, with protective paint conforming to British. Standard Specifications B.S.S. 2521/4 followed, by finish coats. Shop coated metal shall be Protected from corrosion -before and after installation by treating corroded areas immediately upon detection.

Painting on Exposed Concrete Surfaces

The work of-application of plastic painting to exposed surfaces of concrete shall be carried out only after the final finish of exposed concrete' surfaces has been accepted by the Engineer.

The acrylic paint shall be as sprayed with paint sprayers or applied as instructed by the Manufacturer of the product. The number of coats for application shall be as specified in the Bill of Quantities, or as directed by the Engineer.

Cement Based Painting on Plastered Surfaces

No further material shall be added to the cement based Paint obtained in sealed tins. Where different colors may have to be mixed together to provide the desired shade, the quantities of the various colors required to give the desired shade shall be intimated by the. Engineer and this shall be mixed together by weighing (not by measuring volumes of different colors). The weighed quantities of cement based paint should be mixed as well as possible by means of trowel on a clean mixing board after which it must be sieved through 200 mesh sieve. This preparation i.e. mixing with trowel and sieving may have to be repeated two or more times until when cement based paint of various colors shows no signs of steakiness or any trace of separate color remains

Cement based paint must be mixed in two stages. First, by adding a little quantity of water to form-a paste and the further quantity of water being added to get a mix of workable consistency. In the first stage, one measure of water to two similar measures of cement based paint must be thoroughly stirred and allowed to stand for 10 minutes. A further measure of water should then be added and thoroughly mixed. This mix must be applied within one hour of the mixing. The lid of the container must.be tightly replaced after the material has been taken out from it. immediately before the first coat is applied surface shall be thoroughly saturated with water. The cement based paint should be applied with brushes conforming to British Standard B.S.S. 23S2. The first coat of cement based paint shall be well scrubbed and allowed to set for a period of 24 hours, after which period the next coat shall be applied. The number of coats shall be specified in schedule of Quantities but if the Contractor has not produced finished surface to the satisfaction of the Engineer, he shall apply more coats till a uniform smooth surface is obtained at no expense to the Owner.

Polishing of Marble and Terrazo Works.

The polishing of marble and terrazzo work shall be carried out, when the final surface finish of these items of work have been approved and accepted by the Engineer.

The surfaces before application of wax or polish shall be washed with hot water (50°) and soft soap and allowed to dry for receiving final treatment. The Polished surfaces shall be kept clean and protected from dust and stains till final handing over to the Owner.

Wax or French Polishing to Wood Work

Wax Polishing

Before wax polishing is started, the surface shall be knotted stopped and sand papered till a complete smooth and even surface is obtained. The wax polish must be applied strictly in accordance with the specifications and instructions issued by the manufacturers. It shall contain minimum of coloring material to keep the finish surface as light as possible. The polish shall be rubbed into wood until all the pores' have disappeared.

Spirit Polishing

It shall be prepared by dissolving 3 ounces of shollac dissolved cold in a pint of spirit and shall be applied on the prepared surface as specified, under Wax Polishing.

Painting of Timber and Metal Surfaces

Paints and finishing materials shall be free from skins, lumps or any foreign matter when used. Pigments and fillers shall be well stirred while being applied. Work that is not to be finished under this section shall be protected spatters, stains or soiling and each type of finish shall be protected against similar defacement by other finish and shall be left clean.

Cleaning

All cloths and cotton waste that might constitute a fire hazard shall be placed in closed metal containers or destroyed at the end of each day. Upon completion of the work, all staging, scaffolding and containers shall be removed from the Site or destroyed in an approved manner. Paint spots, oil or stains upon adjacent surfaces shall be removed. The Contractor shall be responsible for the protection arrangement of the work while painting or Polishing work is in progress.

DISTEMPERING AND WHITEWASHING

Scope of Work

The work under this section of applying distemper, white washing or color washing at places to be indicated by the Engineer. .

Materials

Distemper: shall be oil bound of approved quality and make. It shall consist of lime proof pigment. Distemper shall be delivered on the work site in original unbroken packages bearing the maker's name and brand.

Lime: shall conform to B.S.S. 890 "Building Lime"

Samples and Tests

Certified data, test samples and detailed applicable specifications shall be submitted for approval of the Engineer. The detailed applicable specifications will be approved by the Engineer. Samples of the distemper used for the work shall be approved by the Engineer and same type of distemper shall be used throughout the work in progress.

Preparation of Surface

All surfaces shall be clean, dry and free from dust at the time any coating is applied. Base coats applied shall be in good condition and. surfaces well covered by touching up any base or abraded spots. Base coats shall be rubbed smooth.

Plaster work shall dry for a minimum of 60 (sixty) days prior to distempering or applying Whitewash. Surfaces shall be clean and free from grit, loose plaster and, surface irregularities before distemper or white-washing are applied.

Distempering Concrete Surfaces

Before work of distempering is commenced the plaster surface must be sized with a priming coat of size to which little distemper has been added and which should be applied hot. Distemper shall be applied quickly and boldly with large flat brushes of approved make. The brush is to be dipped and stroked crosswise on the surface and then immediately stroked up and down. This process shall be considered to form one coat of distemper. The distemper shall be mixed in the manner specified by the makers and each coat shall be inspected and passed

by the Engineer before the next coat is applied. The surface shall be carefully stippled to remove any brush marks. The Contractor shall carry out as many coats as are specified in the Bill of Quantities in accordance with the above specifications. The number of coats specified should be enough for producing a uniform smooth finish and if the finish produced by the Contractor is not up to the requirements, he will be required to apply as many more coats as may be required to produce the required uniform finish, and no payment for the extra coats applied to produce the desired uniformity will be made.

White Washing

The unslaked lime shall be placed in a large vessel full of water and shall be thoroughly mixed and stirred up with a rod until the mixture attains the consistency of thin cream. It will then be strained through a clean and coarse cloth and two chattacks of gum boiled with six chattacks of rice added for each cubic foot of lime. The white wash will then be applied in the same manner as distemper. When completed the wash shall not crack or come off on finger when rubbed.

Cleaning

Paint spots, oil or stains upon adjacent surfaces shall be removed. The Contractor shall be responsible for the protection arrangement of other work while distempering or white-washing work is in progress.

WOODWORK.

Scope of Work

The work under this section comprises providing and fixing wooden doors and fixtures as shown on the drawings, given in the specifications and the Bill of Quantities or as directed by the Engineer.

Materials

Timber

Timber shall be of the best quality seasoned Deodar wood of water borne sleepers or logs. Wood core for flush doors shall be of the best quality block board. The wood shall conform to requirements of specification for 'wood doors.' as given in Pakistan Standard 142:1961. Any timber rejected by the Engineer shall be immediately removed from the site.

Screws

Screws shall conform to the requirements of B.S.S. 1210 'Wood Screws'.

Plywood

Plywood shall conform to the applicable requirements of B.S.S. 1453 for workmanship and quality. Unless otherwise specified or shown on the drawings, the plywood shall be 3 ply, 3/16 inch thick and shall be commercial veneered on all exposed faces.

Flush Doors

Flush doors shall conform to B.S.S. 499 'Flush Wooden Doors' and B.S.S.C.P. 151-Part-l 'Flush Wooden Doors'. It shall have 3ply 3/16 inch thick plywood face, veneered on all exposed faces, conforming to the applicable requirements of B.S.S. 458.

Hardware

Hardware shall be of heavy type and be obtained from approved manufacturers and shall as for as practical be matching in any one unit. Generally ironmongery shall comply with the provisions of codes given in Clause 8.3. All hardware is subject to the approval of Engineer.

Preservative

Wood preservative shall be creosote or pentachlorophenol and shall conform to the applicable requirements of B.S.S. 1282 'Classification Application'.

Samples and Tests

All .samples of the material used for the work under this section shall be approved by the Engineer and same type of material shall be used throughout the work. If the Engineer desires to get the material tested, this will be got done by the Contractor at his own cost from a laboratory approved by the Engineer.

Wooden Doors

The door frames shall be of the best quality Deodar Wood or of the specified timber and shall be fabricated to the exact sizes and dimensions as shown on the drawings or directed by the Engineer. Stops shall be of best quality timber of same specifications as that for frames. Where

the doors frames are not to have nay sills the vertical length shall be embedded in the floor at least 2 inch deep. No extra payment will be made for this extra length. Frames shall have a rebate to receive the leaves. The rebate shall be ½ inch deep and of width equal to the thickness of the leaf. All the frames shall be ready before the work reaches sill level so that they can be built in as the work proceeds. The frames shall be secured to the brick works or concrete by hold fasts or expanded bolts as shown on the drawings or as approved by the Engineer. The number and sizes of hold fast or expanded bolts for each frame shall be as shown in the drawings or directed by the Engineer. Ail surface in contact with masonry or concrete shall be creosoted.

Flush Doors

i) Flush doors shall conform to the applicable requirements of B.S.S, 459 ‘Flush Wood Doors' and B.S.S. Code of Practice 151 ‘Doors and Windows Part-I’. Door leaf shall be of well-seasoned solid core of block board cross grained and both faces veneered with 3 ply 3/16 inch thick plywood of commercial quality. Frame shall be of deodar wood. Door leaf shall have well-seasoned hard wood edge strips, of quality and design shown on drawings, on all four edges of leaf. Overall thickness of door leaf shall be as shown on the drawings.

ii) Face veneers shall be free of saps, mineral streaks, knots and irregularities and shall be suitable for 'pain finish'. Veneer construction shall provide for equal stress on both sides to ensure absence of warp. Flush doors shall be screwed to the frames by means of hinges which shall be counter sunk in the wooden frames.

iii) Toilet doors shall be veneered flush type doors as specified above, fixed in position as shown on the drawings or directed by the Engineer. These doors shall be supplied and fixed with butt hinges, occupancy and slide bar latches, coat hooks and rubber tipped stopper in the toilet compartments.

WATER SUPPLY AND SANITATION

General

The materials used and workmanship shall be of highest quality and grade and unless otherwise specified shall conform to the relevant specifications given in Pakistan Building and Roads Department Specifications Vol. (ii) Public Health Works 1966 and the relevant British Standards and Codes of Practice C.P. 310 (latest) "Water Supply", C.P. 304 (latest) "Sanitary Pipe Work above Ground", C.P. 305 (latest) " Sanitary Appliance", C.P. 301 (latest) "Building

Drainage" and C.P. 303 (latest) "Surface Water and Sub-soil Drainage" and applicable to details and work indicated on the Drawings and Bill of Quantities, In case of any discrepancy/ambiguity the decision of the Engineer shall be final, and the Contractor will act and perform accordingly. •

Water Supply Works (Internal)

G.L. Pipes and Fittings

Paint spots, oil or stains upon adjacent surfaces shall be removed. The Contractor shall be responsible for the protection arrangement of other work while distempering or whitewashing work is in progress.

(a) Scope

All the G. I. Pipe work up to 0.0762 m (3") dia shall be included in this Section.

(b) Standards

All pipes and fittings listed in the building work whether exposed, hidden in brick/concrete work or running underground shall be of Galvanized Iron, to the satisfaction of the Engineer and according to the standards described in "General" above.

It shall be ensured that the threads are not worn out, the fittings shall be tested by jointing at least 5% of them to straight pipes in pipe vices with sufficient pressure, to the satisfaction of the Engineer. The fittings shall also be examined to detect blisters and minor cracks. The fittings shall also withstand a pressure of 200 ft. head of water.

(c) Workmanship

i) Excavation and Refilling

The G.I. Pipe line leading to the building shall be carried through a trench 1.5 ft. in width and 1.5 ft. in depth. After the pipes have been laid, jointed and tested and proved to be water tight the trench will be filled by earth in 6" layers compacted and watered as required.

ii) Laying and Jointing G.L Pipes

All screwed joints, shall be examined before jointing to ensure that the threads are perfect. In case of any flaw proper dies will be used to make threads before they are jointed. The screwed ends of the pipes or specials to be jointed shall be very slightly tapered so that as the joint is screwed up, the threads shall bind together more and more tightly to ensure water tightness. The jointing work shall be so arranged in case of every joint that the two ends of pipes or specials joined thereby shall be equidistant from the middle of the socket and shall have a

space of not more than ¼ inch between them in the centre of the socket. Before any joint is made all burrs from the ends of the thread joints shall be removed. A few very thin strands of best quality country cotton yarn, smeared over carefully with genuine Red lead shall be wound in the grooves of the threads from end to end of the joint if the screwed joint is a little slack in order to ensure tightness. For this purpose hemp or jute or any material other than that described above shall oh no account be allowed to be used. A paste of genuine red and white lead mix shall be lightly smeared over the threads to act as a lubricant. The pipes shall be screwed up tightly with pipe fitter's tongs or wrenches to ensure that each and every joint is perfectly water tight against the test head of water. No red and white lead paste or cotton yarn shall project outside the ends of the joints.

iii) Flanges

Flanged joints shall be provided at intervals of not more than 300 ft. Each flanged joint shall be made by inserting an accurately cut disc of tough multiple rubber insertion about I/8" thick of approved quality between the flanges. The bolt holes in the rubber insertion as well as in the flanges shall be drilled to template. The bolts and nuts for all flanged joints shall consist of British Standard mild steel, hexagonal, round and hexagonal. The bolts shall be pulled up gradually and evenly by the use of standard spanners, so as to ensure a perfect joint.

iv) Bend, Tees and other Specials

Bends, tees and reducers and other specials shall be provided and joined at points as shown on the drawings or as directed by the Engineer. All changes in direction shall be effected by means of bends wherever practicable and the use of elbows shall be restricted only to cases where there is no room for bends. In such cases only round elbows will.be allowed.

(d) Tests

All pipe lines in course of or after laying and jointing but before being covered, shall be tested hydraulically, using a test pump fitted with accurate pressure gauge to be approved by the Engineer to maximum working pressure plus 50% head of water. All pipes, specials and fittings with their joints shall remain perfectly water tight under the full test head for a period of not less than one hour after the whole length of the pipe line has been examined and demonstrated to be water tight. A general leakage of 4.5 litre (1- gallon) per 25 mm of dia per mile per 24 hours per 100 ft. head may be considered reasonable.

(e) Pipe attached to walls or ceilings

Every pipe line attached to walls, floors, roofs or ceiling shall be supported by galvanized holders placed securely into the wails or celling at intervals not exceeding 8 ft. throughout its length. Clear space as fixed by the Engineer shall be left between walls/ceiling etc. to facilitate-

periodic painting etc. Where the pipe passes through a concrete work fabricated steel sleeve as per design approved by the Engineer shall be provided. Where ever the water supply pipe is not embedded in floor it will be suspended from ceiling through hanger rods and pipe clamps attached to concrete inserts through angle supports spaced at not more than 8 ft. apart. Vertical pipe stacks will be supported at each floor level through pipe clamps. In case water supply, soil pipes or roof drainage pipes are running closely together they can all be suspended from ceiling through a trapeze hanger of a design to be approved by the Engineer. The cost of all attachments described above shall be included in the cost of supplying and installation of the respective pipe line.

(f) Insulation for Hot water lines.

Thermal insulating, material to be used on hot water lines shall be performed polystyrene pipe sections 1” thick which are split down two sides (diametrically) opposite. It would be fitted round the pipe and secured by fabric fixed with suitable adhesive and so arranged as to cover the whole outside surface of the insulation and f to provide a lap of not less than 1" at all fabric joints. Afterward the insulation should be further secured with non-corrodible bands of metal not less than 3/8" wide at not more than 18" centres generally and at all points like round bends and screwed fittings.

The material delivered to the site would be of a make acceptable to the Engineer and would be subjected to a thickness inspection test as described in Clause 5 of B.S.S. 1334. The final decision to reject a consignment would be based upon the sampling conditions stated in that clause and to the judgement and discretion of the Engineer.

Taps

(a) Pillar Taps and Mixing Valves

All taps shall be of heavy-duty chromium plated as indicated in the Bill of Quantities and shall be of MASTER, BAIG or other leading make to the approval of the Engineer. The Contractor shall within one month of the signing of the contract, submit to the Engineer the samples for the taps he proposes to use for his approval or the Engineer may in his entire discretion direct to use a particular make available in the market or importable into Pakistan.

(b) Bib Taps

Bib taps shall be heavy duty chromium plated local or imported as indicated in the B.O.Q of best quality to the approval of the Engineer.

Valves

(a) Gate Valves

Wheel valves or gate valves shall conform to B.S.S. 3464, cast iron gate valves for general purposes and to B.S.S. 1952, "Copper Alloy gate valves for general Purposes" as applicable. "Sluice valves shall conform to B.S.S. 1218", "Sluice valves for water works purposes". For these valves the minimum test pressure shall be 300 Lbs./sq. in.

(b) Screw Down Stop Valves

These shall conform to B.S.S. 1010 (latest) and shall be either imported or local of best quality as indicated in the Bill of Quantities. The Contractor shall supply samples of top valves he proposes to use for approval of-the Engineer or the Engineer may ' direct the Contractor to use a particular imported or local make as per the requirement of the Bill of Quantities.

(c) Pressure Reducing Valves

The pressure reducing valves used in the lower stories of the building to reduce the excessive pressure in the supply lines shall be of an approved make. These shall be manufactured from cast iron. The valve gates which are less than 3" in diameter shall be of solid bronze composition of other components shall be:

i) Valve seating, thrust bearing, packing glands, gear spindles, wedding devices, guide rollers and indicator mechanism shall be of gun metal.

ii) Valve stem collars and nuts shall be made of magnese bronze having a tensile stress of 60,000 psi.

iii) Shifting box shall be packed with grapinted hydraulic packing made of jute.

iv) Wrench nuts shall be of cast iron 2 inches square.

v) The valves shall be of clear diameters as specified. Its component parts shall be free from flaws, any bubbles, cracks, sand holes another defects. All ferrous parts of valves except finished or bearing surface shall have three coats of bituministic pipe dip.

vi) The valves shall be such that they can be made to give any desired pressure F between the limits of 14 psi for a supply pressure of 40 psi and a minimum of 20 psi for a supply pressure of 100 psi.

(d) Check Valve

Check valve shall be of an approved manufacturer. The valve shall have composition and quality similar to pressure reducing valve described in previous clause. The valve shall be of substantial construction and the loss of head as specified shall be guaranteed by the suppliers. The gate or flap on the valves shall be easily accessible for cleaning and repairs.

(e) Water Closet Flusho-Meter Valves or Direct Flushing Valves

Water closets and urinals can be flushed by admitting water to the closet bowel directly from the water supply lines. The flushometer valves will be connected to a water supply line that will maintain a pressure of not less than 5 psi when it is flushing. A water supply pressure between 35 psi and 50 psi. is desirable. The valve shall be of a construction that it cannot be held open for continuous discharge and they should fulfill the conditions stated below without requiring regulation for static pressure between 5 and 75 psi. The quantity of water discharged at one flush should be with the following limits:

Fixture	Gallons
Water closets	3 - 5
Pedestal or siphon jet urinals each.	2 - 2 ½
For each 20 inches (500 mm) of Urinal through	2 - 2 ½
Flush rim or individual stall urinals each.	¾ - 2

Noise in flushometer valves is commonly caused by excessive pressure in the water supply lines. The valve shall have an adjustment device to diminish this noise. In the installations of the flushometer valves care should be taken that water cannot back out of the fixture into the water supply pipes when the' pressure in the water supply pipes is low or the water supply pipe is drained.

This can be best done by installing the fixture so that the end of the pipe cannot be submerged and the flushometer valve is above the possible water level in the fixture. The valve will be such that it will remain open long enough to deliver the required amount of water automatically and will have a device for adjusting the amount of water delivered. It will be of a make acceptable to the Engineer and the Contractor within one month of the signing of the Agreement for the work shall submit for the approval of the Engineer, the samples of these valves.

Fire Hose Station

A 2 ½" diameter Hose 'Valve attached to the 4" diameter vertical standpipe riser at a height of 3.5 ft. above floor level shall be .provided on each floor at positions indicated on the drawings. At a height of 5.0 ft. on the same standpipe will be installed a 1 ½" hose valve connected with 150 feet length of 1 ½" diameter unlined linen hose mounted on a hose rack with a standard

nozzle all encased in a Hose cabinet of a design approved by the Engineer

The payment on account of installation of each fire hose station shall include cost of all labour and material including all connections 2 ½" hose valve, 1 ½" hose valve, hose pipe, rack, nozzle, cabinet etc.

Hot Water Heater

Hot water heater for supply of hot water to Domestic Services on the ground floor, shall have a storage Capacity of 35 gallons and to heat 25 US gph of water from 40oF to 140oF.

The heater shall be of any locally available make acceptable to the Engineer.

Centrifugal Water Pumps

The Centrifugal Pumps shall be single stage, vertical split easing volute type, cast iron body, bronze impeller or radial type, with double curvature vanes, stainless steel shaft; sleeve for the pump shaft, properly lubricated bearings, readily accessible stuffing box with packing and seal cage, side discharge and suction flanged connections, integral cast iron base plate for a pump and the motor with drain outlet which shall be connected to the nearest drain point, flexible couplings between the motor and the pump shaft covered with approved guards, pump casing to be complete with drain plug and vent plug and designed for the maximum anticipated-working pressure, and tested and proven tight for a test pressure 1 ¼" times the maximum working pressure.

The pumps shall be direct driven by a constant speed motor and provided with a suitable starter.

Each pump shall be guaranteed for circulating the specified water quantity against specified het discharge head as given in Bill of Quantities .when operating continuously without overheating the motor, bearing etc.

Certified performance data and curves shall be submitted by the Contractor for approval prior to the purchase order.

All pumps to be supplied under this section to be of one manufacturer and of same type. The Contractor shall supply spring type anti-vibration foundation material for the pump foundation.

All pumping machinery like pumps, motors etc. together with ancillaries like suction valves, sluice valves, reflux valves, electric control panels etc. will be supplied and installed in accordance with the specifications given in the Bill of Quantities and drawings and as per instructions of the Engineer. The pumps and motors shall be mounted on a common bed plate

which shall be securely anchored with rag bolts to concrete foundations. The motor and pumps will be test run to the satisfaction of the Engineer before its acceptance for payment.

The rates quoted by the Contractor shall include cost of all suction pipes, reducers and delivery pipes.

Plumber Soil Pipe, Vent Pipe Fittings and Sanitary Appliances

Scope of Work

The work covered under this section of specifications consists in furnishing all plant, labor, equipment appliances and materials and in performing all operations in connection with the soil, waste ventilating pipes plumbing system above ground, both inside and outside building complete with sanitary appliances in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the contract. The work carried out under this section shall further conform to the requirements f the British Standard Code of Practice C.P. 305: (latest) "Soil and Waste Pipes Above

Ground" and C.P. 305: (latest) “Sanitary Appliances" and all the British Standards and other documents relied therein.

Materials, Appliances and Components

All materials, appliances and components to be used in the work shall conform to a standard not less than that of the latest edition of the British Standards listed below or their approved equals as decided by the Engineer, in so far as these are applicable:

(a) Pipes and Fittings

Codes are given in Clause 13.3.

(b) Traps

Codes are given in Clause 13.3.

(c) Any material used for the manufacture of sanitary appliances should be durable, impervious corrosion resisting and have a smooth surface which can be easily cleaned The materials appliances .and components shall conform to the British Standards when applicable, codes given in Clause 13.3.

Design Considerations

(a) Choice of Materials

The following materials will be used for a sanitary pipe work System.

