



**GOVERNMENT OF
THE REPUBLIC OF THE GAMBIA**

TECHNICAL SPECIFICATION

Construction of Rural Roads in The North Bank of the Gambia

Client: The Government of the Gambia

**Implementing Agency: United Nations Development
Programme (UNDP)**

Project:

Lot 1

Construction of Farafenni – Balingho Road (11.2km)

Lot 2

**Construction of Farafenni – Medina Sabakh, Darsilameh Chala
– Sare Jamgido and Dibba Kunda - Mbapa Road (8.9Km)**

Lot 3

**Construction of the Sara Kunda - Kani Kunda and Njain Sanjal
- Samba Soto Road (9.1km)**

Volume II

Technical Specification

Issued on November, 2020

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PROJECT SPECIFICATIONS

The Project Specifications consist of the Standard Specifications referred to as Part I, and the Particular Specifications referred to as Part II.

The Standard Specifications are linked with the Particular Specifications by the consecutive numbering of the Sections, so that Parts I and II together comprise the Project Specifications covering the material, workmanship and quality requirements of the Works. In case of any inconsistency between the Specifications contained in Part I and II, the Particular Specifications contained in Part II shall prevail over those in Part I.

The Contractor is deemed to have fully read, understood and incorporated the required Project Specifications into his Tender Submission.

IMPORTANT: In case of conflict between UNDP General Terms and Conditions for Works and the contents of these technical specifications, the UNDP General Terms and Conditions for Works shall prevail.

PART I - STANDARD SPECIFICATIONS



SERIES 0

GENERAL

SERIES 0—GENERAL

1. TERMS AND DEFINITIONS

2. Abbreviations

Wherever the following abbreviations are used in the Specifications or on the Drawings, they are to be construed the same as the respective expressions represented.

AASHTO	:	American Association of State Highway and Transportation Officials.
ASTM	:	American Society for Testing and Materials
BS	:	British Standards
ACI	:	American Concrete Institute

3. Definitions

Wherever in these Specifications or elsewhere in the Contract, the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows:

Addendum

A written amendment or revision to the Contract issued to Tenderers prior to the final date and time for submission of Tenders indicated in Division 3 - Instructions to Tenderers or to the Contractor at any stage during the construction period.

Ballast

Gravel, broken stone, granular materials, etc., to give added stability.

Bridge

A structure, including supports, erected over a depression or an obstruction such as water, a road, or a railway, and having a track or passageway for carrying traffic or other moving loads.

The length of a bridge structure is the overall length measured along the line of survey stationing, back to back of back-walls of abutments.

The roadway width of a bridge structure is the clear width measured at right angles to the longitudinal

centerline of the bridge between the bottom of kerbs or in the case of multiple height of kerbs, between the bottoms of the lower risers.

The bridge width is the clear width measured at right angles to the longitudinal centerline of the bridge between the outer edges of the bridge inclusive of any walkways.

Certificate of Guarantee

A signed statement by a person having legal authority to bind a company or supplier to its product. Such certificate shall state that the material specifications and test results are in compliance with the specified requirements of the pertinent AASHTO, ASTM, BS and/or other designations.

Detour or Bypasses

A temporary road, adequately maintained, for the use of the travelling public through the project area.

Drawings

Plans, profiles, typical cross sections, and supplemental drawings, or exact reproductions thereof forming part of the Contract Documentation, which show the location, character, dimensions, and details of the Works.

Employer

As defined in the Appendix to Tender.

False Work

Any temporary structure used to support a permanent structure while it is not self-supporting.

Forms and Form Work

The section of the temporary works used to give the required shape and support for the poured concrete. It consists primarily of sheeting material, such as wood, plywood, metal sheet or plastic sheet, in direct contact with the concrete and joints or stringers that directly support the sheeting.

Government

The entity represented by the Employer.

Intentions of Terms

In order to avoid cumbersome and confusing repetition of expressions in these Specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned", it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer".

The phrase "or equal" shall be construed to mean that material or equipment will be acceptable only when composed of parts of equal quality, or equal workmanship and finish, designed and constructed to perform or accomplish the desired result as efficiently as the named brand, pattern, grade, class, make or model.

Laboratory

The field testing laboratories or any other testing laboratories outside the site which may be designated by the Engineer.

Materials

Any substance specified for use in the construction of the Works and its appurtenances.

Pavement Structure

The combination of subbase, base, and surfacing placed on the upper layer of embankment to support the traffic load and distribute it to the road bed.

Profile Grade Line

The trace of a vertical plane intersecting the top surface of the proposed surfacing, along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

Project

The "Works" as defined in the Contract Documents for which these specifications are applicable.

Reasonably Close Conformity

Reasonably close conformity means compliance with reasonable and customary manufacturing and construction tolerances where working tolerances are not specified. Where working tolerances are specified, reasonably close conformity means compliance with such working tolerances. Without detracting from the complete and absolute discretion of the Engineer to insist upon such tolerances as establishing reasonably close conformity, the Engineer may accept variations beyond such tolerances as reasonably close conformity where they will not materially affect the value or utility of the work and the interests of the Employer.

Right of Way

The area of land reserved for the construction and maintenance of the road and for the accommodation of utility services.

Road (Highway)

A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

Roadbed

The graded portion of a road usually considered as the area between the intersection of top and side slopes, upon which the sub-base, base surfacing, shoulders, and median are constructed.

Road Reserve

Same as Right of Way. The road reserve width may be reduced in built-up areas, plantations or similar and increased in high embankments, deep cuttings or where special drainage conditions require, at the decision of the Engineer.

Roadside

A general term denoting the area adjoining the outer edge of the roadway.

Roadway

The portion of a road within the limits of construction, also called road prism.

Scaffold

A temporarily provided structure that provides access, or on or from which person work, or that is used to support material, plant or equipment.

Shop Drawings

As defined in the Conditions of Contract. Same as Working drawings.

Shoulder

The portion of the roadway contiguous with the travelled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Structures

Bridges, culverts, catch basins, catch pits, drop inlets, retaining walls, cribbing, manholes, end walls, buildings, sewers, service pipes, under drains, foundation drains and other features which may be encountered in the Works and not otherwise classed herein.

Sub-Grade

The top 30 cm of embankment in case of fill and the top 15 cm of excavation in case of cut upon which the pavement structure and shoulders are constructed.