Asbestos cement, cast iron, galvanized steel and wrought iron. Care should be taken to select materials resistant to corrosion caused by the liquid carried by atmospheric conditions or by electrolysis.

(b) Pipe System

The pipe work will be as per drawings and instructions of the Engineer.

(c) Layout of Pipes

In case sufficient information is not available on drawings, pipe work and appliances should be so arranged as to allow for close grouping of connections preferably with the W.C near to the main soil pipe. The level of the trap outlet of an appliance should be studied in relation to the levels of the floor and the branch pipe.

Pipes should be placed, fixed and jointed so as to avoid risk of damage through variations in temperature. Unless suitable precautions are taken the jointing of pipes exposed to unduly high temperature may become unsatisfactory.

The pipe work in branch connections should always be arranged to allow free drainage of the system. Connections to main or branch pipes should be so arranged as to prevent cross flow from one appliance to another. Connections should be made with an easy sweep in the direction of flow, except in some connections in the 'single stack' system as per drawing details provided.

Bends should be of long radius where practicable.

Ample provision should be made for access to all pipe work and the embedding of joints in walls should be provided as far as possible.

All pipe work adjacent to living quarter’s should be insulated against sound transmission and steps should be taken to avoid the transmission of noise from toilets to other area by way of the pipe system.

Traps

(a) General

The entry of foul air to the building must be prevented by suitable traps, properly sited.

Traps should always be of self-cleansing pattern. A trap, which is not an integral part of an appliances should be directly attached to its outlet and the pipe bore should be uniform throughout and have a smooth surface.

Traps for use in domestic waste installations and all other traps should be conveniently accessible and provided with cleaning eyes or other means of cleaning.

(b) Selection of Traps for Various Purposes

Integral traps are dealt with 'Sanitary Appliances'. The following factors should receive consideration in relation to attached traps:

1 Minimum Internal Diameter should be

- Drinking fountain: 1"
- Lavatory basins: 1 ¼"
- Domestic Sinks and Baths: 1 3/8 "
- Domestic Wash Tubes: 2"
- Canteen Sinks: 2"

Urinals (with not more than 4 ft. of channel drainage) 2” - 3”

2 Depth of Seal

If the internal diameter of the trap is 2-5/8”or more, it should have a 2”, water, seal. If the trap has an internal diameter of less than 2 5/8” it should have a 3" water seal unless the trap individually ventilated by a branch ventilating pipe (BVP), connected within the limits of 3”, and 8" from the crown of the traps, when 2 5/8" seal will be adequate.

Ventilating Pipes

(a) General

Ventilating pipes as shown in the drawings with proper clamps will be provided. All water closets are ventilated to a common vent pipe in the same duct in order to retain the water seals.

(b) Termination of High Ventilation Pipe

A high ventilating pipe should always be taken to a point above the level of the caves or flat roof and not less than 3.25 ft. above the head of any window with a horizontal distance of 10 ft. from the ventilating pipe. This last dimension should be taken as a minimum and local conditions must be taken into account.

The upper end of every ventilating pipe should be protected by means of a wire baloon made of copper wire or other durable material as specified.

Fixing of Pipes

(a) General

All external piping should be arranged to give free access to the full external surface so that a protective coating may be applied when required. This can be facilitated by avoiding internal, angles of the structure and using projecting fixings. The minimum clearance between the surface of the pipe and the surface of the structure should not be less than 32 min.

Where pipes pass through walls or floors, a layer of heavy hair felt or pipe sleeves of stainless steel approved design, mill board, asbestos cement, or other suitable material should be provided if so required by Bill of Quantities or as otherwise provided by the tender documents.

(b) Types of Fixings (See BS: 1494)

1 For Cast Iron Pipes

(a) Ears cast on the pipe sockets.

(b) Cast iron, malleable iron, or steel holderbats for building in.

(c) Similar holderbats with ears for nailing or screwing to the structure.

(d) Purpose made straps (as per plumbing details).

2 For Mild Steel Pipes

(a) Malleable iron 'School board' pattern brackets for building-in.

(b) Similar brackets for fixing with screws.

(c) Malleable iron pipe rings, with either back plate lugs or girder clips.

(d) Purpose made straps (as per plumbing details).

3 For Asbestos Cement Pipes

(a) Galvanized mild steel straps attached to cast iron bases having ears for nailing or screwing to face of structure.

(b) Galvanized mild steel brackets with shanks or spikes for driving into brick work.

(c) Galvanized mild steel holder bats for building-in.

(d) Similar holder bats with ears for nailing or screwing to the structure.

Maximum Spacing of Pipe Fixings

Material of Pipe	Diameter of Pipe	Maximum Spacing of Fixing (ft)	
		In Vertical Runs	In Horizontal Runs
* Cast Iron:	AH sizes	10	5
*Asbestos Cement	All sizes	10	11
Mild Steel	1	10	8
	1 ¼"	10	9
	1 $^{1}/_{2}$" to 2"	12	10
	2 5/8"to 3"	15	12
	4"	15	13.2

At least one fixing must be provided for each unit length.

Access to Pipe Work

Sufficient access should be provided to enable all pipe work to be cleared and tested. All access points should be carefully sited to allow clearance for the easy entry of cleaning rods. The most likely points at which obstruction nay occur and where access may be needed are as follows:

(a) Water Closets and Urinals

Water closets, bed pan washers, slop sinks and similar appliances are particularly prone to obstruction in or near the trap through misuse and the provision of adequate access are of importance.

Urinal connections should be provided with access at the branch connection to a vertical pipe

and also at a point near the connection to the trap outlet. When diameter of the pipe is greater than 2", access to the trap can be omitted as obstructions can be cleared by the removal of the grated outlet.

(b) Waste Pipes from Ablutionary Fitments & Sinks

Waste pipes of small bore used for branch connection from ablutionary fitments and sinks are liable' to collect solid matter. Single branch pipes seldom become obstructed so that except for sinks; additional access is needed only under exceptional circumstances, as when runs are long or where there are several bends.

Where a sink waste pipe is directly connected to a Soil pipe access should be provided at the connection of the trap to the soil pipe.

(c) Vertical Soil, Waste and Ventilating Pipes

When the vertical soil or waste pipe is not connected directly into a manhole, access should be provided immediately above the surface of the ground to enable the drain to be rodded and tested.

MVPs should be provided with means of access at the ground level for testing and for the removal of rust or debris.

(d) Branch Connections

It is desirable that branch connection on vertical pipes should be provided with access covers at the junctions. Main branch connections serving subsidiary branches should have means of access at the point of connection to the main pipe, with additional access to at the extreme end of the main branch. Waste pipe branches, serving more than one fitment should be provided with means of clearance at their extreme end.

(e) Bends

Access should be provided at or near such of the bends as will enable the pipe work to be properly rodded and cleared.

(f) Traps

There is an advantage in providing traps with union connections at each end to permit removal for rodding.

(g) Access Opening

1 Rectangular access openings should be equal in width to the full diameter of the pipe

and in length to at least one and a half times the width. The internal face should be shaped to form a true completion of the bore of the pipe. The opening should be made gas-tight and watertight with good quality rubber washers, and the covers firmly secured with gun-metal or other suitable screws or studs.

2 Oval access openings should have an area of not less than the cross sectional area of the pipe to which they are fitted. Their internal faces should be shaped to form a true completion' of the bore of the pipe. The opening should be made gas-tight and water tight with good quality rubber washers and the covers firmly secured with gun¬metal or other suitable screws or studs.

(h) Cleaning Eyes

No part of a cleaning eye or stopper should project into the pipe bore.

Work on Site

Jointing of Pipes

(a) General

Care is needed to ensure that no jointing material projects inside the bore of the pipe.

(b) Asbestos Cement Soil Pipes

The joints should be made with tarred or untarred yarn caulked to about 1” in depth and filled and pointed with a stiff mortar made with one part by volume of Portland Cement and two parts of sand.

(c) Cast Iron Pipes

These usually have spigot end socket joint in which the space between socket and spigot is 1st packed with tarred or untarred yarn to a depth depending on the depth of socket which will leave a space for caulking with molten lead not less than 1 3/8“ deep. A form of fibrous lead is obtainable which may be caulked into the socket instead of molten lead.

(d) Wrought Iron and Mild Steel Tubes

The joints for these materials are generally screwed in accordance with BS:21, 'Pipe Threads, Part-I: Basic Size and Tolerances. A jointing paste and fine strands of hemp should be applied to the threads before jointing. For pipes 3" or more in diameter flanged or spigot end socket joints may be used.

(e) Fixing Pipes

Fixing are not built into the wall, they should be securer Plugged thereto.

Suitable bobbins or blocks should be used to keep the pipe work at the requisite distance from the wall.

All fixings should be carefully aligned and spaced. Builtin fixings should be secured with cement mortar.

Pipes embedded in floors and walls should be so fixed as to allow for any movement due to expansion or contraction. In an exposed external wall, the pipes should be securely bound with canvas backed hair felt. This method is recommended for protecting all embedded pipe work where it is desired to provide a cushion for expansion and to reduce noise transmission.

(f) Access Covers

All access covers and cleaning eyes should, at the time of installation, be finally fixed and sealed ready for testing.

Every care should be taken to protect the work and to prevent the entry of foreign matter into any part of the system and opening should therefore be kept sealed.

Inspection and Testing

Inspection

Work should be inspected during installation and tests applied on completion. Care shall be taken that all works which are to be encased or concealed are tested before these are finally enclosed.

Pre-assembled units should be tested at the works or place of fabrication and carefully inspected at the site. Inspection should be carried out to ensure that:

(a) Work accords with drawings and specifications.

(b) All pipe brackets, clips etc. are securely fixed.

(c) Fixings are correctly spaced.

(d) Pipe is protected where necessary by thermal insulation.

(e) Embedded pipe work is properly protected before sealing-in.

(f) All access covers, caps or plugs:

1 are accessible.

2 are so made that the internal faces truly complete the internal bore.

3 Cause no obstruction in the pipe work,

4 are well jointed.

Testing of System

(a) Water Test

The water test may be applied before the appliances are connected and may be carried out in sections so as to limit the static head to 15 ft. It is necessary to seal all openings affected by the test and provide support to the plugs used as stoppers.

(b) Air Test

The air test may be applied by inserting expanding rubber testing plugs in the lower and upper ends of the MSP and MVP and sealing the plugs with water where possible.

The testing plug at the upper end of the ventilating pipe should be fitted with a tee piece with a cock on a manometer. Air pressure is then introduced into the system through the other branch of the tee piece until the desired pressure is shown on the manometer scale. The pressure applied should be equal to 2 5/8“, water guage and should remain constant for a period of three minutes to prove soundness of the installation,

Alternatively the air pressure may be applied by passing a flexible tube from a tee piece attached to a manometer through the water seal of the trap of the sanitary appliance, the test then carried cut as described above.

(c) Smoke Test

Faults indicated by the air test may be located by pumping smoke into the system with a smoke machine. Care should be taken to ensure that the system is filled with smoke before sealing with plugs.

(d) Hydraulic Performance

Discharge tests should be made from all the appliances, singly and collectively. Obstruction in any of the pipe lines should be traced and the whole system examined for proper hydraulic performance, including the retention of an adequate water seal in each trap.

* Any defects reverted by the tests should be made good and the tests repeated until a satisfactory result is obtained.

(e) Testing for Stability of Trap Seals in Soil and / or Waste Pipe System

i) A soil and/or waste pipe system should under test withstand any condition of discharge of its appliances which can occur in practice, without the discharge from one appliance being forced up into another, and every trap should retain at least one inch of its seal under these conditions. The tests should be designed to make full allowance for the maximum action and pressure effects which may occur:

1. In small installations when all the appliances are discharged together.

2. in large installations when sufficient appliances are simultaneously discharged to simulate peak conditions.

ii) The following test is suggested for investigating the seal of water closet pans:

Six pieces of newspaper measuring about 8 “x 6 “ to be laid flat, one by one-, over the water surface and the pan subjected to the normal flush, followed immediately by two gallons of water from a pail.

iii) Then testing the seals of traps fitted to ablutionary appliances, the latter should be filled to over flow level and allowed to discharge in the normal way.

iv) Test

Similar to the above should also be carried out by discharging some appliances, while other are empty with plugs out.

v) Each test should be carried out at least three times and the maximum loss of seal in any of the tests should be taken as the significant result.

SANITARY WORKS

Grease Traps (Waste Appliances)

A grease trip is an appliance arranged to retain grease until solidified and with special arrangements for removal of the solidified grease. It should be of metal or glazed-ware with an easily removable bolted air tight cover. The inlet and outlet should designed as to arrest within the trap any grease contained in the waste water. This is usually achieved by providing a trap of sufficient capacity to ensure separation, and solidification of the grease. To facilitate removal of the Crease the trap should be fitted with a loose perforated metal tray having a long handle. Suitable ventilation should be provided. Grease traps should conform to the plumbing drawings and details as provided in Bill of Quantities and finally passed by the Engineer.

Lavatory Basins: (Waste Appliances)

(a) A lavatory basin should be made of ceramic ware or other material complying with B- 3 ante; and should be at least equal to the requirements of BS:1188. The basin should be made in one piece including a combined overflow and should be designed to facilitate cleaning, where basins are fixed in ranges it is desirable that there should be a space of at least 3 " between basins and the distance from centre to centre should be sufficient to ensure ease when the basin are in use.

(b) The overflow should be of the open weir type with removable grating, or of the slot type.

(c) The basin should be so designed as to prevent 'slopping'.

(d) Soap trays or sinkings should be provided to drain into basin.

(e) Tap-holes should be square to fit BS: 1010 pillar taps and should be level around the opening. They should be so situated as to allow supply pipes to clear waste and vent pipes and far enough apart to prevent the user striking his head on the taps.

(f) The waste outlet should be bevelled or rebated to receive a waste fitting conforming to BS: 1184.

(g) Where there is no other means of fixing a hole should be provided for the stay of the plug chain.

(h) Any back skirting should be true to receive the splash back or the wall filing.

The basins shall besides be of an approved make, kind and dimensions as per standard-catalogue of the approved manufacturers as provided in the Bill of Quantities and passed by the Engineer.

Urinals (Soil Appliances)

(a) Type of Urinal

Urinals for adults use should be designed to allow a minimum width of 2 ft. per person and may be of the following types:

1 Slab Type

A slab type urinal should be of glazed fireclay, or other material complying with B-3 ante, with or-Without divisions and having a separate floor channel and outlet in any suitable position. It is recommended that the face of the slab when fixed should have a slope back from the vertical of

about 1-1/2". Requirements are specified by length in ft. together with .the number of angle returns. Sufficient clearance should be allowed between the slab and the structure to allow for backing.

2 Stall Type

A urinal stall should be glazed fireclay, or other material complying with B-3 ante; and of the curved back pattern with division over laps. The channel may be cast integrally with the stall or may be separate.

Water Closet Suits (Soil Appliances)

(a) General

A W.C. suite consists of a pan,' seat flushing cistern (or a flushing valve), and a flush pipe. In some installations where it is desirable to ensure rapid refilling of flushing cisterns, flushing troughs may be used instead of independent flushing cisterns or a levelling tank-may be installed to feed the flushing cisterns.

(b) Pans

The pans should be made in one piece of ceramic ware or other material complying with B-3 ante. It may be of the pedestal type for fixing to the floor or of the squatter type.

The bowl of the pan should be sufficiently large to prevent the soiling of the surrounding floor in reasonable use and the flushing rim should be so designed as to discharge completely the contents of the bowl at each flush and also to scour effectively the inside of the bowl.

(c) Seats

The seat should be made in accordance with BS: 1254 or BS:2089 and shall be of a make and design approved by the Engineer.

The seat should be flat on the underside and should be fixed to the pan by substantial pillar hinges protected against corrosion.

The pillar bolts should have lead washers and these washers should be held securely against the underside of the pan seat lugs by nuts of self-locking type.

The seats should have rubber buffers securely fixed to the underside to prevent damage to the pan and where a cover flap .is provided, this should have rubber buffers. Damage to W.C. pans is frequently caused by the exposed screws an worn rubber buffers. This can be avoided by

using a solid type of buffer.

Hardwood in-sets are not recommended because the joint between the inset and the pan form a grime trap, and particular care is required to ensure that it is. kept clean and free from contamination.

(d) Flushing Cisterns

The flushing cistern should be made of an impervious non-corrodible material or be protected against corrosion. Its flushing mechanism should be of the valueless siphon type.

The flushing cistern should be provided with a ball-valve suited to the maximum water pressure which may be applied to it.

The flushing cistern should have an overflow at least one size larger than the supply pipes with a minimum internal diameter of ¾. The overflow should be connected to an overflow pipe conspicuous when discharging. The flushing cistern should be supported on brackets securely fixed to the wall.

(e) Leveling Tanks

A leveling tank used with W.C's in ranges should be provided with a ball valve of ample capacity and should be so connected to the flushing cistern that each of these is rapidly refilled to the common water level after every discharge. A non-return valve should be provided in each flushing cistern to prevent back-flow W.C. Suites shall be of an approved make, kind and dimensions as per standard catalogue of approved manufacturers as provided in the BOQ and finally passed by the Engineer.

Workmanship for Sanitary Works

(a) Chases and Ducts

A check should be made to see that all holes, chases and ducts required for pipe work have been properly provided as approved by the Engineer.

(b) Delivery of Appliances

Before delivery of appliances suitable storage spaces which can be retained until the assembly period arrives should be provided as per conditions of contract.

Upon arrival all appliances should be carefully checked to ensure that they are in

(c) Storage of Appliances

All appliances shall be carefully stored under cover to prevent damage. When accepting and storing appliances, every consideration should be given to the sequence of removal from the stores to the assembly positions. Proper stacking to assist the later stage will be advantageous. As nearly all assemblies have need of supporting brackets, these should be readily accessible as they will be required at an early stage.

(d) Siting of Appliances

The outlets of W.C. pans and similar appliances should be examined to see that outlet ends are abutting on the receiving pipes before jointing. It is also necessary to make sure that the receiving pipe is clear of obstruction. Shrinkage of supporting timbers when drying out may cause fractures, and this should be borne in mind when considering the type of joint.

Attention should be given to the possibility of movement and settlement from other causes, and also to noise transmission. Overflow pipes should be so arranged as to give visible warning of discharge, and should always have a fall to the outlet. When terminating externally, the overflow should have sufficient projection to throw discharge clear of the wall, but the projection should be limited to avoid unsightliness.

A check should be made to ensure that the necessary facilities have been provided for supporting lavatory basins and sinks. Where the built-in type of brackets are used, they ' should already have been fixed by the building contractor if so provided in his contract, and where the wall fixing types are involved, the wall finish should have been arranged to make provision for them. Care should be taken when fixing sinks to ensure that they drain satisfactorily to the outlet.

Protection of Appliances are should be taken at all times and particularly after fixing to protect appliances from damage. Glazed, enamelled and plated surface of appliances can be irreparably damaged by carelessness during subsequent operations. All orifices should be temporarily plugged during the progress of the works to prevent obstruction.

Inspection and Testing (For Sanitary Appliances)

(a) Inspection

On completion of the work all appliances, materials and workmanship should be carefully examined for defects and got rectified through the contractor on detection.

(b) Testing

Comprehensive test of all appliances should be made under created simulating conditions of use. Overflows should be examined for obstructions.

BUILDING DRAINAGE WORKS

Scope of Work

The work covered under section of the specifications consists of furnishing all plants labour, equipment, appliances and material in performing all operations in connection with the construction of 'Building Drainage' in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the contract. The work carried out under this section shall further conform to the requirements of the British Standard Code of Practice CP:301 (latest), 'Building Drainage', and all the British Standards and other documents relied therein.

Materials, Appliances and Components

Relevant British Standards

(a) Pipes

Codes given in Clause 13.3.

(b) * Cements.

Codes given in Clause 13.3.

(c) Aggregates

Codes given in Clause 13.3

(d) Bricks

Codes given in Clause 13.3.

(e) Manholes and Gullies

Codes given in Clause 13.3.

(f) Miscellaneous

Codes given in Clause 13.3.

Notes on Materials

(a) Cement

Requirements of specifications given in Section-5 "Concrete Work" be followed.

(b) Pipes

Every Pipe used in the construction of drains of upto 12" diameter should comply with one of the British Standards listed in section 13-3 or approved grades defined below:-

i) Cast Iron Spigot and Socket drain pipes: BS: 437 provides tables of weights and leading dimensions for pipes in 9 ft. lengths from 50 (2 in. to 9 in. diameter; and coated with composition having a tar base; no hydraulic pressure test is demanded.

BS: 78 specified vertically cast iron pipes generally in length of 9 ft. and 12 ft. and appropriate hydraulic test pressure are fixed.

ii) Schedule of cast iron drain fittings, spigot and socket type: In BS:1130, standard diameters for a large range of bends, junctions and fittings for use with pipes to BS;437 are given.

iii) Centrifugal cast (spun) iron pipes: BS:1121 covers three classes of pipe manufactured from cast iron by a centrifugal process. Class 'B' pipes are normally the most suitable for drainage and sewerage.

The pipes are specified to be made in length of 12 ft., 13 ft. 1-¼ in., 16 ft. and18.ft and in diameter from 3 in. upwards. A coating having a tar or other suitable base as specified by the. Engineer shall be provided on all pipes.

iv) Cement concrete cylindrical pipes and fittings: BS:556 covers un-reinforced concrete pipes in effective lengths of 3 ft. and in diameters from 6 in. upwards.

Two classes of pipes are specified:

a. 'Tested' Pipes.

b. 'Standard' Pipes.

Both classes are available in length upto 8 ft. A hydraulic test is laid down and the difference between the two classes is that in the case of 'tested' pipes each individual pipe must have passed the test, while for 'standard' pipes selected samples only are required to be hydraulically tested, if the specifications so demand or Engineer so desire.

Tests for 'hydraulic proof test', 'Water absorption' and crushing strength shall be carried out on batch sampling basis as provided in the relevant B.S. quoted above. Dimensions and tolerances shall be as per table No. 1 at page 14 and minimum crushing test loads shall conform to values as per table 2 at page 19 of the above B.S. Standard.

B.S. 556 covers reinforced concrete pipes on the basis of similar requirements as for un-reinforced concrete pipes,- and shall control for all provisions the qualifying requirements of this class of concrete pipes, for the purpose of this section of specification. A reinforced Concrete pipe is suitably reinforced with steel to resist the tensile stresses imposed on the pipe by the crushing test loads specified in table 2 at page 19 of the above quoted B.S. standard for the particular size and strength class of pipe.

v) Asbestos Cement Pipes, and Fittings for Sewerage and drainage: B.S. 3656 fully covers this class of pipe as designated under the title. These pipes are manufactured in diameters of 4 in. to 36 in. and in lengths of 3 ft. 3 in. to 16 ft. 4-7/8 in. Three classes of pipes are specified as Class 1,2 and 3. Permissible variation in 'Thickness', 'Diameter', 'Length' and permissible deviation from straightness as per the above B.S. shall be the deciding factors in selecting the pipe lengths. The selected pipes shall further be put to 'Hydraulic, Pressure Test' 'Crushing Test' and 'Solubility in Acid Test', as per the above B.S. to finally determine the acceptability of the batch of pipes under test.

The roof is drained through a series of 4" diameter cast iron pipes as per alignment shown on the drawing.

Connections

Rain water down pipes should preferably discharge into a gully trap and then to an existing manhole as indicated by the Engineer on the drawing.

In case of brick or in situ concrete sewer connection is made by the insertion of a pipe into the wall of the sewers, sewerage pumping mains should not discharge into the sewer but into a manhole which will be connected to the public sewer through a concrete pipe.

The manholes, benching, concrete bedding under R.C. pipes embedded in ground shall be as per details given on the drawings, PWD specifications and Engineer instructions.

Pipe Laying and Jointing

i) Inspection of Pipes Preparatory to Laying

Pipes are liable to damage in transit and notwithstanding tests that may have been made before dispatch, each pipe should be carefully examined on arrival at site. Each pipe should be rung with hammer or mallet and those that not ring true and clear shall be ejected. Sound pipes shall be carefully stored to prevent damage. Defective pipe shall be ^segregated, marked distinctly and removed from the site for good.

Cast iron pipes shall be carefully examined for damage to the protective paint. Minor damages

shall be made good by painting over with hot tar or preferably bitumen, but if the major defects in the coating exist, the pipe shall be returned for re-coating.

Each pipe shall be carefully re-examined for soundness before laying.

ii) Laying of Pipes on Ground

(a) Pipes shall be laid with sockets leading uphill and should rest on solid and even foundations for the full length of the barrel. Socket holes should be formed in the foundation, sufficiently deep to allow the pipe jointer, room to work right round the pipes, and as short as is practicable to admit the socket and allow the joint to be made.

(b) Where pipes are not bedded on concrete the trench floor should be left slightly high and carefully bottomed up as pipe laying proceeds, so that the pipes barrels rest on firm and undisturbed ground. If the excavation has been carried too low, any packing up shall be in concrete.

If the floor of the trench consists of rock or very hard ground that cannot easily be excavated to a smooth surface, the pipes should be laid on a cradle of fine concrete so as to ensure even bearing.

(c) Each separate pipe should be individually set for line and for level using one of the following methods:-

i) Where long lengths of sewer or drain are to be constructed in trench with concrete/cement asbestos pipe, properly painted sight-rails should be fixed across the trench at a height equal to the length of the boning rod to be used above the required invert level of the drain or sewer at the point where the sight rail is fixed. There should be at no time less than three sight rails in position on each length of sewer or drain under construction at any one gradient.

Properly cut wooden or iron pegs should be driven into the floors of the trenches at intervals of at least 3 ft. less than the length of the straight edge, which is to be used. With the aid of the boning rod, equal in length to the height of the sight rail above the required invert level, each peg should be driven until its top is at the exact level required for the invert of the pipe line at that point; this will have occurred when a true bone is obtained over boning rod and sight rails. The underside of a straight edge resting of the top of these pegs will give level and gradient of the invert. The pegs should be withdrawn as pipe laying proceeds.

To obtain a true line on the horizontal plane a side line should be used strung tightly- at half pipe level between iron pins firmly- driven in the floor of the excavation for manhole at each end of the proposed pipe line and the pipes should be laid in such a way that the sockets are fixed just

free of this side line. For long lengths of drain the side line may require intermediate support. The practice of laying to a tap line is not recommended.

ii) In the case of-short lengths of branch drains where it is convenient to fix sight tails, pegs should be driven into the floor of the trench and their tops boned-in with the aid of three equal boning rods, one of which is used on the peg to be driven and the other two held at the invert level of the pipes or fillings to be connected. A side line should be used to obtain a true line in the horizontal plane.

iii) in the case of cast iron pipes it is impracticable to use a straight edge and the invert of each pipe should be fixed to a true bone over the sight rails by means of a boningrod, which in such cases should be provided with a bottom shoe to rest on the invert of the pipe being laid.

iii) Jointing of Pipes

(a) Cement Concrete Pipes

Tarred gaskin should first be wrapped round the spigot of each pipe and the spigot should then be placed well home into the socket of the pipe previously laid; the pipe should then be adjusted and fixed in its correct position and gaskin caulked tightly home, so as not to fill more than one-quarter of the total depth of the socket.

The remainder of the socket should be filled in with a stiff mix of cement mortar, one part, cement to one part sharp sand. When the socket is filled, a fillet should be formed round the joint with a trowel, forming an angle of .450 with the barrel of the pipe.

After the joint is made any extraneous material should be removed from the inside of the joint with a suitable scraper or 'badger'.

The newly made joints should be protected until set from the sun drying, wind, rains or frost. Sacking or other suitable materials, which should be kept damp except in frosty weather, may be used for this purpose. The joint holes should be kept free from flowing water. In addition, the spigot and sockets shall be thoroughly wetted before the joints are made.

A number of special joints, incorporating bitumen rings and other devices to ensure correct centering of the pipe spigot in sockets are on the market. There are joints which make pipe-jointing possible in wet trenches, being so arranged that the jointing material can be poured into the top of the socket-in the form of a grout.

(b) Cement Asbestos Pipes

These pipes are jointed with flexible joints of the kind in which jointing rings on the pipe ends are

compressed and held in position inside an enclosing sleeve. The manufacturers of the pipe always prescribe the type of joint including supply of jointing device and materials, which shall have to be relied upon/adopted on the approval of the Engineer.

(c) Cast Iron Pipes

i) Run Lead Joints

The spigot should be centred in the adjoining socket by tightly caulking in sufficient turns of tarred gaskin or lead strip to leave unfilled the required depth of socket for lead as per table given under this clause. When the gaskin or lead strip has been caulked tightly home a jointing ring should be placed round the barrel and against the face of the remainder of the socket. The lead should then be solidly caulked with suitable tools and hammers of not less than 4 lbs. wt. right round the joint to make up ' for the shrinkage of the molten metal on cooling.

It is essential that the pipes be perfectly dry before run lead joints are made, or blow holes-may occur in the lead and injury result to the pipe jointer. This method is therefore unsuitable for use in the wet trenches.

The quantities of lead and gaskin required for jointing are given in the following table:-

Table: Quantities of Jointing Materials for G.I. Pipes to B.S.S. 78, 437 and 1211

Diameter of Pipe in Inch		Depth of Socket inches (mm)	Depth of Lead in Joint inches (mm)	Depth of Gaskin in Joint inches (mm)	Weight of Lead per Joint (lbs)
To B.S. * 437	To B.S. 78 and 1211				
4	—	3 (75)	1.75 (43.75)	1.25 (31.25)	4 ¾
—	4	3.5 (87.5)	2(50)	1.5 (37.5)	5 ½
6	6	3.5 (87.5)	2(50)	1.5 (37.5)	7 ½
7		4 (100)	2.5(62.5)	1.5 (37.5)	11
	7	3.5 (87.5)	2(50)	1.5 (37.5)	9
8	8	4(100)	2.5 (62.5)	1.5 (37.5)	12 ¼
9	9	4 (100)	2.5 (62.5)	1.5 (37.5)	13 ½
—	10	4 (100)	2.5 (62.5)	1.5 (37.5)	14 ½
—	12	4 (100)	2.5 (62.5)	1.5 (37.5)	17

ii) Lead fiber joints: The socket should be caulked with gaskin or lead strip to centre the spigot as described under (i) above.

The lead fiber should be inserted into caulked home skein by skein, with suitable tools and hammers of not less than 4 lb. weight 'Until the joint is filled.

Head fiber joints can be made satisfactorily under very wet conditions. Particular attention to the caulking is necessary.

The quantities of tarred gaskin and lead fiber required for jointing are given in table under (i) above.

iii) Cement mortar joints: The use of Portland Cement for jointing cast iron pipes has been adopted with, success in the U.K. and to a considerable extent in other countries. In making cement joints, certain special precautions should be taken, the more important being:-

Avoidance of disturbance of newly made joints. The use of neat cement mortar, with approximately 17 - 20% of water by weight.

Allowing at least 36-48 hours to elapse before applying a pressure test.

iv) Mechanical Joints: There are numerous mechanical joints available for spigot-sand-socket pipes; the majority incorporate a rubber ring or rings, they possess the following advantages:-

Flexibility, allowing some settlement without leakage.

Speed of work, owing to the fact that caulking is unnecessary.

The joints can' be applied to pipes that are not dry and very unfavorable working conditions. Saving in working space.

(d) Cutting

Where it is necessary to cut pipes, this should be done with a suitable wheel-type pipe cutter so as to leave a clean and square to the axis of the pipe.

Inspection and Testing

i) Inspection

Close inspection should be made at every stage in the work, particularly as to the adequacy of

timber supports used in excavation and the care and thoroughness exercised in filling.

Full cooperation should be extended with the Owners of land or property likely to be affected.

Careful note should be kept of the condition of any sewer manhole or other existing work which may be uncovered and any defects evident should be pointed out immediately to the Engineer.

No work should be covered over or surrounded with concrete until it has been inspected and approved by the Engineer.

ii) Testing

(a) General

At lengths of sewer and drain should be tested for water-tightness, by means of water pressure maintained for not less than ten minutes, (In a sound line of pipes there is no advantage to be gained by continuing the tests longer than one hour).

Testing by means of smoke should not be regarded as adequate.

The test should be applied before the pipes are haunched with concrete or covered in and repeated after back-filling the trench or heading.

Wherever possible testing should be carried out from manhole to manhole. Short branch drains connected to a main drains between manholes should be tested as one system with the main drain. In long branches a testing junction should be inserted next to the, junction with the main drain and the branch tested separately; after the test has been gassed, the testing junction should be effectively sealed. Manholes should be tested separately.

In the case of the water test, where there is a trap at the upper end of a branch drain, a rubber tube should be inserted through the trap seal so as to draw off the confined air as the pipes are filled with water.

(b) Water Test for Pipes other than Cast Iron

Cement asbestos concrete pipes should be subjected to a test pressure of at least 5 ft. head of water at the highest point of the section under test. (N.B. This code does not authorize a clerk of works or other supervisor to require or arrange a test which will result in a pressure greater than 15 lbs. per sq. in head at any point).

The test should be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend should be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head.

Subsidence of the test water may be due to one or more of the following causes:

i) Absorption by pipes and joints.

ii) Seating of pipes or joints.

iii) Leakage at joints or from defective pipes,

iv) Trapped air.

Allowance should be made for (i) by adding water until absorption has ceased, after which the test proper should commence.

Any leakage will be visible, and the defective part of the work should be cut out and made good. A slight amount of sweating, which is uniform, may be over-looked but excessive sweating from a particular pipe or joint should be watched for, and taken as indicating a defect to be made good.

The above test applied to sewer and drain constructed of B.S. or B.C.Q Pipes. In the case of a test for surface water drains constructed of 'second' quality pipes, the drain should be filled with water, and assurance obtained that all joints are sounds and that no fractured pipes are included.

(c) Water Test for Cast Iron Pipes

Cast iron sewers and drains should be tested to a minimum pressure of 5 ft. head of water. The drain plugs should be suitably structured to prevent their being forced out of the pipe. Alternatively, an air test as described in sub-clause may be used for these pipes.

(d) Air Test

The normal method of testing concrete / cement asbestos pipes water as described above but in special circumstances, for example if an adequate supply of water for the purpose is not available, or if there may be difficulty in disposing of the water used, an air pressure test may be employed, but it should be noted that, with this test, while a fall in pressure may indicated defect, the actual point of leakage may be difficult to locate.

The length of pipe under test should be plugged as before described and air pumped in by suitable means until a pressure of 4" of water is .indicated in a glass U-tube connected to the system, without further pumping the pressure should not fall below 8" during a. period of 5 minutes.

(e) Tests for Straightness and Obstruction

Such tests should be applied whenever possible. These, may be carried out.

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter I/2 in. less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball should roll down the invert of the pipe and emerge at the lower end

ii) By means of a mirror at one end of the line and a lamp at the other. If the pipeline is straight the full circle of light can be observed if the pipe line is not straight this will be apparent. The mirror will also indicate obstruction in the barrel.

(f) Tests of Manholes

Manholes should be tested for water-tightness by filling then with water and observing any subsidence of water-level.

(g) Concrete

Allowance should be made for (i) by adding water until absorption has ceased, after which the test proper should commence.

Testing of concrete, if required, should be carried out as specified by the standard methods laid down in code: 114 "The Structural use of normal reinforced concrete in Building

(h) Records

Complete records should be kept of alt tests carried out on sewers and drains both ' during construction and after being put into service.

MEASUREMENT AND PAYMENT

Brickwork

Measurement

Measurement for brickwork required under these Specifications will be made at the rate per cubic foot tendered in the Bill of Quantities for the Employer which will include supply, laying, mortar, curing, finishing of brickwork etc.

Payment

The payment for the item will be made for No. of eft. of brickwork volume laid which will ' cover all related works to the items i.e. procurement of bricks, water, sand, cement, lime, cost of

mixing, batching mortar, placing brickwork,-curing, protection, finishing and repairing work and all other procedures related to this item.

Plastering

Measurement

Plastering and surface rendering work shall be measured as the product of length and height of walls over which it is laid. Deduction of openings of more than 3 square feet will be made. The unit rate for these items shall be per square feet arid payment shall be made for square feet of completed work. The respective rates will include plastering or surface rendering with the mortars specified including cost of preparing, cleaning and watering the surface to be plastered or treated, curing and scaffolding etc.

Payment

The accepted quantities measured as above shall be paid for per square feet for the item listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Structural Steel Work

Measurement

a) The work of steel railings shall be measured in running feet for completed length of railings fixed in position as indicated on the drawings including painting.

b) The work of iron grill, steel grating, frames and steel doors shall be measured in square feet for completed work fixed in position at indicated on the drawings including painting.

Cost of hold-fasts, anchorages, bolts and nuts and embedding pieces for fixing steel doors, windows, ventilators, grill, railings and painting etc. shall deem to be included in the rate of items to be fixed and no separate payment will be made for these.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above" and shown in The Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Doors, Windows, Ventilators

Measurement

Payment for doors, windows, ventilators and gates will be made by measuring clear ■ opening area in square feet in brickwork or concrete.

Unit for these items of work shall be per sq. ft. as given in the respective items of the Bill of quantities and the Rates.

Payment

It is particularly mentioned that the rates for doors and windows, etc. shall include supplying, fixing including glazing, fittings such as locks, peg stays, rollers, holdfasts, handles etc as specified and. indicated on drawings and Bill of Quantities and painting as described above complete in all respects. The external windows will have approved silicon caulking at joints of masonry/concrete and windows.

The accepted quantities measured as above shall be paid for per square feet unit price for the items listed above and shown in the Bill of Quantities, which price" and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Concrete Flooring

Measurement

Measurement for Concrete Flooring shall be done on the basis of square feet of Concrete Floor actually placed as per drawings and as directed by the Engineer.

Payment

Payment shall be made for actual square feet of Concrete Floor made. The rate will include the cost of furnishing and fixing of Marble dividers where as specified on the drawings and as directed by the Engineer.

The accepted quantities measured as above shall be paid for per square feet unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labour and incidentals necessary to complete these items.

Flooring

Concrete Screed 1:2:4 on Top of Concrete Surface 2” inch Thick

Measurement

Measurement will be done in number of square feet for concrete screed for a thickness acceptably placed to the lines and grades and dimensions as shown on the drawings are established by the Engineer.

Payment

Payment will be made for number of square feet of concrete screed for a thickness on the top of concrete surface measured as provided above.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labour and incidentals necessary to complete these items.

Teraazzo Tiles (1’ x 1’ x 1”)

Measurement

Measurement will be done of number of square feet of Terazzo Tiles placed in mortar bedding locally manufactured of good quality acceptably provided and placed to the neat lines and grades including 2" wide marble strip border including cutting, grinding and polishing as shown on the drawing or established by the Engineer.

Payment

Payment will be made for the number of square feet of Terazzo Tiles laid on floors locally manufactured of good quality marble measured as provided.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Brit of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labour and incidentals necessary to complete these items.

Terrazzo flooring, 1 ½ inch Thick Dado and Skirting % inch Thick in Marble

Measurement

Measurement will be done of the number of square feet of terrazzo flooring 1 ½ inch thick including ½ inch thick topping, terrazzo dado and skirting 1 ½ inch thick including ½ inch thick topping acceptably laid and finished to the lines shown on the Drawings or as established by the Engineer.

Payment

Payment will be made for the number of square feet of terrazzo flooring, dado and skirting measured as provided above, laying terrazzo, grinding, finishing, and all other work related to the respective items except construction of sub-floors and walls. No separate payment will be made for the concrete/mortar bedding layers, metal or marble strips, and aluminium nosing.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which' price' and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Colored Tarrazzo Floor 1 ½ inch Thick including ½ inch Thick Topping, Dado and Skirting 1 inch Thick including ½ inch Thick Topping in White Cement

Measurement

Measurement will be done of the number of square feet of colored terrazzo flooring, terrazzo dado and skirting acceptably laid and finished to the lines shown on the Drawings or as established by the Engineer.

Payment

Payment will be made for the number of square feet of terrazzo flooring, dado and skirting in colored cement measured as provided above, lay colored terrazzo floor, Dado and Skirting in White Cement and pigments, laying terrazzo, grinding, finishing, and all other work related to the respective items except construction of sub floors and walls. No separate payment will be made for the concrete/mortar bedding layers, marble strips and aluminum nosing.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Approved Quality Acid Resistant Tiles

Measurement

Measurement will be done for number of sq. ft. Of tile placed to the Satisfaction of Engineer.

Payment

Payment shall be made at the Rate per sq. ft. for the once measured above.

Mosaic Flooring with Grey or White Cement as per the Approval of Engineer

Measurement

Measurement will be made of number of square feet as given in BOQ Item.

Payment

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.,

Marble Dado, or thick Terazzo Tiles approximately 4 inch in Width

Measurement

Measurement will be done of number of square feet as given in BOQ Item.

Payment

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing ail materials, equipment, labor and incidentals necessary to complete these items.

Glazed Ceramic Tiles on Walls and Floors

Measurement

Measurement will be done of the number of square feet as of glazed ceramic tiles acceptably laid on walls and floors to the neat lines as shown on the Drawings or as established by the Engineer.

Payment

Payment will be done for the number of square feet of glazed tiles laid on walls measured as

provided above, filling of joints with white cement and all other work related to the item. No separate payment will be made for setting bed of cement sand mortar and the grey and white cement used in the work covered under this item.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Placing Cement with Fine Gravel Surface

Measurement

Measurement will be done of number of square feet for placing cement with fine gravel surface acceptably placed as mentioned on the drawings or as directed by the Engineer.

Payment

Payment will be made for number of square feet or placing cement with fine gravel measured as provided above.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Cement Mortar Finishing on Concrete Surface

Measurement

Measurement will be done of number of square feet as stated in BOQ Item.

Payment

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Wax on Terrazzo or Colored Terrazo Floors 1 Marble

Measurement

Measurement will be done of number of square feet for applying wax (Polishing) on terrazzo or marble acceptably applied to the surface of the floors to the satisfaction of the Engineer. Payment will be made for square feet for applying wax on terrazzo or colored terrazzo floors measured as provided above, apply wax on terrazzo or colored terrazzo floors, providing, applying, rubbing, buffing and final finishing etc. including all other work related to the item.

Payment

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

500 Guage (0.005 inch or 0.13 mm) Thick Polyethylene Sheets

Measurement

Measurement will be made number of square feet for providing and laying 500 Gauge (0.005 inch or 0.13 mm) thick polyethylene acceptable into the neat lines and dimensions as shown can the drawings or as directed by the Engineer Overlaps at joints will not be measured.

Payment

Payment will be made for number of square feet of polyethylene sheet measured as provided above, Lay 500 Gauge (0.005 inch or 0.13 mm) thick Polyethylene sheets.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Waterproof Mortar Flooring Surface

Measurement

Measurement will be made of number of square feet of waterproof mortar flooring surface acceptably laid and finish to the required lines and grades as shown on the drawings or as directed by the Engineer.

Payment

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Water Proofing and Damp Proofing

Measurement

Measurement for waterproofing and damp-proofing shall be in square feet of area waterproofed or dam proofed. The rate for specific number of layers shall include preparing surfaces, all materials and labor, equipment, heating and all operations required to complete the work in all respect to the satisfaction of the Engineer.

Payment

The accepted quantities measured as above shall be paid for at the contract unit price for

the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Polishing & Painting

Measurement

The polishing of marble and terrazzo works shall not be measured separately, but it shall be included in the rate of these items under respective Sections in Bill of Quantities.

The polishing of wood shall be deemed to be included in the rate of wood work and no separate payment shall be made for the wax or French polishing.

The rate for wooden doors and windows shall include the cost of painting or polishing as specified in the Bill of Quantities and no separate payment shall be made.

The rate for steel doors and windows shall be inclusive of painting as specified in the Bill of Quantities, and no separate payment shall be made for the painting work.

Cement based painting on concrete and plastered surfaces shall be paid for on the basis of area over which they are done and this area shall be obtained by multiplying length by breadth or height less the area of openings for doors and windows in the surface.

The Plastic Painting of exposed concrete surfaces shall be measured and paid for on the basis of superficial area covered and for required number of coats applied as directed by the Engineer.

The deduction for area of openings shall be one time the area of the opening, if the surface is treated on both sides and no deduction of opening, if surface is treated on one side only. No addition shall be made for jambs, soffits, sills, etc. Where two different types of finishes are specified for two sides of the wall, half the opening area shall be deducted from each type of finish.

The rate for all the, items under this section will be paid for with items in other sections shall cover the cost of furnishing all materials (except those to be supplied by the Owner), labor, scaffoldings and appliances at site and performing all operations in accordance with instructions of the Engineer, Schedule of Quantities and specified above.

Payment

The accepted quantities measured as above shall be paid for at the contract unit price for sq. feet the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Distemping and White Washing

Measurement

The work of distempering or white washing on concrete and plaster surfaces shall be paid cn the basis of area over which they are done and this area shall be obtained by multiplying length or breadth by height less the area of opening of doors and windows in the surface. ' This deduction for area of opening shall be one time the area of the opening if the surface is , treated on both, sides and no deduction of opening if surface is treated, on one side only.

No addition shall be made for jambs, soffits, cills, etc. Where two different type of finishes j are specified for two sides of the surface, half the opening; area shall be deducted from each type of finish.

Payment

The accepted quantities measured as above shall be paid for area in square feet unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labour and incidentals necessary to complete these items.

Piping Work

Measurement

The pipe work upto 3" diameter shall be measured in L-ft. under this section. The lengths shall be measured in running foot and no separate measurement will be done for tees, bends, elbows, unions and other fittings; clamps, pipe supports etc.

Payment

The rate shall include all cost of material i.e. pipe, fitting, jointing materials, lubricant cotton yarn and labor of every type and incidentals. The insulation on hot water pipes shall also be included in the rate.

The accepted quantities measured as above shall be paid for at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items."

Sanitary Items

Measurement

Measurement will be done of the number of items of sanitary works provided fixed and maintained as approved by the Engineer.

Payment

The accepted quantities measured as above shall be paid for number of items for unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Pipe Work

Measurement

Rates for all items under this section shall cover the cost of L-ft. of furnishing all materials labor and appliances at site and performing all operations in connection with excavation, backfilling, laying, fixing, jointing and constructing all items under this section in accordance with the drawings, bill of quantities and as specified in this section of specifications, site clearance etc. as per instruction of Engineer complete in ali respects.