Substructure

All of that part of the bridge structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings or rigid frames, together with the backwalls, wingwalls and wing protection railings.

Superstructure

The entire structure except the substructure.

Titles (or Headings)

The titles or headings of the sections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

Tower

A composite structure, usually tall, used principally to carry vertical loading.

Travelled Way

The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Working/Shop Drawings

Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

4. Limits Of Construction

All permanent works shall be within the road reserve unless otherwise shown on the Drawings or directed by the Engineer.

The road reserve is defined as 15 m from centre line of the carriageway each side of the road.

5. Precedence Of Documents

In the event of any conflict between the Documents they shall govern each other in the order as set forth in the Contract Agreement and Clause 6 of the Conditions of Contract.

In case of conflict between the AASHTO and ASTM specifications and methods of sampling and testing, AASHTO shall govern.

6. Non-applicable Sections

Any sections in the Specifications which relate to work or materials not required by the Works shall be deemed to be non-applicable.

7. Cited Specifications

Unless otherwise specified, all references to methods of test or specifications of AASHTO, ASTM, BS, and any others shall be construed to mean those methods of test or specifications which have been most recently adopted and published prior to the date of the Contract. In case of conflict between the different codes and specifications, the precedence of the specs shall be as follows:

1. AASHTO
2. ASTM
3. BS
4. Others

The Contractor shall at his own expense provide the Engineer with two copies of the latest editions of the following books:

AASHTO

"Standard Specifications for Transportation Materials and Methods of Sampling and Testing", Parts I and II.

American Standards for Testing Materials (ASTM)

"Annual Book of Standards", Parts 4, 9, 10 and 1

British Standards (BS)

Appropriate and designated British Standards as specified in the relevant specifications.

CESMM3

Civil Engineering Standard Method of Measurement - The Institution of Civil Engineers - London, UK.

10. CONTROL OF WORKS & MATERIALS

11. General

All work performed shall be in reasonably close conformity (as hereinbefore defined) with the lines, grades, cross sections, dimensions and tolerances shown on the Drawings or indicated in the Specifications, and all materials furnished shall comply with the quality requirements of the Contract.

In the event that discrepancies or errors are detected in the drawings, the Contractor is to highlight the same to the Engineer or his representative in the form of a query before the commencement work on the said item or section of the project.

The Contractor shall be responsible for locating and producing materials adhering to the Specifications. The exploration and development of local materials sources and the costs attached to thereof shall also be the responsibility of the Contractor.

12. Work Program

12.1 Program to be furnished

The Contractor shall, within the period stated in the **Appendix to Tender**, submit to the Engineer, for his approval, a detailed program in the form of a CPM network diagram projecting the Contract Documents and conforming with the accepted Provisional Program of Works forming part of the Contractor's Tender. The program of works shall take into consideration the holidays, construction shut down periods, and the rainy season.

The detailed program shall be prepared using an approved micro-computer based software program. The degree of detail required is as follows:

- a) The total quantities or work scope, monthly production rate, duration, sequence and logic links between major activities and any other activities or group of activities which comprise the Works (both Temporary and Permanent) necessary to define the critical path and logic of the program;
 - b) The planned date for Substantial Completion of the Works;
 - c) The Critical path for the Works;
 - d) Resources planned to be used for each activity in the form of labour and equipment (i.e., crew composition and number of crews);
 - e) A procurement schedule for materials to be approved especially for those materials requiring long term manufacturing and delivery durations (e.g., road signs, guardrails, etc.). The procurement schedule shall include proposed submission dates of samples or documentation to the Engineer, dates for approval, manufacture period, delivery period(s) and means of transport, and proposed arrival date to site. The material procurement schedule shall be coordinated with the respective activity dates stipulated in the Clause 14 program.
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A separate schedule shall be provided by the Contractor for the production of fill and pavement materials (i.e., opening of borrow pits, material extraction period and stockpiling), surfacing material (i.e., basalt) and concrete aggregates. The schedule shall take into consideration provision for sufficient material availability at any time so as not to stop the respective activity.

- f) Schedule of submissions (i.e., Drawings, materials, Sub-Contractors, etc.) pursuant to Section 28.4;
- g) Site investigation activities schedule;
- h) Temporary Works schedule (Mobilization);
- i) An activity "Input by Employer/Engineer" stipulating any approval, data or activity required to be performed by the Employer or the Engineer (*e.g.*, land appropriation) in the form of milestones before any activity to be performed;
- j) A chart of the principle quantities of work for each work element forecasted for execution monthly;
- k) Reasons for any changes to timing, work order, method, or resources from the Preliminary Works program submitted at the time of the Tender;
- l) Detailed Cash flow estimate, in monthly intervals, of all payments to which the Contractor will be entitled under the Contract;
- m) Holidays, construction shut down periods, rainy season should be incorporated and clearly shown on the submitted program; and
- n) General Description of the methods of execution as defined in Sub-Clause 14.1 of the Conditions of Particular Application.

When directed, the Contractor shall promptly furnish a detailed sub-program covering particular sections of the Permanent Works.

Within 15 days from the approval of the detailed program, the Contractor shall furnish the Engineer with 2 copies in paper (hard copy) in the form and content as specified in **SubSection 12.3**. In addition, the Contractor is required to furnish the Engineer with a copy of the software used and a copy of the approved program on diskette.

12.2 Updated & Revised Programs

(a) Updated Programs

The Contractor shall submit to the Engineer an updated construction program and cash flow current to the 25th day of the month. This Sub-Section shall be read in conjunction with **Clause 14 of Division 4 - Conditions of Contract**.

The submission shall be in the form of a bar chart pursuant to Sub-Section 12.3 and shall show any changes to project completion date and critical activities.

(b) Revised Programs

If at any time it should appear to the Engineer that the actual progress of the Works does not conform to the program and that the handover of the project will be delayed, the Contractor, upon the instruction of the Engineer, shall submit a revised program of works in the format of the earlier submitted detailed program highlighting the modifications performed to ensure completion of the works within the stipulated time of Completion.

All changes to the original Clause 14 program of work will have to be highlighted when submitting the above mentioned updated or revised programs inclusive of reasons behind such changes. A copy on disk of all above mentioned programs of work to be handed over to the Engineer upon submission of the work programs.

This Sub-Section shall be read in conjunction with **Clause 14 of Division 4 - Conditions of Contract**.