All pipe work- shall, be measured in running feet including all fittings of finished lengths. No .wastage shall be measured and paid. For measurements end to end lengths on inside finished surfaces of manholes will be taken into account. '

Other special, manholes etc. shall be measured and paid in numbers separately except where otherwise stated in the Bill of Quantities. The rates for pipe work shall include the following in addition to the provision mentioned in the bills of quantities and specifications:-

1. Cost of providing, laying and jointing of pipe work and dewatering of trenches where necessary.
2. Making and repairing any cuts holes in walls floors and slabs etc. where necessary.
3. Providing bedding supports, haunching and surrounds wherever required as per drawing etc. except otherwise provided in Bill of Quantities.
4. Interim/final testing pipe line, appurtenance manholes as per specifications and written instructions of Engineer.

Payment

The accepted quantities measured as above shall be. paid for linear fact at the contract unit price for the items listed above and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete these items.

Marble Slab 1" thick

Measurement

Measurement shall be done of 1” thick approved marble slab in sq ft. (LxB) properly fixed in position.

Payment

Payment shall be made for the measured area at the rate I sq. ft. quoted against item.

Wooden, Kitchen Cabinet

Measurement

Measurement shall be done for the sq ft. area in which the Kitchen Cabinent has been properly installed.

Payment

Payment shall be made for the measured area at the rate / sq. ft. tendered therefore

SECTION 14

MISCELLANEOUS WORKS

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MISCELLANEOUS WORKS

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14.5 Construction of Metalled Approach Roads and Ramps

14.6 Surfacing of Roadways Over Bridges

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14.25 Two G.I Sheets of 1/16 inch thickness each for Roof Felt packing

14.26 Providing Rainwater Outlets for Bridges

14.27 RCC Pipes for Catch Water Drain Inlets

14.28 Gabions

14.29 Geotextile

14.30 Dismantling of Existing Structures

14.31 Operator’s hut and septic tank

14.32 Distributary Data Boards

WATERSTOPS

Scope of Work

Rubber or polyvinylchloride (PVC) waterstops shall be installed where shown on the Drawings or as directed by the Engineer. The Contractor shall furnish all waterstops, including rubber plugs, gum rubber, rubber cement, bolts, nuts, washers and polyvinyl joint material. The Contractor shall fabricate all special intersections, slices and joints, and make bends at corners as shown on the Drawings or as directed by the Engineer. All joints, splices, bends and intersections shall be made in strict accordance with the manufacturer's printed instructions, using materials approved by the manufacturer, and shall be formed to produce a strong, sound and watertight joint.

Material of Waterstops

Rubber waterstops shall be of natural rubber, synthetic rubber or a blend of both. The rubber when tested in accordance with US Federal Test Method Standard No. 601, shall have the following properties:

Physical Characteristic	Requirement	Test Method
Minimum Tensile strength	2500 psi (17.24 N/mm^2)	4111
Minimum Elongation at break	450%	4121
Minimum Tensile strength at 300% elongation	900 psi (6.21N/mm^2)	4131
Durometer Hardness-Shore Type A	60 to 70	3021
Water immersion maximum change in weight	5%	6631
Minimum Tensile strength after aging, as a percentage of tensile strength before aging (Oxygen bomb method)	80%	7111
Compression max.	30%	3311
Minimum Adhesion on 18 ounce cotton fabric	18 psi (0.12 N/mm^2)	8011 & 8021

PVC waterstops shall be extruded from an elastomeric plastic compound, the basic resin of which shall be PVC. The compound shall contain such additional resins, plasticizers, stabilizers or other materials needed to ensure that when the material compound is extruded to the shapes and dimensions shown, it will have the following physical characteristics, when tested by the US Corps of Engineers test method specified below:

Physical Characteristic	Requirement	Test Method

Tensile strength using die III, not less than	1759 psi (12.12 N/mm^2)	C 568
Ultimate elongation using die III, not less than	350 %	C 573
Low temperature brittleness, no sign of failure such as cracking or chipping at	-35°F	C 570
Stiffness in flexure, 1/2 inch span, not less than	400 psi (2.76 N/mm^2)	C 571

The contractor shall submit the manufacturer's literature and samples of waterstops to the Engineer for his approval prior to installation.

The gum rubber for making field splices of rubber waterstops shall be uncured rubber. In case it has been exposed at temperatures above 100 degrees Fahrenheit, it will be considered unfit for use. All rubber shall be stored in as cool a place as practicable, preferably at 70 degrees Fahrenheit or less, and in no case shall the rubber be stored in the open or exposed to the direct rays of the sun. All rubber shall be stored so as to permit free circulation of air about the rubber.

Measurement and Payment

(a) Measurement of waterstops shall be made in linear feet of the length shown on the Drawings.

(b) Payment for waterstops shall be made at the unit rate per foot length of waterstop tendered in the Bill of Quantities for providing and fixing waterstops. The tendered rate shall be deemed to cover all costs of waterstops including supplying, fixing, jointing and all other works related to the item.

EXPANSION JOINTS

Scope of Work

The work to be done under the item “Expansion Joints” consists of providing expansion joints in concrete where designated on the Drawings or directed by the Engineer in accordance with the provisions and requirements stipulated herein. The work to be done by the Contractor shall include all operations and materials necessary for providing an expansion joint in concrete,

filling these expansions joints with expansion joint material or expansion joint filler and sealing the outer exposed surface with expansion joint sealer where shown on the drawings or as directed by the Engineer.

Material

Expansion joint filler shall be preformed, cross-linked, non-absorbent, semi-rigid cellular polyethylene type, to be applied over the full joint width except as otherwise indicated on the drawings and shall conform to requirements of ASTM D1752-84 (Reproduced 1996), "Standard Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction".

Elastomeric joint sealer suitable for use in water conforming to the requirements of ASTM D1190 “Standard Specification for concrete joints sealer not poured elastic type”.

Construction

Expansion joint filler shall be placed in all expansion joints of concrete structures except as shown otherwise on the Drawings. The concrete surface of the expansion joint shall be free of all coatings, dirt, laitance and other foreign materials. The expansion joint filler shall be positioned against the concrete previously placed in a manner recommended by the manufacturer, and with no gaps between adjacent panels of filler material, before the subsequent concrete is placed. Care shall be exercised in storing and handling the joint filler.

After concrete placement is completed, all exposed edges of expansion joint filler shall be sealed. At the top of all horizontal expansion joints and at the surface of all vertical expansion joints that will be in contact with flowing water, the expansion joint filler shall have been set back by one inch or as shown on the drawings, from the base of the chamfer, and this set back depth shall be filled with the joint sealer. The completed expansion joint shall be well-sealed and be neat in appearance to the satisfaction of the Engineer.

Measurement and Payment

(a) Measurement of Expansion joints shown on the Drawings and as described herein above, shall be made in linear feet of the joints acceptably formed according to the length shown on the Drawings.

(b) Payment for expansion joint shall be made according to the rate tendered in the Bill of Quantities per linear foot of the joint which shall be deemed to cover all costs including supplying and installing the joint filler, joint sealer and all other works related to the BOQ item for providing and filling expansion joints.

REINFORCED CONCRETE AND G.I PIPE/ANGLE IRON RAILING

Scope of Work

The work to be done under the item “Reinforced Concrete and G. I. Pipe/Angle Iron Railing” consists of, but not limited to construction of reinforced concrete G. I. Pipe/Angle Iron railing or along the bridges and other structures including the reinforcement, fixing in position and finishing it complete in all respects as given in the specifications and shown on the Drawings and as directed by the Engineer and performing all other works necessary for the proper completion of the Works.

General

All concrete materials and the production, forming, placing, curing and repairing of concrete under this section shall be in accordance with the provisions of, and in complete conformity with the stipulations and requirements for concrete specified in the Section 4 - "Concrete General" and shall conform to the concrete class requirement shown on the Drawings.

All sand and aggregates used for concrete under these specifications shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with, the stipulations and requirements for sand and aggregates specified in the Section 6 - "Sand and Coarse Aggregates".

Cement used shall be Ordinary Portland Cement and shall be in conformity with the stipulations and requirements for Portland Cement specified in the Section 5 - Cement.

Reinforcement used shall be grade 40 steel and shall be in conformity with the stipulations and requirements for reinforcement specified in the section 9 - Reinforcement.

Zinc coated steel pipe (G. I. pipes) shall be galvanized and threaded and shall conform to BS Specification 1387-1957 “Steel tubes and Tubulars” medium tube.

Fitting and specials for zinc coated steel pipe (G. I. pipes) shall be galvanized and threaded and shall conform to the applicable requirements of BS specification 1387-1957.

Measurement and Payment

(a) Measurement and payment for reinforced concrete railing or G. I. pipe or angle iron railing will be made on the basis of linear feet of the railing acceptably constructed and installed. The quantity shall be determined by measurement of the completed handrail from end to

end of rails. Vertical posts and intermediate horizontal lengths shall not be measured for payment.

(b) The rate tendered for respective items in BOQ shall be full payment for constructing RC railing or G. I. pipe or angle iron, railing and shall include cost of all materials including concrete or G.I pipe or angle iron reinforcing steel, construction, fixing in position and for completion of the work specified herein and elsewhere in these specifications for and on the drawings for reinforced cement concrete railing or G. I. pipe railing, and all other work related to the item.

CONSTRUCTION OF METALLED APPROACH ROADS AND RAMPS

Scope of Work

The work under this contract involves the scarification of existing road, breaking of road pavement structure, construction of embankments or excavation for the road formation of metalled approach roads and ramps, brick edging, granular sub-base, water bound macadam and asphaltic wearing course, and other allied works.

Embankments for Road or Road Formation

(1) Scope of Work: The work under this contract involves excavation, earthfill for road embankments, compaction, testing and all other related works in accordance with the Specifications and/or as directed by the Engineer.

(2) Materials and Construction: Materials and construction requirements shall be in accordance with Section - 3 “Earthwork” of Technical Provisions except the following:

a) The material within the three feet below the bottom elevation of roadway sub-base, shall meet the requirements of ‘select material’ as stipulated in section of Earthwork of the Specifications.

In-place density determinations of the compacted layers shall be made in accordance with AASHTO T 191 or other approved methods. For all soils, with the exception of rock fill materials, containing more than 10% oversize particles (retained on ¾ inch/19 mm sieve), the in-place density thus obtained shall be adjusted to account for such oversize particles as directed by the Engineer. Subsequent layers shall not be placed and compacted unless the previous layer has been properly compacted and accepted by the Engineer.

Material for embankment at points inaccessible to normal compaction equipment shall be placed in horizontal layers of loose material not more than 6 inch thick and compacted to the densities specified.

b) Embankment on Existing Roads:

Before fill is placed and compacted on an existing roadway, the existing embankment and/or pavement may be levelled by cutting, rooting or scarifying by approved mechanical means to a depth to be determined by the Engineer. The earth, old asphalt or other material arising as a result of this operation will be declared by the Engineer to be either suitable or unsuitable for use in the embankment subbase.

Scarified material removed from the existing road surface may be placed in the embankment in thin layers in strict compliance with the instructions of the Engineer. No extra compensation shall be allowed for the storing and rehandling of such material for the disposal of material discarded at the Contractor's own choice or for the use of borrow in its place.

c) Embankment in Areas of High Water Level and Salinity:

Irrigation of areas, such as rice fields and fish or natural ponds upon which embankments are to be placed, shall have been halted at least two months in advance of, and drained or kept drained of all surface water prior to commencing with the placing of fill, and all clearing and grubbing shall have been performed, manually if necessary, in accordance with the relevant articles.

Where embankments are to be placed in areas of high water levels and salinity conditions and which is inaccessible to heavy construction equipment, a special working platform shall be first established, consisting of a blanket of fill material placed on top of the soft layer. The material of the working table shall consist of normal or processed granular fill material obtained from borrow excavation. This material shall conform to the following specifications:

Sieve Size	Percentage of Weight Passing
	Mesh Sieve, AASHTO T 27
3 inch (75 mm)	100

The remaining grading shall be such as to avoid intrusion into the working platform material of subgrade or natural ground surface material. For this condition to be met it will be required that the ratio

$$\frac{D_{15}\text{ – (Working Platform Material)}}{\text{D85 (Natural Ground Material)}} < 5$$

D85 and D15 mean the particle diameters corresponding to 85% and 15%, respectively, passing (by weight) in a grain size analysis.

Construction of this working table shall proceed from one edge of the soft area by using the fill as a ramp for further material transport.

The thickness of the working table as prescribed above shall be approximately 1.5 feet unless directed otherwise by the Engineer, and the width shall be that of the embankment.

The placement and compaction of the working table shall be carried out by use of light equipment.

No density requirements are specified for the working platform, however, subsequent layers above it shall be compacted to the densities as specified.

In those area of high water levels and salinity with soft subsoils and where embankment are high such as approach fills to structures, Special Provisions shall be made to measure and determine likely fill settlements will be accomplished. These preconditions are necessary in order to specify particular construction procedures which may be necessary and to establish the time at which the pavement structure can be placed to avoid cracks and subsidence of these layers.

d) Trial Section:

Before starting the formation of the embankment the Contractor shall construct a maximum of three trial sections of 100 feet each for each soil type proposed to be sued for compaction as directed by the Engineer. The soils used in the trials shall be the same as those intended to be used for the formation of embankment and the compacting equipment shall be same equipment that the Contractor will use for the main work and that has been accepted by the Engineer.

The object of these trials will be to determine the optimum moisture content and the relationship between the number of passes of compacting equipment and density obtained for the soil types under trial and for the verification of the soil type itself. No separate payment will be made for this work, which will be required as a subsidiary obligation of the Contractor.

e) Excavation in Embankments:

Unless otherwise specified in the Special Provisions, the Contractor may choose with the approval of the Engineer to excavate for structures, culverts, and pipe culverts after the embankment has been placed. Any space remaining after the placing of such structures or culverts and deducting for specified bed or backfill, shall be filled with material approved by the Engineer and compacted as follows:

Layers not more than 6 inches in loose thickness shall be placed and compacted in succession, with mechanical tampers or tires or tracks of motor driven equipment operated transversely to the roadway, to the densities as specified. Moisture content shall be adjusted as directed by the Engineer.

The excavation in embankment and the placing of backfill for the purposes described above shall not constitute any claims for payment but shall be covered under the contract unit price paid for other works in which the operation is involved.

f) General Requirement:

To avoid interference with the construction of bridge abutments and wing walls the Contractor shall, at points to be determined by the Engineer, suspend work on embankments and/or in cuts forming the approaches to any such structure until such time as the construction of the latter is sufficiently advanced to permit the completion of the

approaches without the risk of interference or damage to the bridge works. The cost of such suspension of work shall be included in the contract unit prices for embankment. In carrying embankments us to or over bridges, culverts or pipe drainage, care shall be taken by the Contractor to have the embankments brought to equally on both sides and over the top of any such structure.

When as a result of settlement, an embankment requires the addition of material up to 12 inches in thickness to bring it up to the required grade level, the top of the embankment shall be thoroughly scarified before the additional material is placed, and no extra payment shall be made for the scarification.

The Contractor shall be responsible for the stability of all embankments and shall replace any portions that in the opinion of the Engineer have been damaged or displaced due to carelessness or neglect on the part of the Contractor. Embankment material which may be lost or displaced as a result of natural causes such as storms, cloud-burst or as a result of unavoidable movement or settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow. No additional compensation will be allowed for the replacement except that the quantity of material required will be paid for at the contract price for the type of material used.

During construction the roadway shall be kept in shape and drained at all times. When unsuitable material has been placed in the embankment by the Contractor he shall remove it without extra payment.

(3) Measurement and Payment: The measurement shall be made in thousand cubic feet of the volume of embankment compacted in place, after clearing, grubbing and stripping, scarification of existing road and/or of breaking of road pavement structure, as directed by the Engineer.

The quantities, determined as provided above shall be paid for at the contract unit price tendered in the Bill of Quantities. The payment for compacted embankments for ramps of approach roads, service roads and banks as measured above shall be deemed to include the cost of stripping under the embankment, scarifying of existing road, breaking of road pavement, excavation, payment of royalties to landowners and/or local communities, if any, the cost of hauling material from any distance compaction and all the costs necessary for the proper completion of the work prescribed in this item.

Brick Edging

(1) **Description:** This item shall consist of brick installed on vertical edge between the pavement structure and shoulders in such a manner that the brick is laid on compacted shoulders and top of brick is flushed with the slope of road pavement.

(2) **Material Requirements:**

Bricks: Quality of bricks shall meet the material requirement as specified under Section 10 - 'Brickwork'.

(3) **Construction Requirements:** A trench of appropriate dimensions shall be excavated to accommodate brick on vertical edge, so that top of the brick becomes flushed with the top of road pavement and to ensure that one face of the brick remains in contact with the pavement structure. The cavities on the other face of the brick shall be refilled with the excavated shoulder material and properly compacted. The brick shall be laid in accordance with the line and grade of the road pavement. It shall be ensured that bricks are installed in vertical positions.

(4) **Measurement and Payment**

(a) **Measurement**

Brick edging when laid and finished to the required grade and line shall be measured per linear foot installed and approved by the Engineer.

(b) **Payment**

The quantity as providing and measured above shall be paid per linear foot for excavation of trench, installation of bricks, compacted backfill of cavities and dressing of berms including material, watering, tamping, labour, equipment, tools and incidentals necessary to complete the item.

Granular Sub-Base

(4) **Description:** This item shall consist of furnishing, spreading in one or more layers and compacting granular subbase according to the specifications and drawings and/or as directed by the Engineer. Granular subbase shall consist of natural or processed aggregates such as gravel, sand or stone fragments which shall conform to the following requirements.

(1) **Material Requirements:** The subbase material shall be clean and free from organic matter and other deleterious substances, and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base.

The material shall comply to the following grading and quality requirements:

(a) The subbase material shall have a gradation curve within the limits for Grading C, D or E given below:

Grading Requirements for Subbase Material

Sieve Designation Standard Alternate		Mass Percent Passing		
Mm		Grading C	Grading D	Grading E
50.0	2 in.	-	-	-
25.0	1 in.	100	100	100
9.5	3/8 in.	50-85	60-100	-
4.75	No.4	35-65	50-85	55-100
2.00	No.10	25-50	40-70	40-100
0.425	No.40	15-30	25-45	20-50
0.075	No.200	5-15	5-20	6-20

The Coefficient of Uniformity D60/D10 shall be not less than 3, where D60 and D10 are the particle diameters corresponding to 60% and 10%, respectively, passing (by weight) in a grain size analysis.

(b) The material shall have a CBR value of at least 50%, determined according to AASHTO T193. The CBR value shall be obtained at a density corresponding to 98% of the maximum dry density determined according to AASHTO T180 Method D.

(c) The coarse aggregate material retained on sieve No.4 shall have a percentage of wear by the Los Angeles Abrasion to (AASHTO T96) of not more than 40 percent.

(d) In order to avoid intrusion in the subbase of silty and clayey material from the subgrade, it will require that the ratio D15 (Subbase)/D85 (Subgrade) is less than 5.

D85 and D15 mean the particle diameters corresponding to 85% and 15%, respectively, passing (by weight) in a grain size analysis.

(e) The fraction passing the 0.075mm (No.200) sieve shall not be greater than two-third of the fraction passing the 0.425 mm (No.40) sieve. The fraction passing the 0.425mm sieve shall have liquid limit not greater than 25 and a plasticity index of 6 or less

(2) **Construction Requirements:**

(a) **Spreading:**

Granular subbase shall be delivered to the roadbed as a uniform mixture. Segregation shall be avoided during spreading and the final compacted layer shall be free from concentration of coarse of fine materials.

Granular subbase shall be deposited on the roadbed in a quantity which will provide the required compacted thickness without resorting to spotting, picking up or otherwise shifting the subbase materials.

Where the required thickness is 6 inches or less, the aggregates may be spread and compacted in one layer. Where the required thickness is more than 6 inches, the aggregates shall be spread and compacted in 2 or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. All subsequent layers shall be spread and compacted in a similar manner.

Granular subbase shall be spread with equipment that will provide a uniform layer conforming to the specified item both transversely and longitudinally within the tolerances as specified.

(b) **Compacting:**

The moisture content of subbase material shall be adjusted prior to compaction by watering with approved sprinklers mounted on trucks or by drying out, as required, in order to obtain the required compaction.

The subbase material shall be compacted by means of approved vibrating rollers or steel wheel rollers (rubber tyre rollers may be used as a supplement), progressing gradually from the outside towards the center, except on super elevated curves, where the rolling shall begin at the low side and progress to the high side. Each succeeding pass shall overlap the previous pass by at least one third of the roller width. While the rolling progresses, the entire surface of each layer shall be properly shaped and dressed with a motor grader, to attain a smooth surface conforming to the required lines and grades.

Any area inaccessible to rolling equipment shall be compacted by means of mechanical tampers.

The compaction of the subbase layer shall be continued until the result in satisfactory to the Engineer.

If the layer of subbase material, or part thereof does not conform to the required finish, the Contractor shall, at his own expense, rework, water, and re-compact the material before next layer of the pavement structure is constructed.

Immediately prior to the placing of first layer of base course the subbase layer (both under the traveled way and the shoulders) shall be to the required level and shape. Any watering and reshaping of the surface of the subbase will be at the Contractor’s expense.

No material for construction of the base shall be placed until the subbase has been approved by the Engineer.

(c) **Compaction Requirements:**

The relative compaction of each layer of the compacted subbase shall not be less than 100 percent of the maximum dry density determined according to AASHTO T180 Method D. The field density shall be determined according to AASHTO T191 or other approved method. For all materials, the field density thus obtained shall be adjusted to account for oversize particles (retained on
19 mm sieve) as directed by the Engineer.

(d) **Trial Sections:**

At least 10 days before the main work of subbase construction is started the Contractor shall spread and compact a trial section as directed by the Engineer. The object of the trial section is to check the suitability of the materials and the efficiency of the equipment and construction methods which is proposed to be used by the Contractor. Therefore, the Contractor shall use the same material, equipment and procedures that he proposes to use for the main work. One trial section of material and/or construction equipment/procedures proposed for use.

After final compaction, the Engineer may carry out compaction tests, field CBR tests and such other tests which he finds necessary.

If a trial section shows that the proposed material, equipment or procedures in the Engineer's opinion are not suitable for subbase, the material shall be removed at the Contractor's expense, and a new trial section shall be constructed.

If the basic conditions regarding type of material, equipment or procedures change during the execution of the main work, new trial sections shall be constructed when directed by the Engineer.

The Engineer may allow that the compaction requirements be changed based on results from the trial sections.

(e) **Tolerance:**

The sub base shall be compacted to the desired level and cross slope as shown on the drawings.

(3) **Measurement and Payment:**

(a) **Measurement:**

The quantity of subbase to be paid for shall be measured in hundred cubic feet by the

theoretical volume in place as shown on the drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed granular subbase course. No allowance will be given for materials placed outside the theoretical limits shown on the cross-sections. Trial sections shall not be measured separately but shall be included in the quantities above.

(b) **Payment:**

The accepted quantities measured as provided above shall be paid for at the contract unit price per hundred cubic feet of GRANULAR SUBBASE, for the Pay Item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labour, equipment, tools and incidentals necessary to complete the item.

Waterbound Macadam Base

(1) **Description:** This work shall consist of furnishing and placing one or more course of mechanically crushed stone base with filler on a prepared surface in conformity with the lines, grades, thicknesses and typical cross-sections shown on the Drawings.