12.3 Program Submission Specifications

The submitted program shall include the following:

➤ Bar Chart & Network

The bar chart shall show the following:

- a. Column Indicating the description and identification of the activity;
 - b. Column indicating the production rate of the activity;
 - c. Column indicating the planned early start date of the activity;
 - d. Column indicating the planned early completion of the activity;
 - e. The listing of activities should be in sequence of operation;
 - f. In case of different sections, the same has to be clearly stipulated in the activities as a main activity heading;
 - g. Schedule in the form of bars indicating the following:
-

1. The early start and early completion as stipulated in items c & d in solid line;
 2. The float for each activity as dotted lines;
 3. Milestones as required;
- h. A heading indicating the name of the project, and the program type. In the case of the submitted program being the Clause 14 program, the same has to be clearly indicated as "Clause 14 Program". In case of updated program, the term "Program Update" should be clearly highlighted along with the relevant date of update. In case of Revised program, the term "Revised Program" should be included with the revision no. and date performed clearly highlighted.
- i. In case of updates or revisions, the bar chart shall incorporate the "as built" data for the start and completion of activities in different colour than that of the "Planned".

A separate program network shall be submitted in the case of the first submission of Clause 14 program and any subsequent revisions to the performed (i.e., Revised Programs). The submission requirement for the network shall not be applicable for the monthly updates to be performed by the Contractor.

The program network shall clearly show the co-ordination and the inter-relation amongst all activities of the different trades, services and furnishings in the project in the form of arrow connections (Start to Start, Start to Finish, Finish to Finish, Finish to Start). The lag (waiting period if any) shall be clearly stipulated for each connection. Networks should be drawn with progress from left to right.

➤ **Size of Bar Chart and Network**

The submitted bar chart shall be at least in A3 paper size.

The size of the drawing sheets generally should not exceed the size of the drawings of the project and it will be much more preferable to reduce the size of the network to the smallest size possible. When more than one sheet is required to produce the network, these drawing sheets should be numbered in a sequential manner in the progress of the networks and the connections between these separate networks should be indicated by the use of interface events/activities which are common to the related networks.

Schematic plans and principal sections of the project, using a reasonable scale, should be indicated on each drawing sheet of the networks.

➤ **Durations**

The duration to be covered by the program shall be the Contract duration as specified in the **Appendix to Tender**.

b)

The Contractor's attention is drawn to the duration and the lags of some activities which are mentioned in the Contract Documents the manufacturer's instructions for installations, and time allowed for submission of shop drawings and samples of materials.

➤ **Resources**

A separate resource program is to be submitted as part of the initial submission of the Clause 14 program and any subsequent revisions to be done to the program. It is not a requirement to submit resource program along with Program Updates unless specifically instructed by the Engineer.

The resource program shall divide the project manpower and equipment into the respective activities to be performed (i.e., to be coordinated with the main Bar Chart activities). The program shall show the mobilization of the resource, the duration on each activity, the movement of the resource from one activity to another, the average daily production and the date expected for its demobilization.

The average rate of production of each team of workers in addition to each type of equipment may be checked by the Engineer and, where manpower or equipment do not produce the rate proposed by the Contractor in the work program, the Engineer will direct the Contractor to secure additional equipment or manpower based on the actual production on site. All equipment of a type on site, whether operational or not, shall be considered in computing average production.

In cases where equipment cannot be rated by a production average, the Engineer will determine its adequacy by the schedule of operations indicated for the equipment in the work program. If the Engineer's analysis of the work program reveals an equipment shortage, he will direct the Contractor to secure additional equipment of the type(s) indicated without additional cost.

The Contractor may, within seven (7) days of receipt of the notice from the Engineer to secure additional equipment, propose an alternate solution to the Engineer for his approval. The Engineer will approve or reject the Contractor's alternate proposal within seven (7) days of receiving it. The Engineer's written approval of the Contractor's alternate proposal shall automatically rescind the notice to secure additional equipment.

If the Engineer rejects the alternate proposal, the Contractor shall, within thirty (30) days of the receipt of the original notice to secure additional equipment, produce the equipment on site or purchase orders acknowledged by suppliers together with the suppliers estimated shipping date and the estimated date of arrival of the equipment in the Republic.

12.4 Progress Monitoring

During the course of the project, site progress meetings shall be held on weekly and monthly basis.

Weekly site meetings shall be held between the Engineer or his representative and the Contractor for the purpose of reviewing and controlling the Contractor's and Sub-Contractor's progress to ensure compliance with the approved program of work.

The Contractor shall submit to the Engineer, 2 days before the date of the scheduled progress meeting, the following information: -

- i. A list of the activities which have been completed.
- ii. A list of those activities currently in progress with an estimate of the time required for the completion.
- iii. A list of any variation in starting dates and durations of outstanding activities from planned dates and times.
- iv. Measures to be taken to rectify the delays from the planned dates.

On the other hand, the monthly site meetings shall be held between all parties of the Contract (i.e., Employer, Engineer or his representative and the Contractor) and other parties that the Employer or the Engineer require to attend.

At every such assigned meeting, the Contractor shall be requested to present specific information on the physical progress of the Works, including executed volume of works, material procurement, revisions and / or updates of the Program of Works as per Clause 14, showing planned and actual progress for all items of work, status of variation orders (if any), status of claims (if any), status of project interim certificates and overall finances, and any problems encountered that may hinder the works and require the attention of the participants. A formal record of the minutes of these meetings, stating the action to be undertaken by the specific party, shall be prepared by the Engineer and signed by all attendants.

13. Daily Reports

The Contractor is required to present Daily Reports showing the works performed on the preceding day. These reports are to be submitted on daily basis to the Engineer. Such report such cover the climate (i.e., rainy, sunny, etc.), outside temperature, rain gage readings, detailed works in terms of completion; in progress; or stopped, work hindrance encountered

due to obstructions, Engineer's approval or Client, plant available on site showing its working hours, materials consumed, labour available and Comments showing any statements to be made by the

Contractor.

This Section shall be read with **Clause 35 of Division 4 - Conditions of Contract**.

14. Construction Methods And Equipment

The Contractor is himself solely and fully responsible for selecting and using methods and equipment which will produce work in conformity with the requirements of the Contract. The Contractor is free to use any methods or equipment that he demonstrates, to the satisfaction of the Engineer, will accomplish the work in conformity with the requirements of the Contract.

Before the commencement of any work item, the Contractor is required to submit for the Engineer's approval **two copies** of the detailed procedure and methodology to be followed in the implementation of any work item highlighting the material to be used (i.e., type, quality, and source) and working crews (i.e., composition covering labour and equipment and production rates) taking into consideration adherence to Contract documents. The format of the method statement shall be agreed with the Engineer before submission. In the event that the Engineer will have comments on the submitted work method, these comments will be relayed to the Contractor for his attention. No commencement of any work item will be permitted until the Engineer or his representative has given the 'no objection' to the submitted work procedure.

In the case of repetitive work, the Contractor is to only highlight the changeable items such as type of materials.

The Contractor shall at all times employ sufficient supervision, labour and equipment for prosecuting the several classes of work to full completion in the manner and time required by the Contract.

All workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

All equipment which is used on the Works shall be of sufficient size and in such mechanical condition as to meet the requirements of the Specifications and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway or adjacent property will result from its use.

If, after use of the methods or equipment selected by the Contractor, the Engineer determines that the work produced does not meet the Contract requirements, the Contractor, upon the written instructions of the Engineer, shall discontinue the use of the method or equipment and shall complete the remaining construction with alternative methods and equipment which produce work meeting said requirements. The Contractor shall remove the deficient work and replace it with work of the specified quality or take such other corrective action as the Engineer may direct.

This Section shall be read in conjunction with **Clause 8 of Division 4 - Conditions of Contract**.

15. Sampling and Testing

All materials to be incorporated into the Works shall comply with the quality requirements of the Contract and meet the appropriate standards and specifications as required by the Contract. To ensure their adherence, all materials shall be inspected, tested and accepted by the Engineer before incorporation into the Works. The Engineer is also at liberty to request testing of the materials after incorporation in the Works. Should the materials, after incorporation, be found not adhering to the specifications, the Engineer shall instruct its removal and the work be redone at the Contractor's own cost.

Material samples shall be taken by the Contractor in the presence of an authorized representative for the Engineer or as otherwise directed by the Engineer and the cost of all materials taken as samples for testing shall be borne by the Contractor. Samples shall be jointly tested by the Engineer and the Contractor and copies of the test results shall be kept by both parties.

All shipments of materials must be accompanied by a Manufacturer's Certificate of Guarantee or a test certificate from an approved independent laboratory when delivered to the Site. The independent laboratory shall be approved by the Engineer before any materials are submitted for test. However, all materials delivered to the Site are subject to additional laboratory testing when requested by the Engineer, even though the materials are accompanied by a Certificate of Guarantee or laboratory test certificate. All costs in connection with Certificates of Guarantee of laboratory tests and certificates shall be borne by the Contractor.

All materials not conforming to the requirements of the Contract at the time they are used shall be considered as unacceptable and all such materials also they will be rejected and shall be removed immediately from the Site unless otherwise instructed by the Engineer. No rejected material, the defects of which have been corrected, shall be used until approval has been given.

Any work in which untested and unaccepted materials are used without approval or written permission of the Engineer shall be performed at the Contractor's risk and may be considered unacceptable, unauthorized and will not be paid for.

16. Handling and Storage of Materials

The content of this Sub-Section shall be considered as the general specifications for the handling and storage of materials and shall be read in conjunction with the material handling and storage items within the specifications related to the work elements in particular. Should any discrepancy arise between the two, the particular specifications shall prevail.

All materials shall be handled in such manner as to preserve their quality and fitness for the Works. Aggregates shall be transported from the storage site to the Works in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities and qualities of materials intended for incorporation in the Works as loaded, and the quantities and qualities as actually received at the place of operations.

Materials shall be so stored as to assure the preservation of their quality and fitness for the Works. Stored materials, even though approved before storage, may again be inspected prior to their use in the Works. Stored materials shall be located so as to facilitate their prompt inspection. Materials shall not be stored on the right-of-way except where and as permitted by the Engineer. Stockpiling of aggregate material within the right-of-way shall be confined to such authorized areas as maybe approved by the Engineer. Where stockpiling is done outside the roadway on Government or private property, the site shall be abandoned immediately upon completion of the utilization of the stockpile material and the natural surface shall then be restored as nearly as possible to the original condition by the Contractor at his own expense and to the satisfaction of the Engineer.

16.1 Explosives

In no case shall the Contractor store explosives on the Site without prior approval of the Engineer. However, should the Engineer grant his permission for the storage of explosives on site, the below mentioned specifications are to be read in conjunction with **Clause 79 of Division 4 - Conditions of Contract**.

- Storage shall be to the satisfaction of the Engineer and, in general, not closer than 300 m from the road or from any building or camping area;
 - The Contractor shall store all explosives in a secure manner marked clearly in English "Danger Explosives";
 - The Contractor shall keep a current inventory of all explosives and explosive devices and submit a monthly report to the Engineer, detailing the usage of all explosives by date and location.
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17. Temporary Works

The Contractor shall provide and maintain all necessary temporary works including but not limited to his site establishment, ER housing, office and laboratory facilities, temporary traffic diversions, roadways, footpaths, accesses, drains, sheet-piling, cofferdams, beams, revetments, staging, scaffolding and other temporary supports, and he shall make them safe and suitable in every respect to carry all plant required for the work or for providing access or for any other purpose connected with the Works, to the satisfaction of the Engineer. Where timber is being used for temporary works, consideration shall be given to termite attack, particularly when the temporary works are being used over a long period.

Complete details, in duplicate, of the temporary works proposed shall be submitted to the Engineer for his approval a minimum of twenty-one clear working days prior to the construction of such temporary works. No permission will be given to the Contractor to commence any permanent work until all its related temporary works have been submitted and approved by the Engineer.

The furnishing to the Engineer or the Engineer's Representative of any design for any temporary works shall not relieve the Contractor of any liability or obligation under the Contract in respect of such temporary works.

18. Notice of Operations

The Contractor shall give the Engineer in writing not less than 24 hours' notice of his intentions to commence any works to enable the Engineer to make his arrangements for the supervision of operations in the Works. This notice shall be in the form of a Request for Inspection.