(2) **Material Requirements:** Coarse aggregate shall conform to the quality requirements as specified, except that no CBR testing will be required. The gradation curve of the coarse aggregate shall be within the envelope limits given below

US Standard Sieve Sizes	Percent Passing by Weight
63.5 mm (2½ in.)	100
50 mm (2 in.)	90-100
37.5 mm (1½ in.)	35-70
25 mm (1 in.)	0-15
19 mm (3/4 in.)	0-5

Fine aggregate (filler material or screenings) shall consist of natural sand or crushed stone screenings free from clay lumps, dirt and other objectionable material. The fine aggregate shall be of the following gradation:

US Standard Sieve Sizes	Percent Passing by Weight

9.5 mm (3/8 in.) 4.35 mm (No.4) 0.15 mm (No.100)	100 85-100 10-30

The material passing the No.40 sieve shall have a Liquid Limit of 25 (maximum) and a Plasticity Index between 4 & 6.

(3) **Construction Requirements:**

(a) **Equipment:**

Any combination of machines or equipment that will produce the results meeting these specifications may be used. These include mechanical spreaders, water sprinklers and rollers/compactors.

(b) **Surface Preparation:**

The surface on which the base material is to be constructed shall be approved and accepted by the Engineer prior to placing the crushed stone base aggregate.

(c) **Spreading and Compaction:**

Crushed stone shall be deposited and spread on the prepared surface to the proper depth so that the compacted layer will not exceed 4 inches maximum thickness. Each layer shall be inspected thoroughly before rolling to detect high or low spots. Crushed stones shall be added or shifted to provide a true surface. The coarse aggregate layer, after being laid to proper thickness, shall be lightly rolled sufficient only to establish the required grade and level of the stones.

Spreading of the coarse aggregates shall be followed by rolling with a smooth wheel roller weighing at least 10 tons. Rolling shall begin at the lower edge of the shoulders to lock the stones firmly at the edge, then progress gradually towards the other edge. Rolling shall continue until the aggregate is well keyed and does not creep ahead of the roller.

Following the initial rolling, dry screenings shall be applied uniformly over the surface. Dry rolling shall be continued while screenings are being applied. The surface shall be swept with mechanical or hand brooms to aid spreading of the screenings.

When the intersitices in the coarse aggregate are filled with screenings, the surface shall be sprinkled with water until it is saturated. The rolling, sprinkling and application of additional screenings shall continue until a grout is formed that fills all the voids and

forms a wave of grout in front of the roller.

When more than one layer is required to complete the base course to the thickness shown on the drawings, each layer shall be constructed as before prescribed.

(d) **Construction Control Testing:**

Tests for compliance with the requirements will be made as often as deemed necessary and to the satisfaction of the Engineer.

(e) **Maintenance:**

The completed base course shall be maintained in an acceptable condition until the necessary subsequent treatment is applied.

(4) **Measurement and Payment:**

(a) **Measurement:**

The quantity of base shall be measured in hundred cubic feet by the theoretical volume in place as shown on the Drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed Waterbound Macadam Base Course. No allowance will be given for materials placed outside the theoretical limits shown on the cross-sections.

(b) **Payment:**

The accepted quantities measured as provided above shall be paid for at the contract unit price per hundred cubic feet of Water-bound Macadam Base, for the pay item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all material, hauling, placing, watering, rolling, labour, equipment, tools and incidents necessary to complete the item.

Bituminous Prime Coat

(1) **Description:** The work shall consist of furnishing and applying asphaltic material on a prepared and untreated surface in accordance with these specification and to the width on the typical cross section or as directed by the Engineer.

(2) **Material Requirements:** Asphaltic Material shall conform to the requirement of Asphaltic material, either cut back MC 70 or emulisified.

(3) **Construction Requirements:** Prime coat shall be applied only when the surface is dry

except that when emulsified asphalt is used, the surface may be reasonably moist. No application shall be made when the weather is foggy or rainy or when the atmospheric temperature is below 15 deg C unless otherwise directed by the Engineer.

(a) **Equipment:**

The liquid asphalt material shall be spread by means of pressure distributor of not less than 1200 liters capacity, mounted on pneumatic tyres of such width and number that the load produced on the road surface will not exceed 560 lb per inch (100 Kg per cm) width of tyre and it shall be of recognized manufacturer.

The tank shall have a heating device able to heat a complete charge of asphaltic liquid up to 180 deg. C.

The heating device shall be so that over heating will not occur. The tank shall be insulated in such a way that the drop temperatures when the tank is filled, will be less than 2 deg. C per hour. A thermometer shall be fixed to the tank in order to control continuously the temperature of the liquid.

The distributor shall be able to vary the spray width of the asphalt liquid in steps of maximum 4 inch (100 cm) to a total of width of 13 feet (4 m). The spraying base shall have nozzles from which liquid is sprayed fan shaped on the road surface equally distributed over the total spraying width.

The distributor shall be furnished with a tachometer indicating the speed in foot or in meter per minute. The tachometer shall be visible from the driver's seat. The function of the distributor shall be so exact that the deviation from the prescribed quantity to be sprayed on any square meter does not exceed 10%. The distributor shall be equipped with a device for hand spraying of the bituminous liquid.

(b) **Application of Asphlatic Material:**

Before applying prime coat, the full width of the surface to be treated shall be swept with a power broom to remove all dirt and other objectionable material. Where required by the Engineer, the surface shall be lightly sprayed with water but no saturated. Asphaltic material shall be applied by mean of pressure distribution and at a temperature ranging between 27 deg. C to 100 deg. C depending on the type of asphalt being used. Spraying of asphalt will be between 1.33 and 3.58 gallons per 100 square feet (0.65 to 1.75 litres per square meters). The temperature and the exact rate shall be specified by the Engineer. The prime coat shall be left undisturbed for a period of at least 24 hours and the contractor shall maintain the prime coat until next course is applied. Care shall be taken that the application is not in excess of the specified amounts; any excess shall be

blotted with sand or similarly treated. Arrangement should be made that the surface of structures, trees etc. are not marred with the spray.

(4) **Measurement and Payments**

The quantities of liquid asphalt either Cut Back or Emulsified shall be measured in hundred square feet as actually covered by the prime coat within the limits shown on the drawings or as directed by the Engineer and paid for separately as per BOQ Item.

The rate shall include all material, labour, equipment and any work necessary therefore to complete the work satisfactorily

Asphaltic Wearing Course (Bituminous mat)

(1) **Description:** The Contractor shall furnish all materials for the complete construction of the asphaltic wearing course including liquid asphalt and mineral aggregates, mixing at specified temperature, transporting, spreading and compacting in approved manner on bituminous prime coat. The materials to be used in surfacing of roadways shall conform to the following requirements:

(2) **Material Requirements**

(a) Liquid asphalt shall be cut-back asphalt, medium curing type (MC), and shall be provided in the proper grades for its intended use.

(b) Mineral aggregates used for metalling of roadways shall consist of sand and aggregates furnished by the Contractor in accordance with the provisions of, and in complete conformity with the stipulations and requirements for sand and aggregates specified in Section "Concrete Aggregates". The Contractor will be required to blend the required quantity of sand and aggregates to produce mineral aggregates with the following gradation properties:

Screen Size designation	Percent by weight passing sieve
1 inch	100
3/4 inch	95 to 100
3/8 inch	60 to 80
No. 4	50 to 60
No. 8	25 to 45
No. 50	5 to 25
No. 200	2 to 10

All screens used for gradation test shall be woven wire cloth sieves conforming to the requirements of ASTM Designation: E-11.

(3) **Construction Requirements:** After the completion of the prime coat and when the quantity of asphaltic material to be mixed with the mineral aggregates has been determined by the Engineer, the bituminous mat shall be prepared by mixing the mineral aggregate with the required quantity of asphaltic material on the primed base course or by other means and methods approved by the Engineer. The Contractor shall mix the mineral aggregates and asphaltic material until a product of uniform color and consistency is produced. The asphaltic material shall be applied uniformly and under pressure and at the specified temperature. The bituminous mat materials, with or without additive, shall have a moisture content of two percent or less by weight at time of laying.

After the asphaltic material and mineral aggregates have been prepared as described above, the bituminous mat shall be spread to a uniform thickness at the required locations and be compacted until the surface is smooth, firm and of the density specified by the Engineer. Rolling shall proceed longitudinally starting at the edges of the material and progressing toward the center and shall be performed immediately after the material has been spread. On completion of the rolling operation the bituminous mat shall be true to the section shown on the Drawings, smooth, and free from humps, depressions or irregularities. When a straight edge 10 feet long is laid on the finished surface of the bituminous mat, the surface shall not vary more than one quarter inch from the lower edge of the straight edge in any place. Should the bituminous mat show an excess or deficiency of asphaltic material or uneven distribution thereof due to insufficient mixing or other causes, after the mat is laid, the condition shall be corrected by thorough scarifying of the mixed material; adding surfacing or asphalt as required; and spreading and compacting until a bituminous mat satisfactory to the Engineer has been produced.

(4) **Measurement and Payment:**

(a) Measurements for payment for surfacing of roadways will be made of hundred (%) square foot of the asphaltic wearing course constructed in accordance with these Specifications and the Engineer's instructions, placed to the lines and thicknesses specified herein. The areas of all roadways and other areas designated by the Engineer, will be measured for payment only once and no additional payment will be made because of the thickness of pavement required, because of the number of layers involved in constructing the pavement or because of prime coats being required.

(b) Payment for surfacing of roadways will be made at the unit rate per hundred (%) square feet tendered in the Bill of Quantities for Surfacing of metalled approach roads and ramps.

The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for Surfacing of metalled approach roads and ramps. No separate or additional payment will be made under this or any other item for use at the Contractor's option of alternative method for surfacing of roadways.

SURFACING OF ROADWAYS OVER BRIDGES

Scope of Work

The work to be done under Surfacing of Roadways over Bridges, consists of constructing asphalt wearing course (bituminous mat) including application of bituminous coating for roadways as shown on the Drawings or as directed by the Engineer. The asphaltic wearing course shall consist of bituminous mat of mineral aggregates and asphalt. The operations in constructing the asphalt wearing course shall include but not be limited to cleaning of deck, application of prime coat, mixing, placing, spreading and compacting the bituminous mat of mineral aggregates and asphalt on the designated areas and all incidental work required for surfacing of roadways in accordance with the Contract Documents and the Engineer's instructions.

Material

The Contractor shall furnish all materials for the complete construction of the asphaltic wearing course including liquid asphalt for prime coat, for mineral aggregates and mineral aggregates and construct the surfacing in conformity with the stipulations and requirements specified in the Sub-Section 14.5 “Construction of Metalled Approach Roads and Ramp”.

Construction Requirements

After cleaning and removing any foreign material from the final prepared surface, as approved by the Engineer, bituminous prime coat shall be applied prior to start the construction of asphaltic wearing course in accordance with the requirements of section 14.5.6 “bituminous prime coat” except that rate of application shall be 0.31 to 0.82 gallons per 100 square feet (0.15 to 0.4 liters per square metres). The prime coat shall be applied over the areas designated on the Drawings or as directed by the Engineer. The temperature during application shall remain within the range specified for the grade of asphalt being used. After the liquid asphalt has penetrated the surface, the treated area shall be covered where necessary with sand or other granular material in sufficient quantity to absorb any excess of asphalt remaining on the surface. The asphalt wearing course shall not be placed on top of the primed base until authorized by the Engineer. Prior to the placement of the asphalt course, the primed base shall

be broomed and thoroughly cleaned of all extraneous material.

After the completion of the prime coat and when the quantity of asphaltic material to be mixed with the mineral aggregates has been determined by the Engineer, the bituminous mat shall be prepared by mixing the mineral aggregate with the required quantity of asphaltic material on the primed base course or by other means and methods approved by the Engineer. The Contractor shall mix the mineral aggregates and asphaltic material until a product of uniform color and consistency is produced. The asphaltic material shall be applied uniformly and under pressure and at the specified temperature. The bituminous mat materials, with or without additive, shall have a moisture content of two percent or less by weight at time of laying.

After the asphaltic material and mineral aggregates have been prepared as described above, the bituminous mat shall be spread to a uniform thickness at the required locations and be compacted until the surface is smooth, firm and of the density specified by the Engineer. Rolling shall proceed longitudinally starting at the edges of the material and progressing toward the center and shall be performed immediately after the material has been spread. On completion of the rolling operation the bituminous mat shall be true to the section shown on the Drawings, smooth, and free from humps, depressions or irregularities. When a straight edge 10 feet long is laid on the finished surface of the bituminous mat, the surface shall not vary more than one quarter inch from the lower edge of the straight edge in any place. Should the bituminous mat show an excess or deficiency of asphaltic material or uneven distribution thereof due to insufficient mixing or other causes, after the mat is laid, the condition shall be corrected by thorough scarifying of the mixed material; adding surfacing or asphalt as required; and spreading and compacting until a bituminous mat satisfactory to the Engineer has been produced.

Measurement and Payment

(1) **Bituminous prime coat**

The quantities of liquid asphalt either Cut Back or Emulsified shall be measured in hundred square feet as actually covered by the prime court within the limits shown on the drawings or as directed by the Engineer and paid for separately as per BOQ Item.

The rate shall include all material, labour, equipment and any work necessary therefore to complete the work satisfactorily

(2) **Asphaltic wearing course (bituminous mat)**

Measurements for payment for surfacing of roadways will be made of the volume in hundred square foot of the asphaltic wearing course constructed in accordance with

these Specifications and the Engineer's instructions, placed to the lines and thicknesses specified herein. The areas of all roadways and other areas designated by the Engineer, will be measured for payment only once and no additional payment will be made because of the thickness of pavement required, because of the number of layers involved in constructing the pavement or because of prime coats being required.

Payment for asphaltic wearing course will be made at the unit rate per hundred (100) square feet tendered in the Bill of Quantities.

The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for Surfacing of Roadways over Bridges. No separate or additional payment will be made under this or any other item for use at the Contractor's option of alternative method for surfacing of roadways.

GALVANISED IRON PIPES

Scope of Work

The work to be done under this item consists of fabrication and placing of standard galvanized iron drain pipes of specified diameter at the decks of bridges, gauge wells or elsewhere as shown on the Drawings or as directed by the Engineer.

Material

The standard schedule 40 pipe shall conform to requirements of ASTM Designation A 120.

Galvanizing

All steel and iron work of whatever kind, described to be galvanized, is to be pickled in dilute hydrochloric acid and then washed, fluxed and stoved and coated with zinc by means of dipping in a bath of molten zinc. All articles are to be immersed in the bath only for the time sufficient for them to attain the temperature of the bath and they are to be withdrawn at such speed that a coating of 90 micron thickness on each face is achieved. Every article is to be covered evenly on all sides. The galvanizing shall conform to the BS 729 "Hot dip galvanized coatings on iron and steel articles".

Measurement and Payment

(a) The pipes of the approved type provided and installed in place shall be measured by length in linear feet of pipe actually installed in place in accordance with the Drawings and accepted by the Engineer.

(b) The payment shall be made at the unit rate tendered in the BOQ for drain pipes and shall constitute full compensation for all costs of labour, material and placing of drain pipes, in concrete to the satisfaction of the Engineer.

PVC PIPES

Scope of Work

The work to be done under this item consists of providing and placing PVC pipes of specified diameter in place or as shown on the Drawings or directed by the Engineer.

Material

The PVC pipes shall conform to following standards and specifications

Standard	Item
ASTM D1785	Polyvinyl chloride (PVC) pipe, schedules 40, 80 and 120.
ASTM D2466	Polyvinyl chloride (PVC) pipe fittings, schedule 40.
ASTM D2467	Socket type polyvinyl chloride (PVC) pipe fittings schedule 80.

In addition:

(a) The pipe should be homogenous throughout and free of visible cracks, holes or other defects. The pipe shall be as uniform as commercially practicable in colour, opacity, density and other physical properties.

(b) The pipes should meet all the necessary requirements of dimensions and tolerances, sustained pressure, burst pressure, workmanship and appearance as outlined in the above referred standards to ensure quality.

(c) The Contractor will be responsible for carrying out all the tests required to confirm that the material/product meets the prescribed requirements as outlined in the above referred specifications to the satisfaction of the Engineer.

Measurement and Payment

(a) The pipes of the approved type provided and installed in place shall be measured by length in linear feet or pipe actually installed in place and accepted.

(b) The unit rate of PVC pipe shall be for providing in place the specified diameter pipe per ft. run and shall be deemed to be the full payment of material, labour and all other activities required to complete the work.

(c) The measurement for payment of flap covers shall be made as numbers of flap covers provided and installed in accordance with the Specifications, Drawings and as approved by the Engineer.

(d) The payment for flap covers shall be made at the rate per number quoted in BOQ for this item. The quoted rate shall be deemed to cover all costs of providing, fixing and all other related works complete in all respects.

RUNGS

Scope of Work

The work to be done under Rungs will consist of 1 inch diameter deformed mild steel bars embedded in new concrete or drilling and grouting in the existing concrete or in brick work at the specified locations and in the manner shown on the Drawings. The shape, dimensions, depth of embedment of the rungs in concrete, the spacing between rungs and other details shall be as shown on the Drawings or as directed by the Engineer and in accordance with the Specifications.

Materials and Construction

The rungs shall be of deformed mild steel of minimum yield strength of 40,000 psi and shall be fabricated to the shape and dimensions as shown on the Drawings and conforming to ASTM 615. The materials, mixing, placing, and curing of concrete lining shall conform to the provisions of Section – “Concrete, General” and “Canal Lining” of these Specifications.

Measurement and Payment

Measurement will be made by number of rungs acceptably furnished and embedded in concrete, concrete canal lining and brickwork.

Payment will be made at the unit rate per number tendered in the Bill of Quantities for Rungs,

and shall constitute full compensation for all cost of labour, materials, tools and equipment required for furnishing and installing Rungs to the satisfaction of the Engineer.

CANAL/ DISTRIBUTARY DISTANCE MARKERS AND BOUNDARY PILLARS

Scope of Work

The work to be done consists of furnishing and placing permanent Canal/Distributary distance markers on dowel at intervals of 1,000 feet along the service road of Canal/Distributary and boundary pillars at intervals of 5,000 feet on both sides of the Canals at edge of ROW in accordance with the Drawings and these Specifications, and of furnishing, placing and maintaining temporary Canal/Distributary distance markers and boundary pillars at the same intervals until placement of the permanent one.

Materials and Workmanship

All concrete materials, casting, curing and repairing of concrete for canal distance markers and boundary pillars shall be in accordance with the provisions of, and in complete conformity with, the stipulations and requirement for concrete specified in the Section-4“ Concrete, General”.

Permanent Markers and Boundary Pillars

Permanent canal distance markers and boundary pillars shall be the `concrete burjies’ and shall be in accordance with the dimensions and details shown on the Drawings. The finished surfaces of distance markers shall be free of adhering concrete and shall be reasonably smooth. Castings have all figures and features shall be casted integrally by embossing in the markers on all three sides. All markers shall be identical except the numbers indicating the canal RD shall be one, two and three-digit numbers as required for the appropriate canal distance. The size/font of letters shall be as approved by the Engineer.

Boundary pillars and distance markers shall be pre-cast units of concrete class B (3000 psi) using Ordinary Portland Cement, placed accurately in accordance with the Drawings and the Engineer’s instructions. Distance markers shall be painted as shown on the Drawings and to the satisfaction of the Engineer.

Temporary Markers

On commencement of work on the Canal/Distributary, the Contractor shall furnish and place temporary canal distance markers and boundary pillars at or near the locations designated for

the permanent one and maintain each temporary marker/pillar in good condition until such time as it is replaced by a permanent one. The temporary markers may be of any type and material suitable for the intended purpose provided the size and design are such as to be clearly visible and are acceptable to the Engineer. The temporary marker/pillars for a designated location shall be removed from the site after the permanent marker/pillars for the position has been fixed and accepted by the Engineer.

Measurement and Payment

(a) Measurement for payment of Canal/Distributary distance markers and boundary pillars will be made in number only for the permanent markers/pillars furnished and installed in accordance with these Specifications, Drawings and instructions of the Engineer.

(b) Payment for both Canal/Distributary distance markers and boundary pillars will be made at the respective unit rate tendered in the Bill of Quantities for these Items.

The amount tendered shall be full payment for furnishing all material, casting, curing, and fixing including labour for completion of the work specified herein and elsewhere in these Specifications and as shown on the Drawings for the respective BOQ items for Canal/ Distributary distance markers and boundary pillars, including all costs of furnishing and installing permanent and temporary Canal distance markers and boundary pillars.

SHINGLE ROAD SURFACING

General

Shingle Road surfacing shall be done for the Inspection road on the left bank of the canals as shown on Drawings or as instructed by the Engineer. Interchanges/ramps providing access to other roads shall also be provided with shingle surfacing.

This section shall consist of furnishing, spreading, compacting granular base material, in one or more layers and on a prepared subgrade according to the Specifications and Drawings and/or as directed by the Engineer.

Subgrade Preparation

The embankments compacted for which required compaction has been ensured by the contractor in accordance with the requirements and specifications described in Section - “Earthwork”, shall be used as prepared subgrade under Shingle Road Surfacing.

Granular Base

(1) **Material:** Granular base material shall consist of natural or processed aggregate such as gravel, sand, or stone fragments, and shall be clean and free from dirt, organic matter and deleterious substances, and shall be of such nature that it can be compacted by rolling to form a firm, stable base.

(2) **Gradation:** The material shall comply with the following grading and quality requirements:

(a) The base material shall have a gradation within the limits given below:

Sieve Designation	Percentage Passing, by Weight
2 inch	100
1 inch	55-85
3/4 inch	50-80
3/8 inch	40-70
No. 4	30-60
No. 10	20-50
No. 40	10-30
No. 200	5-15

The Coefficient of Uniformity D60/D10 shall be not less than 3, where D60 and D10 are the particle diameters corresponding to 60% and 10% respectively, passing (by mass) in a grain size analysis curve.

(b) The material shall have a CBR value of at least 50%, determined according to ASTM D1883. The CBR value shall be obtained at a density corresponding to 98% of the maximum dry density determined according to ASTM D1557.

(c) The coarse aggregate material retained on sieve No. 4 shall have a percent wear by Los Angeles ASTM C131 of not more than 40% at 500 revolutions.

(d) The ratio D15 Base/D85 Subgrade should be less than 5, where D85 and D15 are the particle diameters corresponding to 85% and 15% respectively passing by mass in a grain size analysis curve.

(e) The fraction passing the No. 200 sieve shall not be greater than two thirds of the fraction passing the No. 40 sieve.

(f) The fraction passing No. 40 sieve shall have a liquid limit of not greater than 25, and a plasticity index of between 4% and 8% as tested according to ASTM D4318.

(3) **Construction:** Granular base shall be spread on approved subgrade layer as a uniform mixture. Segregation shall be avoided during spreading and the final compacted layer shall be free from concentrations of coarse or fine material.

Granular base shall be deposited on the subgrade in a quantity which will provide the required compacted thickness without resorting to spotting, picking, or otherwise shifting the base material.

When the required thickness is 6 inches or less, the aggregate may be spread and compacted in one layer. When the required thickness is more than 6 inches, the aggregates shall be spread and compacted in 2 or more layers of approximately equal thickness.

No hauling or placement of material will be permitted when, in the judgment of the Engineer, the weather or road conditions are such that the hauling operation would cause cutting or rutting of the subgrade.

(4) **Compaction Trials:** Prior to commencement of granular base operations, the Contractor shall construct a trial length of 1500 feet with the same approved base material as will be used in the construction to determine the adequacy of the Contractors method and equipment, the loose depth measurement necessary to result in the specified thickness of compacted material, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the material.