The format of the "Request for Inspection" shall be as agreed with the Engineer but shall have at minimum the following elements:

- Activity Description
- Survey stations (i.e., start and end point)
- Submission date and time
- time required for inspection
- Signature of Project Manager or other authorized personnel member
- Comments, signature and time of survey inspection
- Comments, signature and time of materials inspection
- Inspection Approval (i.e., approved, approved as noted, and not approved)
- Comments and signature of Resident Engineer

He shall also give to the Engineer sufficient written notice of the preparation or manufacture at a place not on the site of any article or material to be used in the Works, whether by himself or by Sub-Contractors, stating the time and place of preparation or manufacture so that the Engineer may arrange

to make what so-ever inspections or tests he may require. Where the preparation or manufacture is taking place outside the country of the Employer as stipulated in the **Appendix to Tender**, similar notice shall also be given to the supervising consultant's head office.

19. Construction Procedures

19.1 General

The Contractor shall investigate the weight limits on the existing bridges and structures along the existing project roads in order to prevent local failure and some restrictions to the weight of construction vehicles will apply. If strengthening is required the Contractor should allow in the bill rates for any strengthening needed to maintain the flow of traffic during the Contract.

The Contractor shall be responsible for the organization, planning, documentation and transportation to site of all plant, machinery and construction items imported into the country of the Employer as stipulated in the **Appendix to Tender**. It will be assumed that the Contractor will have taken into account the facilities for lifting and transportation existing in the country of the Employer and have allowed for any additional facilities necessary to carry out the Works.

Any dredging necessary for the transportation of any items by river to the site shall be agreed with the port authorities in addition to the Engineer.

19.2 Setting Out

The Contractor is required to record and submit to the Engineer for his approval existing surface levels, both above and below water level, of any portion of the Site and Works before the surface is interfered with or the works thereon are begun. Once the agreement is obtained from the Engineer on all particulars on which the survey is to be made, such levels shall form the basis of the quantity measurement for completed work items which will be submitted in the respective interim payments.

The Contractor shall be responsible for setting out all Works including the toes of embankments, the edges of cuttings, drainage lines in accordance with the details given in the Contract Drawings or as directed by the Engineer, bridges and culvert structures (i.e., position, distances, invert levels and angles of structures). The setting out data shall be submitted for the approval of the Engineer. In the event that a discrepancy arise in the setting out data from those on the drawings, the Contractor is to query the Engineer and await the Engineer's decision on the submitted query.

The Contractor shall furnish the Engineer with one original and three copies of his setting-out notes showing clearly the applicable dimensions and quantities for the section in question. The form of these notes (i.e., cross sections pursuant to **Section 22** and printouts) shall be approved by the Engineer prior to submission and shall be supplied by and at the cost of the Contractor.

The Contractor shall be responsible for the setting out of all works based on the available designated survey beacons, benchmarks or traverse points, permanent land survey markings and special markings on or around the Site of the Works installed by Employer or the Engineer for reference purposes. Should additional survey beacons, benchmarks or traverse points be deemed necessary for the setting out or checking of the works, the Contractor shall erect the additional pegs or benchmarks at his own cost.

The Contractor shall be responsible for maintaining and protecting all reference pegs and permanent benchmarks for the duration of the works. If any of the benchmarks or traverse points, beacons, and / or permanent land survey markings are disturbed or damaged without the Engineer's consent, the Contractor is to immediately notify the Engineer of such damage. All costs related to the re-establishment of the said survey marker by the Engineer will be at the Contractor's own expense.

In order to achieve control on the final subgrade level and each pavement layer, level checks / shall be taken at 20 m intervals along the road at centre, left and right ends.

This Sub-Section shall be read in conjunction with **Clause 17 of Division 4 - Conditions of Contract**.

20. Stability Of Existing Structures

The Contractor shall ensure that the stability of the existing structures is in no way impaired as a result of his operations during the construction period. The Contractor shall submit his detailed proposals and stability calculations, in duplicate, to the Engineer for approval a minimum fourteen working days immediately prior to carrying out any work which may affect the stability of the structure. No work shall commence until the approval of the Engineer has been given in writing.

21. Preservation, Protection And Reconstruction Of Existing Facilities

All water or gas mains, public or private sewers or drains, conduits, service pipes, telephone or electricity lines and all other structures or property in the vicinity of the work, whether above or

underground shall be sustained and supported in place and protected from damage unless otherwise instructed by the Engineer to be relocated or removed. This covers all gas and water service, flow in all sewers, drains, house or inlet connections and all watercourses encountered during the progress of the work shall be maintained. The work shall be made pursuant to the relevant sections within **Series 200** of these specifications.

22. Working And Shop Drawings

Detailed working and shop drawings are required to be submitted by the Contractor but are not limited to the following items:

(a) Site Establishment

Upon commencement of the mobilization period, the Contractor is to submit four copies of the detailed site installation drawings for the Engineer's approval. These drawings should cover the Engineer's housing, offices and laboratory services such as telephone, water, and electricity mains and connections and parking areas, the Contractor's facilities such as housing, offices and finally fencing and security measures,

(b) Structural Elements

The Drawings included for all structures elements (i.e., bridges, box culverts, etc ...) serve to provide a visual representation of the Employer's requirements for these elements. As part of his duties under the Contract, the Contractor is required to perform and submit to the approval of the Engineer the following:

- (a) Two copies of the soil investigation report for each;
- (b) Four copies of the detailed shop drawings for each element in the form of dimensional plans, sections and reinforcement plans and sections; and
- (c) Reinforcement Bar Bending Schedules

The dimensional plans for culverts (both pipe and box) should clearly show the natural ground levels, the road template and the culvert structure and the wingwalls. Invert levels should be clearly shown both at inlet and outlet of each culvert along with the slope of the culvert.

(c) Other Drawings

1. Cross sections of the roads

The Contractor and within two weeks of finalising the topographic surveys of the project road or any part thereof should produce cross sectional drawings at every 25 metre intervals. These drawings should clearly show the natural ground surveyed jointly with the Consultant and the proposed road template according to the designs shown in the Tender Drawings. The offset and elevation of each break point should be clearly indicated in writing at each point both for the natural ground and the road template. Catch points and side ditches should be clearly plotted and elevated. Super elevation calculations should be carefully taken into consideration during the preparation of these cross sectional drawings.

These drawing should also show the pavement layers. The offsets and levels should be clearly indicated in writing at each breakpoint of each pavement layer.

The scale of these drawings will be decided by the Engineer. These drawing should be submitted in five copies to the Engineer for his approval. No earthworks or pavement construction will be allowed before the preparation and approval of these drawings.

2. Installation drawings for incidental items such as sign posts, kerbs, etc;

3. Road intersections, lay bys, bus stops, and farm entrances;

4. All modifications or revisions to the road alignment proposed on site.

All working and shop drawing submissions for the Engineer's approval shall consist of four prints (minimum of A2 size) with copies of design calculations, Specifications and parts catalogue in duplicate. All drawings submitted shall properly indicate the revision of the drawing and the signature of the Contractor.

Should the Contractor submit minor modifications to drawings in the form of sketches, then the same should clearly indicate the drawing to which the modification is made with a clear sketch and revision numbers. The Contractor can submit the sketches in A4 or A3 size paper depending on the degree of clarity required and at the approval of the Engineer.

23. Record Drawings

The Contractor shall maintain a set of as-built drawings on which all changes, modifications and, in general, the Works as-constructed shall be recorded. The drawings shall be minimum of A2 size. The drawings shall cover all permanent works constructed on site Inclusive any changes to standard drawings, new work sketches, etc.....

Within 30 days after substantial completion of each section, the Contractor will submit one (1) set of

prints of the respective record drawings to the Engineer, who will return them to the Contractor for corrections or modifications, as deemed necessary, within a further 30 day period. The Contractor will, within a final 14 day period, submit to the Engineer a complete set of reproducibles drawn in ink (Cypia) and 2 complete sets of prints.

24. Photographic Records

For the purpose of the inception report, the Contractor shall take sufficient coloured photographs of the existing condition of the site (road, drainage structures and bridges) before disturbance of the surface occurs or commencement of any construction activities. Such photographs shall be of 7"x5" size, properly numbered and presented in a booklet to the Engineer. with a statement provided for each on its location, date taken, and a brief description. In addition, the Contractor is to provide a video film illustrating the state of the project prior to commencement of the Works.

At the end of each month the Contractor is to take sufficient photographic record of the works performed during the month (Le., a minimum of 24 photos). The Engineer shall then select a maximum of 10 pictures which shall be properly printed by the Contractor in 6" x 4" size. The photographs shall be properly numbered and presented in a booklet to the Engineer with a statement provided for each photograph's location, date taken, and a brief description.

The Contractor shall provide a video film narrated at the end of each month showing all works in progress and completed for the same period.

The costs for the production of these photographic records shall be deemed to be included within the Contractor's rates in the BOQ and shall not be paid separately.

25. Quality Control

All completed work performed shall be in reasonably close conformity with the lines, grades, cross sections, dimensions, quality and tolerances shown on the Drawings or indicated in the Specifications and all materials furnished shall comply with the quality requirements of the Contract.

The Contractor shall be responsible for locating and producing materials adhering to the Specifications. The exploration and development of local material sources and the costs attached to thereof shall also be the responsibility of the Contractor.

To achieve the necessary quality control, the Contractor is required, at his own cost, to:

- perform all standard field testing necessary to determine conformance of the work with the requirements of the Contract (i.e., field density tests, etc.) and submit as support documentation
-

along with the Request for Inspection form;

- collect samples of completed works for laboratory testing (i.e., compaction tests, etc.) in the presence of the Engineer and test the same jointly with the Engineer;
- submit to the Engineer the actual and design levels of the finished subgrade and each of the pavement layers as required. This will be done from a grid on the centre line and lines parallel to the centre line offset left and right by 1.5m and 3.5 m every 20 m.
- If during the execution of the works, the construction control tests indicate that the requirements for the material are not being consistently achieved, then work on that layer shall stop until the cause is investigated by the Contractor. Such Investigation may include further laboratory and site trials on the material to determine a revised set of data as above which, when agreed, shall be the basis on which all subsequent material will be provided and processed to achieve the specified requirements.

The Contractor shall, at his own expense, supply the Engineer with all necessary tools and resources (i.e., labour, equipment, tools, booklets, and other necessary expendable materials) required for maintaining quality control of the project works.

26. Queries

In the event that discrepancies or errors are detected in the drawings, the Contractor is to highlight the same to the Engineer or his representative in the form of a query before commencement of work on the said item or section of the project.

27. Printed Forms

The Contractor shall at his own expense provide the Engineer with such printed forms as the Engineer may require for the administration and control of the project. The style, lay-out, quality and quantity of forms shall be agreed with the Engineer before printing is to take place.

28. Procedures For Submissions

28.1 General

1. Coordinate preparation of the submission with construction, fabrication, other submissions, and activities that require sequential operations. Transmit in advance of construction operations to avoid delay.
2. Coordinate the submissions for related operations to avoid delay because of the need to review the submissions concurrently for coordination. The R.E. (Engineer Rep.) reserves the right to withhold action on a submission requiring coordination until related submissions are received.
3. No extension of Contract time will be authorized because of failure to transmit submissions sufficiently in advance of the work to permit processing.

28.2 Processing

The review duration of submissions by the Engineer shall be as stipulated in the **Appendix to Tender**.

28.3 Submission Preparation

A permanent label shall be placed on each submission for identification. A100x125-mm space shall be provided on the label or beside title block to record review and approval markings and action taken. The below listed information are to be included on the label for processing and recording action taken:

- A. Project name;
- B. Date;
- C. Name and address of the Contractor;
- D. Name and address of the subcontractor / supplier / manufacturer;
- E. Number and title of appropriate Specification Section;
- F. Drawing number and detail references, as appropriate.

Each submission shall be packaged separately and transmitted via a transmittal form. No submissions will be accepted by the Engineer from sources other than the Contractor. On the Transmittal form, record requests for data and deviations from requirements shall be included in addition to the Contractor's certification that the submitted information complies fully with the requirements.

28.4 Schedule of Submissions

A schedule of submissions is to be prepared and submitted with the Contractor's Clause 14 construction schedule. The schedule of submissions shall be:

- a. Coordinated with the list of subcontracts, list of products, and the Contractor's Construction Schedule.
- b. Prepared in accordance to the chronological order for the submission of products with the following information clearly highlighted:
- c.
 - 1. Date for first submission;
 - 2. Related Work element or Task;
 - 3. Submission category (Le., shop drawings, product data, or samples);
 - 4. Date for the R.E. final approval
- c. Updated and revised following each site meeting. The updated schedule shall be issued concurrently with the site meeting minutes.

Copies of the finally approved schedule of submissions and any respective revisions or updates shall be distributed to the Employer, the Engineer, the Engineer's representative on site and any other concerned party required to comply with submission dates.