(5) **Compaction:** The moisture content of base material shall be adjusted prior to compaction by watering with approved sprinklers mounted on trucks, or by drying out, as required in order to obtain the specified compaction.

The base shall be compacted by means of approved vibrating rollers or steel wheel rollers, and rubber tyred rollers, progressing from the outside towards the center. Each succeeding pass shall overlap the previous pass by at least one third of the roller width. While the rolling progresses, the entire surface of each layer shall be properly shaped and dressed with a motor grader, to attain a smooth surface free from ruts and ridges and having a proper section. Rolling shall continue until the entire thickness of each layer is thoroughly and uniformly compacted to specified density.

Any area inaccessible to rolling equipment shall be compacted by means of mechanical tampers, where the thickness in loose layer shall not be more than 4 inches.

If the layer of base material or part thereof does not conform to the required finish, the Contractor shall, at his own expense, rework, water and recompact the material.

The relative compaction of each layer of the compacted base shall not be less than 98% of the maximum dry density determined according to ASTM D1557. The field density shall be determined according to ASTM D1556 or other approved method. For all material, the field density thus obtained shall be adjusted to account for oversize particles retained on 3/4 inch sieve

as directed by the Engineer.

Measurement and Payment

(1) **Subgrade Preparation:** No measurement and payment shall be made separately for preparation of subgrade under Shingle Road Surfacing.

(2) **Granular Base:**

(a) The quantity of granular base for payment shall be the theoretical volume in place as shown on the Drawings or as directed and approved by the Engineer. No allowance will be given for material placed outside of the theoretical limits shown on the cross sections.

(b) The accepted quantities calculated as provided above shall be paid for, at the unit price per thousand cubic feet tendered in the Bill of Quantities.

(c) The rate quoted in BOQ for this item shall be full compensation for furnishing all materials, hauling, placing, watering, mixing, rolling, labour, equipment, tools, and all incidentals necessary to complete the item.

MISCELLANEOUS METAL WORK

Scope of Work

The work to be done under Miscellaneous Metalwork, consists of furnishing, transporting, storing, erecting, installing, galvanizing and painting miscellaneous metalwork as shown on the Drawings and in accordance with these Specifications.

The Contractor shall furnish and install all anchor bolts and nuts, assembly bolts and nuts, brackets, clips and miscellaneous plates and shapes required including those to be embedded in concrete, if any.

Materials

All materials shall be new, of the best commercial quality, as approved by the Engineer, and shall meet the following requirements:

(a) Structural steel shall be in accordance with ASTM Designation: 36.

(b) All bolts and nuts shall be in accordance with ASTM Designation A 307, Grade A.

(c) All arc-welding electrodes shall be of the E60 classification in accordance with the latest edition of the American Welding Society “Specifications for Iron and Steel Arc-Welding Electrodes”, and shall be suitable for the positions and other conditions of intended use.

(d) Expansion anchors shall be the lead and metal-alloy compound unit type.

(e) All galvanized steel pipe shall be Schedule 40 Steel Pipe conforming to the requirements of ASTM Designation: A120.

(f) Floor grating shall be of galvanized steel of the required size, type and strength for the intended use and shall be of best commercial quality as determined by the Engineer.

Drawings

The Contractor shall prepare necessary shop and erection drawings covering materials to be furnished for the miscellaneous metalwork. All drawings shall be furnished for approval of the Engineer in accordance with the applicable provisions of SP-11 – “Drawings and Data to be Furnished by Contractor”, of the Special Provisions.

Fabrication

All work shall be equal to the best modern practices in the manufacture and fabrication of metalwork notwithstanding any omissions from these Specifications or Drawings. Details of design and fabrication not covered by the Drawings or by these Specifications shall conform to the latest “Specification for the Design, Fabrication, and Erection of Structural Steel for Building” of the American Institute of Steel Construction, herein-after designated the AISC Code.

Before being laid out or worked in any away, materials shall be straight and free from sharp kinks and bends. If straightening is necessary, it shall be done by methods that will not injure the metal.

Shearing and cutting by torch or electric arc shall be performed carefully, and all portions of the work which will be exposed to view after completion shall be finished neatly. Re-entrant cuts and copes on beams or channels shall be filleted before cutting.

All holes shall be cylindrical, unless otherwise shown on the Drawings; perpendicular to the member, clean-cut and without burred or ragged edges. Holes shall be punched or drilled to full size. Holes shall be accurately and carefully placed. Edge distances and bolt spacing shall conform to the requirements of the AISC Code.

Welding

All welding and work related thereto shall comply with the latest edition of the American Welding Society “Standard Specifications for Welded Highway and Railway Bridges”. All welding terms shall be interpreted in accordance with the American Welding Society definitions of welding terms, unless otherwise noted.

Members to be joined by welding shall be cut accurately to size. The edges of the member shall be sheared, flame cut or machined to suit the type of welding. The cut surfaces shall expose sound metal free from injurious defects. The surfaces of plates to be welded shall be free from rust, grease and other foreign matter for a distance of at least ¾ of an inch back from the edge of the weld.

All welding shall be performed by the electric-arc method, by a process which will exclude the atmosphere from the molten metal, and where practicable, using automatic machines. After being deposited, welds shall be cleaned of slag and shall show uniform sections, smoothness of weld metal, feather edges without overlap, and freedom from porosity and clinkers. All pinholes, cracks and other defects shall be repaired by chipping or grinding the defects to sound metal and rewelding.

Arc-welding equipment shall be of a type approved by the Engineer that will produce proper voltages, amperages and polarity for all uses and positions for which the electrodes are suitable.

All welding operators assigned to the work shall have passed the qualification test for welding operators as specified in the ASME Code. If required, the Contractor shall furnish to the Engineer a certified copy of the results of physical tests of specimens welded in the qualification tests. If in the opinion of the Engineer, the work of any welder at any time appears questionable, such welder shall be required to pass another qualification test witnessed by the Engineer. All cost connected with making the qualification tests of welding operators shall be borne by the Contractor.

Erection and Installation

All structural steel parts shall be accurately assembled and erected as shown on the Drawings, and all match marks of the fabricator shall be accurately followed. Hammering that will injure or distort the members will not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned carefully before the members are assembled or erected. At bolted connections, the bolts shall be drawn tight, and where required, the threads shall be burred or spot welded so that nuts cannot become loosened. Where required, bolt holes shall be reamed in the field to provide a light-driving fit.

For the installation of the miscellaneous metalwork, only mechanics skilled in their various trades shall be employed. The material shall be carefully handled so that no part will be bent, broken, or otherwise damaged, and any damage caused by the Contractor shall be repaired by and at the expense of the Contractor and in a manner satisfactory to the Engineer.

Metalwork to be embedded in concrete shall be installed when the concrete is being placed or, if shown on the Drawings or directed by the Engineer, recesses or blockout shall be provided in the concrete and the metalwork shall be grouted in place after the concrete has been placed. Anchor bolts and anchor bolt inserts shall be placed when the concrete is placed, unless otherwise directed by the Engineer. Where it is impracticable to place anchors or anchor bolts required for the installation of comparatively light metal accessories before the concrete is placed, holes shall be drilled in the concrete after the concrete has set thoroughly and expansion bolt or lead expansion anchors shall be installed therein.

Metalwork to be embedded in concrete shall be placed accurately and shall be held in its correct position while the concrete is being placed. The surfaces of all metalwork to be in contact with or embedded in concrete shall be thoroughly cleaned of all paint, rust, dirt, grease, loose scale, grout, mortar and other foreign substances immediately before the concrete is placed. No surface in contact with concrete shall be painted. Exceptional care shall be taken to ensure that all frames, guides and other fixed metalwork are installed in exact position and alignment.

Anchor Bolts

Anchor bolts shall be cleaned of all foreign material before they are embedded in concrete. Anchor bolts shall be supported rigidly in such a manner as to prevent displacement or undue vibration during the placing of the concrete.

Galvanizing

All steel and iron work of whatever kind described shall be galvanized as per standards and specifications given herein under Clause 17.7.3.

Painting

(a) **General:** All miscellaneous metalwork other than mentioned as galvanized, shall be painted with approved colour as directed by the Engineer. The contactor shall clean the surface and apply paint and protective coatings as hereinafter provided and furnish all required material. Surfaces not required to be painted coated, but adjacent to surfaces that are to be cleaned and painted shall be appropriately protected during the cleaning and painting operations. Tinting for color contrast, except for the last coat, shall be done by

using not more than three ounces of tinting color per U.S. gallon (22 gms/1) of paint. Surfaces which have been painted shall be handled with care and protected as necessary to preserve the coating in good condition. Temporary or permanent welding will not be permitted on area where the welding will damage the paint unless the painted surfaces that would be damages thereby are accessible for repairing and inspection.

Each undercoat and of paint shall be of a different color enabling easy differentiation between the coats of paint.

Except where specified, the contractor will to be required to disassemble machinery, equipment or other metal work for the purpose of painting the interiors.

Metalwork which is required to be painted shall be procured with a single undercoat applied in the workshop. On site this coat shall be touched up and repaired as required before further coats are applied in the field. Any shop coat on manufactured item shall be cleaned and painted as specified.

The contractor shall procure the painting materials according to a schedule which will ensure that the paint will not be stored longer than the limits recommend by the manufacturers.

(b) **Cleaning and Painting Tabulation**

Sr. No.	Item	Method of surface preparation A, B or C as in para (c)	Painting or coating material as in para (e)	Number of Coats.
1	Ferrous metal exposed to view, water bearing, wet, intermittently submerged or submerged.	('C)	VR-6 vinyl resin paint and mastic	6 or more to produce a minimum dry film thickness of 3 mm
2	Ferrous metal exposed to view, water bearing, wet, intermittently submerged or submerged but for item not included in 2 above:	'B' for areas of type IV, red lead shop coat	Prime coat – red lead primary paint type IV	1
		'C' for unpainted surfaces	Finish coat – phenolic resin aluminum paint	2
3	Ferrous surfaces to be in contact with water.	'C'	Coal tar epoxy paint, Black	2 or more to produce a minimum dry film thickness of 4 mm
4	Non-water bearing metal work subjected to ordinary atmospheric exposures and public view but for items not included in this tabulation. i) Canal Distributary distance markers ii) Miscellaneous metalwork	'A' for damaged painted surface to receive additional paint 'B' for unpainted ferrous surfaces damaged areas of painted surfaces.	Prime coat – red lead priming paint type II for ferrous metal surfaces Finish coat – machinery paint or regular aluminum paint as directed	1 for unpainted surface 1 or more as required for repair or damaged painted surfaces

Sr No.	Item	Method of surface preparation A, B or C as in para (c)	Painting or coating material as in para (e)	Number of Coats.
5	Ferrous surface which will be inaccessible after installation or assembly	'B' or 'C'	Priming paint specified for other surfaces or the same metal work	3 if unpainted 2 if primed
6.	All machine – finished surfaces of ferrous metal work including screw threads that will be exposed during shipment and while awaiting installation	'A'	Corrosion preventive compound grade 1	1 heavy coat
7.	Damaged area of galvanized surfaces that do not require finish painting	'B'	Zinc dust – Zinc Oxide or Zinc dust chlorinated rubber priming paint (surfaces subject to normal exposure) zinc dust chlorinated rubber priming paint (for buried and damp surfaces)	2 or more coats to produce a minimum dry film thickness of 1 mm. 2 or more coats to produce a minimum dry film thickness of 2 mm.

(c) **Preparation of Surfaces**

Surface preparation shall be in accordance with one of the following methods. The method to be used for each item, is indicated in the painting tabulation. Weld spatter, burrs, or other objectionable surface irregularities shall be removed or repaired before cleaning. Any grit or dust remaining from the cleaning operation shall be removed before the surfaces are painted. Cleaning solvent shall be mineral spirits or xylol except that xylol shall be used for surfaces which require coal-tar coatings. In the event that rust forms or the surfaces become otherwise contaminated in the interval between cleaning and painting, or between coats of paint, recleaning will be required.

Method A: All oil, grease and dirt shall be removed by the use of clean solvent and clean wiping material.

Method B: All oil, grease and dirt shall be removed by the use of clean solvent and clean wiping material. Following the solvent cleaning, the surfaces to be painted shall be cleaned of all defective or damaged areas of existing paint, and of all loose rust, loose mill scale, and other foreign substance by scraping, chipping, blasting, power wire brushing or other effective means.

Method C: All oil, grease and dirt shall be removed by the use of clean solvent and clean wiping material. Following the solvent cleaning, the surfaces to be painted shall be blast cleaned to base metal, using dry, hard, sharp sand or steel grit, to produce a grey-etched surface. The blasting material shall pass a No.16 United States standard screen and at least 85 per cent shall be retained on a No.50 United States standard screen.

(d) **Application**

Materials shall be thoroughly mixed at the time of application. Surfaces shall be clean and free from moisture at the time of application. Effective means shall be provided for removing free oil and moisture from the air-supply lines of all spraying equipment. Nozzle pressure consistent with acceptable finish results shall be employed when spray painting. Each coat shall be free from runs, pinholes, and sags. Each coat shall be allowed to dry or to harden before the succeeding coat is applied. Thickness specified in millimeters shall be measured by an approved dry-film thickness gauge. Red-lead priming paint, regular or phenolic-resin aluminium paint, and machinery paint may be thinned if necessary to permit satisfactory application, in which event mineral spirits shall be used and the amount of thinner shall be kept to a minimum and in no event shall it exceed 15 percent of the paint. Thinning of other materials will be permitted only if approved. If necessary to improve application properties, cold-applied paints may be heated by means of a hot-water bath to temperatures not exceeding 42.5°C.

Application of specific materials shall be as follows:

i. Red-lead priming paint shall be applied at a maximum coverage of 500 square feet per U.S. gallon per coat (10.76 m^2/l). The first coat shall be applied by brush and subsequent coats shall be applied by either brush or spray. Following the first coat, an additional tinted brush coat shall be applied over all rivets, welds, bolts, seams, sharp corners and edges before subsequent painting. Alternate coats shall be tinted for colour contrast using 1B black.

ii. Aluminium paint shall be applied by spraying at a maximum coverage of 500 square feet per U.S. gallon per coat. The paint shall be prepared by mixing two pounds of aluminium paste per U.S. gallon of mixing varnish and only enough paint for each day's use shall be prepared at one time. The first coat shall be tinted for colour contrast using 2A blue.

iii. Machinery paint shall be applied at a maximum coverage of 500 square feet per U.S. gallon per coat.

iv. Rust-preventative compound shall be applied by any convenient method to ensure complete coverage with a heavy uniform coating.

v. Coal-tar epoxy coating shall be applied at a maximum coverage of 110 square feet per U.S. gallon per coat (2.37 m^2/l), Alternate coats shall be of different colours and the final coat shall be a colour other than black, the colour being subject to approval by the Engineer. Surface preparation, application and thinning shall all be done in accordance with the manufacturer's instructions.

vi. Vinyl-resin Paint VR-6

Coat	Alternate Colours of	Apply by	Max. coverage Ft^2/US gal (m^2/l)	Min. drying time

Prime	Dark Gray Brush	250(5.38)	4 hours	
Body	3 of more coats alternated red	Spray	120(2.58) each coat	12 hours each coat
Seal		Spray	200(4.30) each coat	12 hours between coats & at least 10 days before placing in service

Note: Figure in brackets in m^2/l.

(e) Materials

All pigmented paints and primers shall be purchased in sealed containers packaged by the manufacturer and shall be delivered with the seals unbroken. Colours of finish paints shall match colour samples furnished to the Engineer unless colour requirements are specifically stated otherwise. Materials shall be in accordance with the following specifications:

i) Federal Specifications

(1) Red lead priming paint, TT-P-86a, Type II
(2) Zinc dust zinc-oxide primer, TT-P641b, Type II
(3) Mixing varnish for regular aluminium paint, TT-V 8 lb. Type II, Class B
(4) Aluminium paste, TT-A-468a, Type II, Class B
(5) Machinery enamel, TT-E-489, Class A
(6) Pigment-in-oil (tinting colours), TT-P-38 lb Colours IB black and 2A blue
(7) Mineral spirits TT-T-29la, Grade 1
(8) Xylol (xylena), TT-X-961, Grade A or B

ii) United States Maritime Administration Specifications

Rust preventative compound, 52-MA-602A, Type B, Medium, except that equally effective inhibitors in suitable quantities, may be used in lieu of the specified percentage of chromates

iii) Military Specifications

Vinyl-resin paint, VR-6 aluminium paste thinner

iv) U.S. Bureau of Reclamation Specifications

v) Certification of Materials

The Contractor shall furnish manufacturer’s certificates of compliance with specifications for all paint material being furnished. The Engineer reserves the right to test materials accepted on certification when, in the opinion of the Engineer, such tests are necessary.

Measurement and Payment

(a) Measurement for payment for miscellaneous metalwork will be made of the actual quantity of the miscellaneous metalwork furnished, galvanized or painted and installed in Kilograms (Kgs) in accordance with the Drawings and as directed by the Engineer. The weight shall be determined in the most practicable manner using actual weights measured at the Site, calculated weights or manufacturer's weights. Net weights only will be paid for. The weight of all tare packing and blocking will not be included.

(b) Payment for miscellaneous metalwork will be made at the unit rate per kg tendered in the Bill of Quantities.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings.

ELASTOMERIC BEARING PADS

Scope of Work

The work to be done under elastomeric bearing pads consists of providing all materials for elastomeric bearing pads of required size and shape and placing in position as shown on the Drawings, in accordance with the stipulations stated herein or as directed by the Engineer

Elastomeric bearings pads as specified herein shall include plain bearings (consisting of elastomer only) and laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded laminates). The elastomer portion of the elastomeric compound shall be 100 percent Virgin Chloroprene (neoprene) meeting the requirements of the AASHTO Standard Specification (1983) for Highway Bridges. Laminates shall be rolled mild steel sheets conforming to ASTM A36 unless otherwise specified. Neoprene bearing pads shall be furnished by the Contractor and installed at the locations shown on the Drawings. All operations of the Contractor in storing and installing the neoprene bearing pads, shall be in strict accordance with the manufacturer's instructions and as directed by the Engineer.

Material

Elastomeric bearings pads as specified herein shall include plain bearings (consisting of elastomer only) and laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded laminates). The elastomer portion of the elastomeric compound shall be 100 percent Virgin Chloroprene (neoprene) meeting the requirements of the AASHTO Standard Specifications (1983) for Highway Bridges. Laminates shall be rolled mild steel sheets conforming to ASTM A36 unless otherwise specified. Neoprene bearing pads shall be furnished by the

Contractor and installed at the locations shown on the Drawings. All operations of the Contractor in storing and installing the neoprene bearing pads, shall be in strict accordance with the manufacturer's instructions and as directed by the Engineer.

Measurement and Payment

(a) Measurement of elastomeric bearing pads shall be made in the cubic inches of the bearing pads.

(b) Payment for elastomeric bearing pads will be made according to the unit rate per cubic inch tendered in Bill of Quantities for elastomeric bearing pads. The rate for bearing pad shall include supplying, fixing and all other work related to the BOQ item for providing and fixing bearing pads.

3-PLY BITUMENASTIC FELT PAPER

Scope of Work

The work to be done under the item "3-ply bitumenastic felt paper" includes providing, placing and installing as shown on the Drawing and or as directed by the Engineer.

Material and Construction Method

Bearings for bridge decks shall consist of 3-ply bitumen paper laid over two coats of hot bitumen using 0.35 lbs/sft blinding with sand at 0.01 cft/sft. The concrete surfaces on which the bitumen paper is to be placed shall be wood float finished to a level plane which shall not vary more than 0.1 inches from a 10 feet straightedge placed in any direction across the area. The finished plane shall not vary more than 0.1 inches from the elevation shown on the Drawings or that required by the Engineer.

Measurement and Payment

(a) Measurement for payment of 3-ply bitumenastic felt paper will be made at the unit rate per100 sq.ft. tendered in the Bill of Quantities.

(b) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for the respective BOQ items for 3-ply bitumenastic felt paper including all costs of furnishing and installing.

ENAMELED IRON GAUGE

Scope of Work

The work to be done under the item “enameled iron gauge” includes providing, placing and installing as shown on the Drawing and or as directed by the Engineer.

Material and Construction Method

(a) Gauges to be made of No.18 gauge mild steel plate and to be covered with vitreous enamel with a minimum thickness or 12 mils on numerical side and 3 mils on the reverse side and on edges where plate, has been cut, punched or drilled.

(b) All cutting, drilling and punching of the plates shall be completed before the vitreous enamel is applied.

(c) The face of the gauge shall be white and all numerals and graduations shall be black.

(d) Graduations shall be sharp and accurate to the dimensions shown.

(e) In case a greater length than shown on the drawings required, the details shall be similar to details shown for shorter lengths.

Measurement and Payment

(a) Measurement for payment of enameled iron gauge will be made at the unit rate of number tendered in the Bill of Quantities.

(b) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for the respective BOQ items for enameled iron gauge including all costs of furnishing and installing.

EXPANSION JOINTS IN BRIDGE DECK SLABS

Scope of Work

The work covered in this item shall consist of furnishing all plant, equipment, materials and labour in performing all operations in connection with furnishing and placing (in concrete structures) all deck expansion joints and seals, in accordance with the specifications, the Drawings, and or as required by the Engineer.

Material Requirements

Concrete Joint Filler:

(a) Neoprene Rubber Sheet

Unless otherwise directed by the Engineer, neoprene rubber sheets ¼ inch in thickness, meeting the requirements given below, shall be used as a joint filler covered with joint sealer as shown in the Drawings.

Neoprene rubber sheet shall be of neoprene or of polyvinyl chloride (PVC), at the option of the Contractor. Neoprene shall be manufactured from a vulcanized elastomeric compound containing neoprene as the sole elastomer and shall have the following physical characteristics in accordance with ASTM Method D15, Part B.

Hardness, Durometer A, ASTM D 2240	45 ± 5 points
Tensile Strength, ASTM D 412	127 Kgs/square centimeter min
Elongation at Break	400 percent min.
Compression Set, 22 Hours at 70 degree C. ASTM 395, Method B.	20 percent max.
Low Temperature, ASTM D746	Not brittle at 40 degree C.
Ozone Resistance, Exposure to 100 PPHM Ozone for 70 hours at 38 degree C. Sample under 20 percent. ASTM D 1149	No cracks
Oil Deterioration – Volume increase after soaking in ASTM oil No.3 for 70 hours at 100 degree C ASTM D 470	120 percent max.

(b) Joint Sealer

The joints sealer shall conform to the requirements of item 17.3.2 of the Specifications.

Measurement and Payment

(a) Measurement of Expansion joints shown on the Drawings and as described herein above, shall be made in linear feet of the joints acceptably formed according to the length shown on the Drawings.

(b) Payment for expansion joint shall be made according to the rate tendered in the Bill of Quantities per linear foot of the joint which shall be deemed to cover all costs including supplying and installing the joint filler, joint sealer and all other works related to the BOQ item for providing and filling expansion joints.

RCC PIPES FOR OUTLETS

Scope of Work

The work to be done under this item consists of providing and placing Reinforced Cement Concrete Pipes of specified diameter in outlets according to size, lines and grades shown on the Drawings and in accordance with the Specifications hereunder and directions of the Engineer.

RCC Pipes for Outlets

Pipes for outlets are reinforced concrete pipes for conveying the water from canal to outside sump. The sizes, slopes and other details of RCC pipes are shown on the Drawings. All materials, methods of manufacture and strength requirements for the RCC concrete pipe shall conform to the requirements of ASTM Designation C-76 for Class IV pipe and shall be subject to inspection and approval by the Engineer. The cement used in the manufacture of the pipes shall be Ordinary Portland Cement.

The ends of RCC pipe shall be spigot and socket type and of such design that when laid, the joints shall form a continuous conduit with a smooth and uniform interior surface. The concrete used in joints of pipes shall conform to the Specifications given in Section “Concrete General”, Drawing and direction of the Engineer.

Unless otherwise shown on the Drawings, pipe lines shall be straight and each pipe shall be laid accurately within 0.25 inch tolerances to the lines and levels shown on the Drawings or ordered by the Engineer provided always that there shall be no reverse gradient on any pipe or on the line as a whole.

Excavation and Backfill of Trenches for RCC Pipes and Sumps

Trenches for outlets shall be excavated after compaction of canal banks upto their design levels. The trenches shall be excavated only to that widths shown on the Drawings and no excess excavation shall be allowed. The trenches excavated wider than the specified widths shall not be accepted and shall be refilled, compacted and re-excavated by the Contractor at his own cost. After placing and laying the RCC pipes to satisfaction of the Engineer, the trenches shall be backfilled as soon as possible with suitable material in two stages.

(a) **First Stage**

First stage would involve compaction to have a minimum cover of 12 inches above the crown of the pipe. The backfill material shall be evenly placed and compacted in layers not exceeding 4 inches thick after compaction. The layers shall be compacted in such a

way as will not disturb the alignment or grade of the pipe. The compaction shall be achieved as specified under Section – “Earthwork”.

(b) **Second Stage**

The remainder of the trench shall then be filled with excavated material evenly placed and compacted in layers not exceeding 6 inches thick after compaction. The method of compaction shall be achieved as specified under Section – “Earthwork”.

Measurement and Payment

(a) Measurement for payment of RCC pipes shall be made in running feet of pipes provided and placed as per drawings, Specifications and approved by the Engineer.

(b) Payment shall be made per R.ft at rates quoted for respective diameter pipes in BOQ and shall be deemed to be the full compensation for all material and labour for the work including jointing, complete in all respects.

PRECAST CONCRETE BLOCK APRON

Scope of Work

The work to be done under Precast Concrete Block Apron consists of constructing precast concrete block apron at the end of downstream floor of the weir and elsewhere as shown on the Drawings or as directed by the Engineer. The work includes manufacturing, storing, handling, transporting and placing of the precast concrete blocks; furnishing and placing a filter of screened sand and aggregates; and all incidental operations necessary to construct the precast concrete block aprons in accordance with these Specifications.

Alternative proposal for constructing the precast concrete block aprons, such as casting of the concrete blocks in place, may be submitted to the Engineer for consideration, however, approval of any such alternatives proposed by the Contractor shall not waive or modify his responsibility for constructing the concrete block aprons in accordance with all other requirements of these Specifications.

Precast Concrete Blocks

(1) **Material**

(a) All concrete materials and the producing, forming, placing curing and repairing of concrete under these Specifications shall be in accordance with the provisions of and in complete

conformity with the stipulations and requirements for class B concrete specified in the section, “Concrete General”.

(b) All cement, sand and aggregates for concrete for precast concrete block aprons shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with the stipulations and requirements specified in the section, “Concrete General”. The filter material shall be as per specification designated under sub-section, Construction.

(2) **Concrete Blocks**

Precast concrete blocks shall have a minimum plan dimension and thickness as specified on the Drawings. The blocks shall be cast on level platform having adequate foundations to prevent settlement during casting and curing operations. Casting in tiers will be permitted when approved by the Engineer. Forms shall be arranged to provide ample working room and easy for carrying out all operations required for the proper placing, consolidating and finishing of the concrete. Side forms shall remain in place at least 24 hours after the concrete is placed. Each block thoroughly worked into the corners of the forms and compacted by the internal vibrating, spading and rodding during the concrete placing operation.

Blocks shall remain undisturbed after casting until completion of a 3-day curing period. Storing, handling and placing of the precast concrete blocks shall be accomplished by methods that will not damage the blocks, using suitable bridles, slings or other approved means. Blocks which are damaged in any way during casting, curing or handling will be rejected and shall be removed from the Site by the Contractor and disposed of in a manner approved by the Engineer.

(3) **Construction**

Precast concrete block aprons shall be constructed on firm foundations or on filter blanket and to the lines and grades shown on the Drawings or established by the Engineer. Depressions in the foundation shall be filled with suitable material and compacted in 6-inch layers. The precast concrete blocks shall be laid with the top surface reasonably level and with uniform spacing of 2-inches between blocks. Alternate transverse courses shall be offset one-half the standard block width such that longitudinal joints will not be continuous. All spaces between precast concrete blocks shall be filled with ½ inch aggregate. Corners on top shall be champhered.

Measurement and Payment

(a) Measurement for payment for precast concrete block aprons will be made to the dimensions of the areas of the precast concrete block aprons calculated in hundred (%) cubic feet volume and constructed in accordance with the Drawings and the Specifications excluding filter, which will be measured separately.

(b) Payment for precast concrete block apron will be made at the unit rate per hundred (%) cubic feet tendered in the Bill of Quantities for Precast Concrete Block Apron.

The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for Precast Concrete Block Apron except filling depressions or excavation for foundation which will be paid for under Items Excavation from Borrow Areas and Excavation for Structures.

Filter Blanket/Under Concrete Blocks Apron

(1) **Material**

The contractor shall furnish all materials for the complete construction of the filter including fine aggregates and coarse aggregates in conformity with the stipulations and requirements specified in the section 7 “Stone Pitching and Stone Apron”.

(2) **Foundation Preparation**

Sub-grade on which filter blanket is to be placed shall be firm and if necessary be lightly tamped or rolled to conform to levels on the Drawings. Where such areas are below or above grade, these will be brought to the required grade by filling with suitable material and compacted in 6 inch layers or by excavating as the case may be.

(3) **Filter Blanket and its Construction**

After the foundation has been satisfactorily prepared, the Contractor shall place thereon a filter material blanket 18 inch thick or as per thickness on the drawing. When approved by the Engineer, the 18-inch thick filter shall consist of a bottom 6-inch layer of local screened sand followed by a 6-inch layer of ¾ inch aggregate and a top 6 inch layer of 1½ inch aggregate. The bottom layer shall have sufficient water content (3 to 10%) during placement. Any damage to the surface of the filter base during placing the filter shall be repaired before proceeding with the work. The filter shall provide a firm foundation for the precast concrete blocks and be finished to a reasonably smooth and even surface, such that the average elevation of each precast concrete block will not vary more than 2-inches from the elevation shown on the Drawings or established by the Engineer, nor more than 2-inches with respect to any adjacent block.

Measurement and Payment

(a) Measurement for payment will be made in hundred cubic feet of filter blanket to the required thickness and specification and approved by the Engineer.

(b) Payment for furnishing transporting and placing filter blanket will be made at the unit price per 100 Cft bid in the Bill of Quantities. The amount bid shall be full payment for completion of the work specified herein as filter blanket under concrete blocks.

Payment for filling depressions or excavation for foundation will be made under Items Excavation from Borrow Areas and Excavation for Structures.

Damp Proofing

Scope

The work covered under this section shall consist of damp proofing concrete surface or brick/block masonry surface, in accordance with these specifications and at the location shown on the Drawings or as directed by the Engineer.

General

The concrete surface shall be damp proofing with bitumen by the absorptive method where as brick/block masonry surfaces shall be first treated with a horizontal layer of Portland cement concrete and then covered with bitumen damp proof cover with Hessian base. Vertical faces of walls likely to come in contact with earth shall be first plastered with sulphate resisting cement plasterin1:2 cement sand mortar and then treated with bitumen by the absorptive method. Damp proofing shall not be applied when the temperature is below 39o F and falling. The work shall be done by workmen experienced in the application of damp-proofing. Damp proofing shall be applied as shown on the Drawings.

Damp-proofing materials

All asphaltic materials shall be delivered in sealed containers bearing the manufacturer's original labels as provided under relevant Clauses of these Specifications and shall conform to the designated Specifications and be approved by the Engineer. Damp proofing materials shall conform to the following requirements along with the requirements shown on the Drawings.

Asphalt primer

The asphalt primer shall consist of an asphaltic base thinned to a suitable brushing consistency, with a volatile solvent, and shall conform to the requirements set forth under ASTM 41-73 or latest revision.

Asphalt

Asphalt for damp proofing shall meet the requirements of ASTM D 449-73, Type C or latest revision.

Preparation of surfaces

17.19.6 Surfaces to receive damp proofing shall be smooth, clean and dry. Holes, joints and cracks shall be painted flush with mortar and high spots ground level with the surrounding surface. Before damp proofing, surfaces shall be swept clean of all foreign matter and shall be inspected and approved.

Placement procedures

The selection of various waterproofing and damp proofing materials for different locations shall be as shown on the drawings or as directed by the Engineer. Unless otherwise directed or approved by the Engineer, the following procedures shall be adopted:

Damp Proofing under Brick Masonry walls

The damp proofing shall comprise of 1 ½" thick layer of plain cement concrete Class B shall be placed over the area to be damp proofing.

A priming coat of asphalt primer confirming to BS specification 1097 October 1973 before the application of asphalt coating.

An asphalt coat using not less than 30 lbs per 100 sq. ft.

ROOF INSULATION

Scope

The work consists of insulation with brick tiles of sizes 9"x4/2"x 1 ½" or any other approved size laid in cement mortar (1:3) over rammed mud laid to grade as shown on drawings after applying two coats of bitumen on the R.C.C. roof slab surface at 30/25 lbs, respectively for first and second coats at specified heat.

Materials

The brick tiles shall comply with the standards set in "Section Bricks" except for their thickness and strength. The cement, sand and water shall meet the requirements as given in Sections 5 "CONCRETE, CEMENT AND GENERAL"

Bitumen shall be PB3 or PB4

The clay for making mud shall be clean, free of all organic and other injurious matters.

Application

Bitumen Painting

Bitumen heated to the specified temperature and applied on R.C.C roof slab cleaned and dried surface including sanding at 1 ½ cu.ft per hundred sq.ft of surface.

Laying Mud

The clay shall be mixed with reasonable quantity of water thoroughly kneaded to from a thick paste to which copped straw at the rate of 10 lbs. per cu-ft of mud shall be added. It shall be laid and thumped with wooden trowels to from the slope as shown on the Drawings.

Laying of tiles

The Brick tiles shall be laid in cement mortar (1:3) in fall/slope as shown on drawings.

Pointing

The brick tiles shall then be flush pointed in cement mortar (1:2)

Curing

The tiles laid shall be cured properly for ten days.

STEEL DOORS AND WINDOWS WITH MS SHEET OR MS GRATING

Scope

The Section of specification consists of furnishing all plant, labor, equipment and materials in performing all operations in connection with providing and fixing metal windows and doors, all metal windows and doors including painting shall be according to the Schedule specified on drawings and manufactured by a firm to be approved by the Engineer. They shall be handled with care, shall be staked on edge on level bearers and be supported evenly against a wall or vertical bearers, under cover.

Contractor to fix

The Contractor shall fix the windows, doors as described. He shall be responsible for storing windows etc., and carrying to their respective positions, assembling composites, bedding and

jointing with matic at the mullions and transoms, fixing lugs and screws to frames, placing in the openings and bedding with cement and pointing externally with mastic.

Building in

Where applicable metal windows, doors shall be built in, set to plumb and line and cement mortar shall be grouted into the channel of the frame as brickwork proceeds. Fixing lugs shall be grouted in at the jambs, head and sill. When screwing up lugs or fixing screws, care shall be taken to ensure that windows etc. are not distorted.

Fixing into prepared openings

Windows to be fixed into prepared openings shall have at least 1/8 inch to tolerance all round. Window frames shall be grouted with cement mortar into the channel of the frame joints between building openings and window etc. frames shall be chalked with mastic cement of an approved make.

Fabrication of doors, windows

The steel section shall be thoroughly strengthened in the shape by methods that will not injure it before being laid off or worked in any way.

All members shall be so cut and formed that they can be accurately assembled with out being unduly cracked strained or forced into position.

The jointing of the different parts of the members of mild steel shall be carried out by welding process in conformity with the requirements of American Welding Society fore such joints. Welding points shall be made quite smooth by filing them and making smooth.

Putty

The putty shall be of a type specially prepared for use with metal work in tropical conditions.

Protection of Fittings

Fittings shall be wrapped and protected from damage until all rough trades have been completed.

Glazing

Glazing shall be fixed in metal windows by proprietary PVC or neoprene molded soling strips as provided by the manufacturers of the windows, or as may be directed by the Engineer.

All windows shall be glazed with 5 mm thick glass.

The contractor shall be responsible for protecting and maintaining all glazing in its prime condition. On completion all glass shall be cleaned inside and out and all cracks and broken glass shall be replaced, all to the satisfaction of the Engineer.

Painting preparation of the metal work

Iron and steel surface shall be cleaned by means of solvents approved methods., cleaned surfaces shall be primed as soon as practicable after cleaning.

Paint Application

Unless otherwise specified or instructed the Contractor shall apply paints as follows:

Internal Surface of Steel Work

2 coats Zinc Chrome primer
2 under coats
1 glass finish coat

External Surfaces of steel Work

2 coats Zinc Chrome primer
1 aluminium bitumastic under coat
1 aluminium bitumastic finish coat

All painting coats up to and including the first undercoats, shall be applied under cover at “WORKS” before despatch to the Site.(the second undercoat and the finishing coat shall be applied after erection on Site). Extreme care shall be taken to protect paint coats during transit.

Paint

The paints for any painting sequence shall be mutually compatible and of the same approved manufacture. All paints shall be supplied in small sealed containers each not exceeding one gallon capacity.

Wire gauze

Unless otherwise specified the wire gauze shall be of best quality as approved by the Engineer uniformly woven wire webbing of 12x12 meshes to 645 mm (one sq.inch) made from 22 guage galvanized iron wire. All panel shall be in one piece and no joints shall be allowed in the guaze.

Wire guaze shall be fixed as shown on the drawings or as directed by the Engineer. The guaze shall remain right to the full width and without any sag.

CAST IRON PIPE AND FITTINGS

General

Cast Iron Pipes and Fittings shall comply with BS 78 for spigot and socket vertically cast pipes BS 1211 for Spigot and Socket Spun Iron Pipes and BS 2035 for Flanged Pipes.

MILD STEEL PIPES

General

The mild steel pipes shall conform to ASTM A53/A 53M for steel pipes.

Measurement and Payment

Measurement will be made for linear feet of Pipe provided and installed complete in all respects.

Payment will be made for linear feet of Pipe work as measured at the contract unit price and shall constitute full compensation to provide, handle lay and jointing Pipes complete.

Two Layers of 8 gauge G.I sheets used as bearing pad with bitumen in-between

Measurement and Payment

Measurement and Payment for providing and installing two layers of 8 guage G.I Sheets combined in one unit with in-between bitumen in Super Passages over pile cap shall be made in hundred (%) square feet of combined sheets actually placed as per drawings and shall constitute full compensation for procurement of materials, installation and all other costs involved therein.

Two G.I Sheets of 1/16 inch thickness each for Roof Felt Packing

Measurement and Payment

Measurement and Payment for providing and installation of two G.I Sheets of 1/16 inch

thickness each for Roof Felt packing used alongside of pile caps for Super Passages shall be made in hundred (%) square feet of such sheets actually installed as per drawings and shall constitute full payment for procurement, installation and all operations involved therein.

Providing Rainwater Outlets for Bridges

Measurement and Payment

Measurement for providing rainwater outlets for road bridges shall be made in number of rainwater outlets installed as per drawings.

Payment for rainwater inlets measured as above shall be made as per unit rate tendered in BOQ and shall constitute full payment for all the materials and operations required to complete the work.

RCC PIPES FOR CATCH WATER DRAIN INLETS

The work to be done under this Item consists of providing and placing Reinforced Cement Concrete Pipes of specified diameter in catch water drain inlets according to sizes, lines and grades shown on the Drawings and in accordance with the Specifications hereunder and directions of the Engineer.

RCC Pipes and Gravel Bedding Material

All materials, manufacturing method, strength requirements, placing, jointing and tolerances for RCC pipes and gravel bedding material under pipes shall be in accordance with the standards and Specification and as directed and approved by the Engineer. Concrete used in base slabs of sumps and joints shall conform to the Specifications.

Excavation and Backfill of Trenches for RCC Pipes and Sumps

Trenches and sumps for catch water drain inlets shall be excavated after compaction of canal banks upto their design levels. The trenches shall be excavated only to that widths shown on the Drawings and no excess excavation "shall be allowed. The trenches ' excavated wider than the specified widths shall not be accepted and shall be refilled, compacted and re-excavated by the Contractor at his own cost. After placing and laying the RCC pipes to satisfaction of the Engineer, the trenches shall be backfilled as soon as possible with suitable material in two stages in accordance with Specifications and approval of Engineer.

GABIONS

The- work shall consist of furnishing shop drawings, assembling and installing rock filled, wire mesh gabions and Geotechnical filter fabric bedding, and preparing foundations, as shown on the Drawings, or as instructed by the Engineer.

Material

The materials shall be as specified herein below.

Wire

AII wire shall confirm to ASTM specification A 510, grade number 1006 through 1020. Wire shall have a minimum tensile strength of 60,000 lb/in2 and a class 3 galvanized coating conforming to ASTM A641. The galvanized coating will be applied by the hot dip process in accordance with ASTM A 385 and ASTM A 386.

Gabion Baskets

Gabions basket shall be minimum of 6 SWG galvanized steel wire, fabricated into hexagonal triple-twist woven mesh with openings as shown on the Drawings. Selvedge wire running through all edges shall be minimum of 5 SWG galvanized steel wire.

Lacing

Lacing, tie and connecting wire shall be a minimum of 10 SWG galvanized steel wire.

Rock

Rock used as filling shall be clean, hard unweathered boulders or rock fragments and shall be in accordance with specification. No rock fragment or boulder shall exceed the maximum size given below, and at least 85% of the rocks shall be of a size equal to or above the minimum size given below.

Depth of basket (inch)	Rock size according to the largest dimension of the rock	
	Minimum (inch)	Maximum (inch)
36	4	12

12	4	6

After the Contractor has determined that the rock meets the Specification and at least 30 days prior to delivery to the site, the Contractor shall inform the Engineer in writing of the source from which the rock will be obtained, and include the test data and other information by which he determined the material to be satisfactory. The Contractor shall provide the Engineer free access to the source for the purpose of obtaining samples for testing and source approval.

Foundation Preparation and Geotechnical Filter Fabric Bedding

Foundation Preparation: The foundation on which the gabions are to be placed shall be cut or filled, grade and compacted to the lines and grades shown on the Drawings. When fill is required, it shall consist of approved materials and shall conform to the specified requirements. Vegetation surface irregularities and loose materials shall be removed from foundations. Filter bedding gabions shall not be placed until the foundation preparation is completed, and the sub-grade surfaces have been inspected and approved by the Engineer.

Gabions Assembly and Placing

Assembly of gabions shall consist of shaping and tying each individual basket. Where the length of the gabion exceeds its horizontal width, the gabion shall be equally divided by ■ diaphragms into cells whole length does not exceed the basket horizontal width. Diaphragms shall be fabricated of the same mesh and gauge as the body of the gabions the gabions shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this junction will be necessary.

Tying united edges, including diaphragms, with lacing wire in accordance with the following method shall assemble each gabion basket. Welding of gabion caoes will not be permitted.

Lacing shall be used for both the closure of basket lids and connecting baskets together. The lacing procedure consists of cutting a length of lacing wire approximately 1% times the distance to be laced not to exceed 5 feet, securing one end of the. wire at the corner by looping and twisting, alternately lacing with single and double loops at approximately four (4) inch intervals, and securing the other end of the wire to selvedges by looping and twisting.

Placing of gabions shall consist of installing baskets to the lines and grades shown in drawings. Gabions shall be securely tied to each adjoining gabion with lacing wire along the vertical reinforced edges and the top selvedges. Empty gabion sections stacked on a filled line of gabions shall be tightly laced to the latter along the front and back. When the upper . section only- partially overlaps the lower section, the lacing shall be done along the line where the front edge of the upper section meets the lower section and where the back edge of the lower section

meets the base of the upper section. For the end section only, the layer of empty gabions placed on top of filled gabions must be wired to the latter at the front, back and external lateral edge.

Prior to placement of rock, the baskets shall be stretched. If necessary, the gabions shall be temporarily staked to maintain proper alignment. Constructing wires shall be attached during the filling operation to preserve the strength and shape of structure.

Filing Operation

The gabions shall be carefully filled with rock by hand to ensure alignment, avoid bulges and provide a compact mass with minimum of voids. Cells in rows shall be filled in stages such that the depth of rocks placed in any cell does not exceed the depth in an adjoining cell by more than one foot.

The placement of rock in gabions, including the installation of connection wires, shall be performed in the following sequences:

Fill gabions to a depth of 12 inches wires evenly spaced shall be used in lieu of one between an exposed front face and the opposite back face.

Fill gabions another 12 - inch and tightly tie connecting wires to opposite faces for each gabion at this level as described in step 2 above.

Complete filling of gabions to the top.

All connecting wires shall be looped around two mesh openings and shall securely twisted with a minimum of five (5) twists after looping.

When the gabions have been filled, the lid shall be bent and stretched until it meets the perimeter edges of the front and end panels. To assist in closing and lacing, a pinch bar or ■ a special closing tool may be used. The lid shall then by tightly laced with lacing wire to the each adjoining gabion with lacing wire along all contact edges. Lacing adjacent lids to the vertical panels in one operation is acceptable. Lacing the back edge of the lid to adjoining gabions shall be done prior to filling the gabions; The lid shall be tied to each diaphragm by lacing wire. Lacing shall be performed in the same manner as described in this section.

Tolerance

Tolerance for height, length and width shall be subject to plus or minus 5 percent of the dimensions Specified or shown on the Drawings. Similarly, the alignment of boxes shall be such

that the position of one face is within + 5% of the face length of its correct position ■ relative to the opposite face.

Wire diameter shall be within a tolerance of 0.004 inches per ASTM A641.

Tightly tie one connecting wire in each direction to opposite faces of each gabions cell at a 12 - inch height above the except for exposed cell faces. Two connecting

GEOTEXTILE

The work to be done under geotextile shall include providing and placing geotextile under Gabions in accordance with these Specifications and Drawings or as approved by the Engineer.

All material procurement, installation, field and laboratory testing shall be done according to the procedure specified herein below.

If the formulation of Geotextile lot changes during the work, the Contractor shall provide the Certificate of Analysis (COA) at every change of formulation/ product to the Engineer. The material shall meet the following ASTM standards.

It shall be capable of preventing slipping of the fresh in-situ concrete on canal side slopes.

it shall be made of polypropylene or polyester fiber comprising of continuous-fiber needle-punched non-woven geotextile of unit mass at least 7.37 ounces per square yard. It will conform to ASTM D-5261 or ASTM D 3776.

Its measured thickness, conforming to ASTM D-5199 shall be at least one (1) inch.