28.5 Submission of Sub-Contractors

The Contractor is required to submit in writing the details for Sub-Contractors as listed below at least one month prior to commencement of work, for the Engineer's approval:

- a. Scope of work to be undertaken and percentage of project price;
- b. Detailed account of previous experience performing similar works;
- c. Company registration;
- d. Nationality of shareholders; and
- e. CV of proposed site staff.

28.6 Submission of Suppliers

The Contractor is required to submit in writing the details for any material or equipment supplier as listed below at least one month prior to commencement of work, for the Engineer's approval:

- a. The product name, list of related specifications and drawings, location (if specific);
 - b. Company registration and nationality of shareholders; and
 - c. Listing of previous supplies made to other projects or Employers.
-

The Engineer shall review the Contractor's submission and reply in writing within the period stipulated in the Appendix to Tender.

Once approval was granted for the supplier, the Contractor shall submit the product for approval with all related drawings, manufacturing and testing certificates, and specifications for installation as specified in other Sub-Sections of this specification.

28.7 Submission of Samples

Full-size samples of materials or products cured and finished as specified and identical with the material proposed shall be submitted. With the sample, the following information shall be included:

- a. Specification section number and reference;
- b. Generic description of the sample;
- c. Source of sample;
- d. Product name or name of the manufacturer;
- e. Compliance with recognized standards; and
- f. Availability and delivery time.

The samples shall be submitted for review of size, kind, color, pattern, and texture, for a check of these characteristics, and for a comparison of these characteristics between the final submission and the actual component as delivered and installed. Where variations are inherent in the material, submit at least 3 units that show limits of the variations. Samples shall illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar characteristics.

Samples must be undamaged at time of use and the Contractor shall indicate on the transmittal any special requests regarding disposition of sample submissions. Samples not incorporated into the work, or designated as the owner's property, are the Contractor's property and shall be removed from the site.

A full set of choices of samples are to be submitted for selection of color, pattern, texture, or similar characteristics from standard choices. Sample sets may be used to obtain final acceptance of the construction associated with each set.

28.8 Submission of Shop Drawings

The Contractor shall submit newly prepared information drawn to scale with deviations from the Contract documents clearly indicated. The produced shop drawings shall include the following information:

- a. Dimensions;
- b. identification of products and materials included by sheet and detail number;
- c. Compliance with standards;
- d. Notation of coordination requirements;
- e. Notation of dimensions established by field measurement.

28.9 Submission of Product Data

Product Data shall be collected into a single submission for each element of construction. Each copy shall be marked to show applicable choices and options. Where product data includes information on several products, the copies shall be marked to indicate applicable information.

The following information shall be included with the submitted product data:

- a. Manufacturer's printed recommendations;
- b. Compliance with trade association standards;
- c. Compliance with recognized testing agency standards;
- d. Application of testing agency labels and seals;
- e. Notation of coordination requirements.

Where selection of options is required, the Contractor is to submit only a preliminary single copy of Product Data.

28.10 Quality Assurance Submissions

The Contractor is required to submit quality-control submissions, including design data, certifications, manufacturer's instructions, and manufacturer's field reports required under other Sections of the Specifications.

28.11 Submission of Certifications

Where certification that a product or installation complies with specified requirements is required, the Contractor is required to submit a notarized certification from the manufacturer certifying compliance. The Certification shall be signed by an officer authorized to sign documents on behalf of the company.

28.12 Submission Sets

Except for samples illustrating assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics (1 set only) and shop drawings (4 sets), the

Contractor is required to submit 3 sets for each submission. One set will be returned marked with the action taken by the Engineer. One set of each submission (i.e., rejected or approved) shall be kept on site for quality comparison and record basis.

28.13 Approval Procedure

Except for submissions for the record or information, where action and return are required, the Engineer or his representative will review each submission, mark to indicate action taken, and return. Compliance with specified characteristics is the Contractor's responsibility. When revisions are made, the submission will be returned to the Contractor with the required comments to be adhered to.

The Engineer or his representative shall stamp each submission with an action stamp showing appropriately the action taken. Unless noncompliance with Contract Documents is observed, the approved submission shall serve as the final submission which shall form the basis for the construction on site.

The Engineer or his representative shall stamp each submission with an action stamp showing appropriately the action taken. Unless noncompliance with Contract Documents is observed, the approved submission shall serve as the final submission which shall form the basis for the construction on site.

50 MEASUREMENT & PAYMENT

51 Measurement Of Quantities

The units of measurements applied throughout the Contract documents are those of the Metric International System of Units (S.I.). The metric system shall be used on all drawings, design calculation sheets, material technical specifications or other documentation to be submitted by the Contractor unless otherwise stated in specific instances. All work completed under the Contract shall be measured according to the Metric System

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the Contract shall be those methods specified under the item or generally recognized as conforming to good engineering practice. All methods shall be as approved or directed by the Engineer.

Unless otherwise specified, longitudinal measurements for area computations shall be made horizontally, and no deductions will be made for fixtures (manholes, etc.) Having an area of 1 m² or less. Unless otherwise specified transverse measurements for area computations shall be the neat dimensions shown on the Drawings or ordered in writing by the Engineer.

Structures shall be measured according to the neat lines shown on the Drawings or as altered by

direction of the Engineer to meet field conditions.

All items which are measured by the linear metre, such as pipe culverts, shall be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the Drawings.

In computing volumes of earthwork, the average end area method shall be used in computing quantities, except where the error exceeds ± 5 (five) percent as compared with the prismatic formula, in which case the Engineer will direct the use of the more accurate method. However, the Contractor shall request such direction before he submits his quantities for approval. He will not be allowed to ask for review of quantities previously approved in order to revise them, if they have been submitted on the average end areas basis, without prior permission to use a more accurate method.

The Contractor may, as an alternate method for earthwork computations, submit to the Engineer for approval, a proposal for the use of an electronic computer. Such proposal shall include details of the computer hardware, the earthwork program or programs, the input, the output and a complete summary of the methods and procedures to be used. The Contractor may use the electronic computer method only with the prior approval of the Engineer, and continuance of such approval is contingent on satisfactory results. If results from the computer are not as proposed or are deemed unsatisfactory, the Contractor shall redo the earthwork computations by the cross sectional method.

The quantities of the various classes of excavation which will be paid for under unit prices bid shall be limited to the lines shown on the Drawings, and will be indicated on approved cross sections. Excavation beyond lines shown on approved cross sections will not be paid for. The Engineer will adjust the angle of said slopes for cuts and fills as the work proceeds, and make his determination of the advisable rate of slope in accordance with his evaluation of the soil conditions.