Placement

The Contractor shall submit his plan and method for placement of geotextile in detail to the Engineer prior to material being delivered to the job site. Geotextile shall be placed after approval of the proposed panel layout diagram and all applicable certificates / field checklists by the Engineer. If the material does not meet the specifications it shall be removed from the site by the Contractor at his own cost. All persons walking or working on the geotextile shall wear shoes that will not damage the product. No vehicles shall be allowed on the geotextile.

Packaging, Transport and Storage

The geotextile layer shall comprise pieces as large practicable, preferably with the long dimension of each piece lying along the canal. Junctions between adjacent pieces shall be plain

overlaps of not less than 6 inches. Each piece of geotextile as defined here shall have a unique reference number, which shall be used for making the piece for transport and storage, and also for reporting tests.

The pieces of geotextile shall be packaged so as to prevent damage during normal handling transporting and storage. Each piece or roll shall be clearly marked with the contract number unless the Engineer has agreed that such numbering is not necessary.

Geotextile shall be stored or exposed in direct sunlight for more than a total of fourteen days before being installed and covered.

Any pieces of geotextile that is damaged, or exposed to more than the permissible sunlight, shall be removed from the site and replaced, unless the Engineer agrees, that the damage can be remedied by cutting off par of the piece repaired by patching by using field seams.

DEMOLISHING OF EXISTING STRUCTURES

The work to be done under this item may consist of dismantling of Concrete structures such as bridges, culverts, siphons, aqueducts, outfall structures, drainage junctions and drainage inlets etc, whether in part or as a whole, as shown in Drawings or specified or as directed by the Engineer.

All such structures having salvage value, such as gates and embedded items of the structures, if any, shall be dismantled without hazard and cleared upto level as approved by the Engineer. The dismantled material shall be removed and disposed off within the Project area as directed by the Engineer.

To the extent possible the contractor shall also extract material of salvage value without any loss. The Employer may require that material salvaged be properly stored prior to handing over to the Employer.

Operator’s hut and Septic Tank

Measurement and Payment

Measurement and payment for constructing operator’s hut along with septic tank shall be made on lump sum basis against the amount tendered in the BoQ.

The Contractor shall submit the breakup of this lump sum item such that the proportion of payment at any time shall correspond reasonably with the value of work done at that stage. The Engineer shall approve the payment schedule.

Payment against this item shall constitute full payment for providing material, labour, operations and equipment for completion of Operator’s hut and septic tank as per drawings and specifications complete in all respects.

SECTION 15

ENVIRONMENTAL PROTECTION

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ENVIRONMENTAL PROTECTION

GENERAL

References

The documents listed below form a part of this specification to the extent refined:

World Bank (OD/OP 04)

Pakistan Land Acquisition Act.

The Environmental Protection Agency, Government of Pakistan.

The Environment Management Plan of the project is available with the Employer.

Definitions

Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

Contractor Generated Hazardous Waste

Contractor generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of

materials brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners, excess paints, excess solvents, waste solvents, and excess pesticides, and contaminated pesticide equipment rinse water.

General Requirements

The Contractor shall minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this contract. The Contractor shall comply with all applicable environmental laws and regulations of Government. The Contractor shall be responsible for any delays resulting from failure to comply with environmental laws and regulations.

Subcontractors

The Contractor shall ensure compliance with this section by subcontractors.

Submittals

The following shall be submitted in accordance with Sub-Clause 1-1.4 Submittals Procedures:

Preconstruction Submittals

Environmental Protection Plan

Environmental Protection Plan

Prior to commencing construction activities or delivery of materials to the site, the Contractor shall submit an Environmental Protection Plan for review and approval by the Engineer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor must address during construction. Issues of concern shall be defined within the Environmental Protection Plan as outlined in this section. The Contractor shall address each topic at a level of detail commensurate with the environmental issue and required construction task. Topics or issues which are not identified in this section, but which the Contractor considers necessary, shall be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, the Contractor shall meet with the Engineer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and

revisions to the plan including any reporting requirements; and methods for administration of the Contractor's Environmental Plans. The Environmental Protection Plan shall be current and maintained on site by the Contractor.

Compliance

No requirement in this Section shall be construed as relieving the Contractor of any applicable Environmental protection laws and regulations of the Government. During Construction, the Contractor shall be responsible for identifying, implementing, and submitting for approval any additional requirements to be included in the Environmental Protection Plan.

Contents

The Environmental Protection Plan shall include, but shall not be limited to, the following:

(a) Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.

(b) Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

(c) Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

(d) Description of the Contractor's environmental protection personnel training program.

(e) An erosion and sediment control plan which identifies the type and location of the erosion and sediment controls to be provided. The plan shall include monitoring and reporting requirements to assure that the control measures are in compliance with the erosion and sediment control plan, laws and regulations of the Government.

(f) Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on the site.

(g) Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

(h) Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or non-use. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

(i) Drawing showing the location of borrow areas.

(j) The Spill Control Plan shall include the procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated under laws and regulations of the Government. The Spill Control Plan shall include as a minimum:

(1) The name of the individual who will report any spills or releases of hazardous substances and who will follow up with complete documentation. This individual shall immediately notify the Engineer and the local fire department in addition to the legally required reporting channels if a reportable quantity is released to the environment. The plan shall contain a list of the required reporting channels and telephone numbers.

(2) The name and qualifications of the individual who will be responsible for implementing and supervising the containment and cleanup.

(3) Training requirements for Contractor's personnel and methods of accomplishing the training.

(4) A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

(5) The methods and procedures to be used for expeditious contaminant cleanup.

(a) A non-hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris. The plan shall include schedules for disposal. The Contractor shall identify any subcontractors responsible for the transportation and disposal of solid waste. Licenses or permits shall be submitted for solid waste disposal sites that are not a commercial operating facility. Evidence of the disposal facility's acceptance of the solid waste shall be attached to this plan during the construction. The Contractor shall attach a copy of each of the Non-hazardous Solid Waste Diversion Reports to the disposal plan. The report shall be submitted on the first working day after the first quarter that non-hazardous solid waste has been disposed and/or diverted and

shall be for the previous quarter (e.g. the first working day of January, April, July, and October). The report shall indicate the total amount of waste generated and total amount of waste diverted in cubic meters or tons along with the percent that was diverted.

(b) A recycling and solid waste minimization plan with a list of measures to reduce consumption of energy and natural resources. The plan shall detail the Contractor's actions to comply with and to participate in Government sponsored recycling programs to reduce the volume of solid waste at the source.

(c) An air pollution control plan detailing provisions to assure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site.

(d) A contaminant prevention plan that: identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with Government laws and regulations for storage and handling of these materials. As new hazardous materials are brought on site or removed from the site, the plan shall be updated.

(e) A waste water management plan that identifies the methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfections water, hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, the plan shall include the design of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the waste water, the plan shall include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, a copy of the permit and associated documents shall be included as an attachment prior to discharging the waste water. If disposal is to a sanitary sewer, the plan shall include documentation that the Waste Water Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

(f) A historical, archaeological, cultural resources biological resources and wet lands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on the project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be on site or in the area are discovered during construction. The plan shall include methods to assure the protection

of known or discovered resources and shall identify lines of communication between Contractor personnel and the Engineer.

(g) A pesticide treatment plan shall be included and updated, as information becomes available. The plan shall include: sequence of treatment, dates, times, locations, pesticide trade name, authorized uses, chemical composition, formulation, original and applied concentration, application rates of active ingredient (i.e. pounds of active ingredient applied), equipment used for application and calibration of equipment. The Contractor is responsible for the Government regulations on pest management record keeping and reporting requirements.

Appendix

Copies of all environmental permits permit application packages, approvals to construct, notifications, certifications, reports, and termination documents shall be attached, as an appendix, to the Environmental Protection Plan.

Protection Features

Prior to start of any onsite construction activities, the Contractor and the Engineer shall make a joint condition survey. Immediately following the survey, the Contractor shall prepare a brief report including a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned storage area and access route(s), as applicable. This survey report shall be signed by both the Contractor and the Engineer upon mutual agreement as to its accuracy and completeness. The Contractor shall protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference which their preservation may cause to the Contractor's work under the Contract.

Environmental Assessment of Contract Deviations

Any deviations, requested by the Contractor, from the drawings, plans and specifications which may have an environmental impact will be subject to approval by the Engineer and may require an extended review, processing, and approval time. The Engineer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Engineer determines that the proposed alternate method will have an adverse environmental impact.

Notification

The Engineer will notify the Contractor in writing of any observed noncompliance with the Government environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. The Contractor shall, after receipt of such notice, inform the Engineer of the proposed corrective action and take such action when approved by the Engineer. The Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions the Engineer may take under the Contract.

EXECUTION

The Contractor shall be responsible for obtaining and complying with all environmental permits and commitments required by the Government environmental laws and regulations.

Land Resources

The Contractor shall confine all activities to areas defined by the drawings and specifications. Prior to the beginning of any construction, the Contractor shall identify any land resources to be preserved within the work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without approval. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. The Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following Sub-Clauses. Stone, soil, or other materials displaced into uncleared areas shall be removed by the Contractor.

Work Area Limits

Prior to commencing construction activities, the Contractor shall mark the areas that need not be disturbed under this contract. Isolated areas within the general work area which are not to be disturbed shall be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, any markers shall be visible in the dark. The Contractor's personnel shall be knowledgeable of the purpose for marking and/or protecting particular objects.

Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques. The Contractor shall restore landscape features damaged or destroyed during construction operations outside the limits of the approved work area.

Erosion and Sediment Controls

The Contractor shall be responsible for providing erosion and sediment control measures in accordance with Government laws and regulations. The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's construction activities. The area of bare soil exposed at any one time by construction operations should be kept to a minimum. The Contractor shall construct or install temporary and permanent erosion and sediment control best management practices which may include, but not be limited to, vegetation cover, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. Any temporary measures shall be removed after the area has been stabilized.

Contractor Facilities and Work Areas

The Contractor's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Engineer. Temporary movement or relocation of Contractor facilities shall be made only when approved. Erosion and sediment controls shall be provided for on-site borrow and spoil areas to prevent sediment from entering nearby waters. Temporary excavation and embankments for plant and/or work areas shall be controlled to protect adjacent areas.

Water Resources

The Contractor shall monitor construction activities to prevent pollution of surface and ground waters. Toxic or hazardous chemicals shall not be applied to soil or vegetation unless otherwise indicated. All water areas affected by construction activities shall be monitored by the Contractor. For construction activities immediately adjacent to impaired surface waters, the Contractor shall be capable of quantifying sediment or pollutant loading to that surface water when required by concerned Government Agencies.

Cofferdams, Diversions, and Dewatering Operations

Construction operations for dewatering and removal of cofferdams shall be controlled at all times to maintain compliance with existing Government Water Quality standards and designated uses of the surface water body.

Stream Crossings

Stream crossings shall allow movement of materials or equipment without violating water pollution control standards of the Government.

Air Resources

Equipment operation, activities, or processes performed by the Contractor shall be in accordance with all air emission and performance laws and standards of the Government. The Contractor shall provide temporary ventilation system for working inside the grouting and inspection gallery until the permanent ventilation system, as specified in Section 22 – Ventilation System for Grouting and Inspection Gallery, is installed and commissioned.

Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphaltic batch plants; shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards of the Government to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. The Contractor must have sufficient, competent equipment available to accomplish these tasks. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs. The Contractor shall comply with all the Government Visibility Regulations.

Odors

Odors from construction activities shall be controlled at all times. The odors shall not cause a

health hazard and shall be in compliance with Government regulations and/or ordinances.

Sound Intrusions

The Contractor shall keep construction activities under surveillance and control to minimize environment damage by noise. The Contractor shall comply with the provisions of the Government, rules.

Burning

Burning will not be allowed on the project site unless specified in other sections of the specifications or authorized in writing by the Engineer. The specific time, location, and manner of burning shall be subject to approval. Fires shall be confined to a closed vessel, guarded at all times, and shall be under constant surveillance until contents have burned out or have been extinguished. Burning shall completely reduce the materials to ashes.

Chemical Materials Management and Waste Disposal

Disposal of wastes shall be as directed below, unless otherwise specified in other sections and/or shown on the drawings.

Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. Handling, storage, and disposal shall be conducted to prevent contamination. Segregation measures shall be employed so that no hazardous or toxic waste will become co-mingled with solid waste.

Chemicals and Chemical Wastes

Chemicals shall be dispensed ensuring no spillage to the ground or water. Periodic inspections of dispensing areas to identify leakage and initiate corrective action shall be performed and documented. This documentation will be periodically reviewed by the Government. Chemical waste shall be collected in corrosion resistant, compatible containers. Collection drums shall be monitored and removed to a staging or storage area when contents are within 150 mm of the top. Wastes shall be classified, managed, stored, and disposed of in accordance with the Government laws and regulations.

Contractor Generated Hazardous Wastes/Excess Hazardous Materials

Hazardous wastes are as defined by applicable regulations of the Government. The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing. The Contractor shall segregate hazardous waste from other materials and wastes, shall protect it from the weather by placing it in a safe covered location, and shall take precautionary measures such as berming or other appropriate measures against accidental spillage. The Contractor shall be responsible for storage, describing, packaging, labeling, marking, and placarding of hazardous waste and hazardous material in accordance with the Government laws and regulations. The Contractor shall dispose of hazardous waste in compliance with the Government laws and regulations. Spills of hazardous or toxic materials shall be immediately reported to the Engineer Cleanup and cleanup costs due to spills shall be the Contractor's responsibility.

Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spill and evaporation. Fuel, lubricants and oil shall be managed and stored in accordance with all Government laws and regulations. Used lubricants and used oil to be discarded shall be stored in marked corrosion-resistant containers and recycled or disposed in accordance with the Government laws and regulations.

Waste Water

Disposal of waste water shall be as specified below.

(a) Waste water from construction activities, such as onsite material processing, concrete curing, foundation and concrete clean-up, water used in concrete trucks, forms, etc. shall not be allowed to enter water ways or to be discharged prior to being treated to remove pollutants. The Contractor shall dispose of the construction related waste water in accordance with all the Government laws and regulations or by collecting and placing it in a retention pond, where suspended material can be settled out and/or the water can evaporate to separate pollutants from the water. The site for the retention pond shall be coordinated and approved by the Engineer. The residue left in the pond prior to completion of the project shall be removed, tested, and disposed of from project site in accordance with the Government laws and regulations. The area shall be backfilled to the original grade, top-soiled and seeded/sodded.

(b) For discharge of groundwater, the Contractor shall obtain a Government permit specific for pumping and discharging ground water prior to surface discharging. Land application shall be in accordance with all Government laws and regulations for pumping and land applying ground water.

Recycling and Waste Minimization

The Contractor shall participate in the Government sponsored Recycling Programs. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project.

Non-Hazardous Solid Waste Diversion Report

The Contractor shall maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris. The Contractor shall submit a report to the Engineer on the first working day after each fiscal year quarter, starting the first quarter that non-hazardous solid waste has been generated. The following shall be included in the report:

(a) Construction and Demolition (C&D) Debris Disposed in cubic meters.

(b) Construction and Demolition (C&D) Debris Recycled in cubic meters.

(c) Total C&D Debris Generated in cubic meters.

Historical, Archaeological, and Cultural Resources

If during excavation or other construction activities any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. Resources covered by this paragraph include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rock or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human activities. Upon such discovery or find, the Contractor shall immediately notify the Engineer so that the appropriate authorities may be notified and a determination made as to their significance and what, if any, special disposition of the finds should be made. The Contractor shall cease all activities that may result in impact to or the destruction of these resources. The Contractor shall secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources.

Biological Resources

The Contractor shall minimize interference with, disturbance to, and damage to fish, wildlife, and plants including their habitat. The Contractor shall be responsible for the protection of threatened and endangered animal and plant species including their habitat in accordance with Government laws and regulations.

Integrated Pest Management

In order to minimize impacts to existing fauna and flora, the Contractor, through the Engineer, shall coordinate with the concerned government agency to give opportunity to their representative to be present at all meetings concerning treatment measures for pest or disease control and during application of the pesticide.

Pesticide Delivery and Storage

Pesticides shall be delivered to the site in the original, unopened containers bearing legible labels and the manufacturer's registered uses. Pesticides shall be stored according to manufacturer's instructions and stored under lock and key when unattended.

Qualifications

For the application of pesticides, the Contractor shall use the services of a subcontractor whose principal business is pest control. The subcontractor shall be licensed and certified in the Governorate where the work is to be performed.

Pesticide Handling Requirements

The Contractor shall formulate, treat with, and dispose of pesticides and associated containers in accordance with label directions and shall use the clothing and personal protective equipment specified on the labeling for use during all phases of the application. Material Safety Data Sheets (MSDS) shall be available for all pesticide products.

Application

Pesticides shall be applied by a Government Certified Pesticide Applicator in accordance with the Government restrictions and recommendation. The Certified Applicator shall wear clothing and personal protective equipment as specified on the pesticide label. Water used for

formulating shall only come from locations designated by the Engineer. The Contractor shall not allow the equipment to overflow. Prior to application of pesticide, all equipment shall be inspected for leaks, clogging, wear, or damage and shall be repaired prior to being used.

Previously Used Equipment

The Contractor shall clean all previously used construction equipment prior to bringing it onto the project site. The Contractor shall ensure that the equipment is free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds.

Maintenance of Pollution Facilities

The Contractor shall maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

Military Munitions

In the event the Contractor discovers or uncovers military ammunitions as defined the Contractor shall immediately stop work in that area and immediately inform the Engineer.

Training of Contractor’s Personnel

The Contractor's personnel shall be trained in all phases of environmental protection and pollution control. The Contractor shall conduct environmental protection/pollution control meetings for all Contractor personnel prior to commencing construction activities. Additional meetings shall be conducted for new personnel and when site conditions change. The training and meeting agenda shall include: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection / pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

Post Construction Cleanup

The Contractor shall clean up all areas used for construction in accordance with Sub-Clause 4.23 of the Conditions of Contract. The Contractor shall, unless otherwise instructed in writing

by the Engineer, obliterate all signs of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed area shall be graded, filled and the entire area seeded unless otherwise indicated.

MEASUREMENTS AND PAYMENT

Payment

No separate payment will be made for work covered under this section. The Contractor shall be responsible for payment of fees associated with environmental permits, application, and/or notices obtained by the Contractor. (The Contractor shall be responsible for payment of all fines / fees for violation or non-compliance with the Government laws and regulations).

All costs associated with this section shall be deemed covered in the rates quoted in the Bill of Quantities & included in the Contract Price.

SECTION 16
DISMANTLING OF EXISTING STRUCTURES

SECTION 16 DISMANTLING OF EXISTING STRUCTURES ii

16.1 Scope of Work ii
16.2 General ii
16.3 Measurement and ii
16.4 Payment ii
16.5 Backfill of Exploratory Bore Holes ii

DISMANTLING OF EXISTING STRUCTURES

Scope of Work

The work to be done under item - Dismantling of existing structures consists of dismantling of existing structures required to be dismantled such as fall structure etc. Whether in part or as a whole as shown in drawings or specified or as directed by the Engineer.

General

(1) The dismantled material shall be removed and disposed off within the right of way as directed by the Engineer.

(2) The Contractor to the extent possible shall extract salvage material without any loss. The Employer shall require that material should be stored typewise properly and handed over to him.

(3) Useful retrieved material like stone and Bricks shall be removed, stacked at locations as directed by the Engineer.

Measurement and

Payment

Measurement for payment for dismantling of structures, stone, Brick masonry and concrete shall be made as per B.O.Q.

Backfill of Exploratory Bore Holes

21.4 Grouting with suitable grout starting from bottom to top of backfilling of exploratory bore holes.

SECTION 17
CLEANING AND CLEAN-UP

SECTION 17 CLEANING AND CLEAN-UP..... ii

17.1 Scope of Work..... ii
17.2 Clean-up during Construction ii
17.3 Final Cleaning of Structures and Equipments ii
17.4 Final Site Clean-up..... ii
17.5 Measurement and Payment.....iii

CLEANING AND CLEAN-UP

Scope of Work

The work to be done under Cleaning and Clean-up covers furnishing of all labour, materials, equipment and services and performing all operations necessary for and incidental to clean-up during construction and final cleaning of structures and the site prior to acceptance of the Works by the Employer as specified herein and elsewhere in the Contract.

Clean-up during Construction

It is required that the entire site be kept in a neat and orderly condition and the Engineer may, at any time during construction, order a general clean-up of the site as part of the work under this section.

Contractor shall dispose of waste, trash, and debris in an acceptable manner, in accordance with applicable laws and as prescribed by the Engineer or authorities having jurisdiction. Burying of waste material on the site and/or burning of trash and debris on the site will not be permitted, unless approved by the Engineer.

Location of dump of trash and debris and its haul will be Contractor’s responsibility.

Final Cleaning of Structures and Equipments

Prior to final inspection by the Engineer and Employer and after all construction work is essentially complete, the Contractor shall thoroughly clean structures and equipment as required or appropriate.

The Contractor shall follow the recommendations of the manufacturers of materials, equipment and items to be cleaned, for all cleaning and other recommended treatments.

Final Site Clean-up

Also prior to final inspection, the Contractor shall thoroughly clean the entire site and put it into a neat, acceptable condition. He shall remove from the entire site all construction waste and unused materials, loose rock and stones, waste earth and debris of any description resulting from the work.

Measurement and Payment

No separate measurement or payment will be made for work required under this Section. All costs in connection with the work specified herein shall be included in the various items of work in the Bill of Quantities.

SECTION 18

GENERAL REQUIREMENTS

SECTION 18 CONTRACT CLOSE-UP ii

18.1 Scope of Work ii
18.2 Close-up Schedule and Procedure ii

CONTRACT CLOSE-UP

Scope of Work

The work to be done under Contract Close-up covers performing all operations necessary for and incidental to closing up the Works or portions of the Works and assisting in the Employer's final inspection.

Close-up Schedule and Procedure

Requirement Preparatory to Final Inspection:

(a) The Contractor shall request the Engineer/Employer to perform a preliminary final inspection for the purposes of determining the state of completion. He shall notify the Engineer and Employer at least seven (7) days in advance of when this inspection is to be performed. From the information gathered from this inspection, the Engineer will prepare a "punch list" of work to be performed, corrected, or completed before the Works will be accepted. All work on the "punch list" shall be completed by the Contractor prior to final inspection.

(b) All temporary facilities shall be removed from site, unless directed otherwise by the Engineer.

(c) The site and all applicable appurtenances and improvements shall be cleaned as specified.

(d) All operating instructions for equipment shall be properly mounted and posted as specified or required.

(e) All guarantees and warranties shall be submitted to the Employer in care of the Engineer, as specified in the various sections of the Specifications, along with required or printed maintenance instructions and manuals.

1) Final Inspection

(a) After all requirements preparatory to the final inspection have been completed as hereinbefore specified, the Contractor shall notify the Engineer and Employer to perform the final inspections.

(b) The Contractor, or his authorized Representative, shall accompany the Engineer/Employer on the final inspection, together with any Subcontractors that the Engineer or Employer may request to be present.

(c) If the works have been completed in accordance with the Contract Documents, and no further corrective measures are required the Engineer will issue a Taking-over certificate and the Employer will accept the Works. Subject to the provisions of Clause 48 of the Conditions of Contract.

(d) If the works have been substantially completed in accordance with the Contract Documents, and only minor corrective measures are required, the Employer will conditionally accept the Works and the Engineer will issue a Taking-over Certificate based upon the Contractor's assurance that the corrective measures will be completed within the shortest practicable time within the Defects Liability Period-Clause 49 of the Conditions of Contract.