The actual lines of the cuts as made shall be duly measured and recorded by the Contractor. The Engineer will check these records and, where he finds them correct; will approve the measurement as a basis for payment.

The term "gauge" when used in connection with the measurement of plates, will mean the U.S. Standard Gauge, except that when reference is made to the measurements of galvanized sheets used in the manufacture of corrugated metal pipe, metal pipe culverts and arches, and metal cribbing, the term "gauge" will mean that specified in AASHTO M 36 or AASHTO M 167.

When the term "gauge" refers to the measurement of wire, it shall mean the wire gauge specified in AASHTO M 32.

The term "tonne" shall mean the metric ton consisting of 1,000 kg (2204.623 pounds avoirdupois). All materials which are measured or proportioned by weight shall be weighed on accurate and approved scales by competent and qualified personnel, at locations designated or approved by the Engineer. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the Engineer directs, and each truck shall bear a plainly legible identification mark.

Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles shall be loaded to their level capacity and the Engineer may require loads to be re-Leveled when the vehicles arrive at the point of delivery.

When requested by the Contractor and approved by the Engineer in writing, material specified to be measured by the cubic metres may be weighed and such weights will be converted to cubic metres for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

Bituminous materials shall be measured by the litre.

Volumes shall be measured at 15 °C or corrected to the volume at 15°C using ASTM D 1250 for asphalts or ASTM D 633 for tars.

Net certified scale weights shall be used as a basis of measurement, subject to correction when bituminous material has been lost, wasted, or otherwise not incorporated in the Works.

When bituminous materials are shipped by truck or transport, net certified weights or volumes, subject to correction for loss or foaming, may be used for computing quantities.

Cement shall be measured by the 'bag'. The term 'bag' shall mean 50 kg of cement.

The term "sum", when used as unit of payment, shall mean complete payment for the work described.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit or measurement, the unit shall be construed to include all necessary fittings and accessories.

When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc., such identification shall be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

52 Scope Of Payment

The Contractor shall receive and accept compensation provided for by the Contract as full payment for all labour, material, job organizational costs, overhead, profit, payment for damage to property of others, incidental work, where herein specified for the proper completion of the Works, which is not paid separately but is subsidiary to the work of pay items, including drainage to protect the Works during construction, haulage, tools, placement of material where specified herein or directed, sheeting, shoring, centering and supports, laboratory equipment and personnel for testing, housing for his personnel and all other costs necessary or usual to the proper completion of the Works.

If the "Basis of Payment" Section in the Specifications relating to any unit price in the Bills of Approximate Quantities requires that the said unit price cover and be considered full compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item which may appear elsewhere in the Specifications.

53 Compensation For Altered Quantities

When the accepted quantities of work vary from the Bills of Approximate Quantities, the Contractor shall accept as payment in full, so far as Contract items are concerned, payment at the original unit prices bid for the accepted quantities of work done. No allowance, except as provided in **Clause 52 of Division 4- Conditions of Contract** will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the Contract items or overhead expense and subsequent loss of expected reimbursements therefore or from any other cause.

54 Field Measurements

All field measurements shall be made by the Contractor in the presence of the Engineer, including measurements for monthly certificate quantities and for final quantities. Original copies of the field measurement notes, signed by the Contractor, will be retained by the Engineer.

Prior to submission of any Interim Payment Certificate and in conjunction with **Clause 60 of Division 4 - Conditions of Contract**, the Contractor shall submit to the Engineer for his approval, the calculation tables, notes and the plots of the original and final earthwork computations in the form of road cross sections. The Contractor's cross sections shall be on transparent cross section sheets for print reproduction. All sheets shall have a title block and be of size designated by the Engineer. On final approval of the Contractor's cross sections, the Contractor shall give the Engineer the original transparent tracings and three (3) prints of the same. If the Contractor fails or refuses to submit cross sections within the specified time, the Engineer will withhold payment for all or any part of the earthwork quantities involved.

In the case of any variations from the approved Drawings, the Contractor shall give the Engineer the original and three (3) copies of cross sections and profiles of the graphical record and the notes and computations of his stake-out, as required by the Engineer. The Contractor shall take cross sections at each station, each half station, and at other locations as may be directed by the Engineer. At his option, he may submit cross sections intermediate to these locations. The Engineer will indicate, on one copy, his approval of the proposed lines of the work or his revision thereof and return it to the Contractor. The Contractor shall resubmit for approval any cross sections the Engineer may revise.

If the Contractor fails to or refuses to measure items of work, the Engineer may, at his discretion, either estimate the quantities for the monthly pay certificate or make no payment certificate for the items of work and quantities not measured nor computed.

55 Prime Cost And Provisional Sums

This Sub-Section shall be read in conjunction with **Sub-Clause 58 of Division 4 - Conditions of Contract**.

For any Prime Cost or Provisional Sums as listed in the Bills of Approximate Quantities, the Contractor is required to submit three (3) quotations from different suppliers with all supporting documentation as specified in **Section 28** of these specifications (i.e., company brochure, sketches or drawings, testing results, and I or catalogues) for the Engineer's approval. The Contractor is required to indicate clearly the source which conforms for the specifications and to which he recommends the approval for. The Engineer will then approve the quotation from one source for which payment will be based on. In order to get paid, the Contractor is required to supplement his request for payment with actual invoices from the supplier.

99 METHOD OF MEASUREMENT & PAYMENT

No separate measurement or payment will be made for complying with the requirements of **Series 0**. The costs therefore shall be deemed to be included in the other pay items listed in the Bills of Approximate Quantities.

SERIES200

EARTHWORKS

SERIES 200 – EARTHWORKS

133 GENERAL

134 Scope

Earthworks shall include all clearing and grubbing, removal of trees, removal of obstructions and relocation of services, roadway cut excavation, embankments and all other operations and processes contingent upon or related to the works mentioned above and necessary for the preparation for the application of pavement layers.

135 Definitions

In relation to earthworks, the following words and expressions shall have the meaning hereby assigned to them:

- a) 'Existing ground level' - means the ground level existing before the commencement of the Works;
 - b) 'Cleared Level' - means the level arrived at after completion of clearing and grubbing, and removal of topsoil. It is calculated by subtracting the thickness of the topsoil as directed by the Engineer for removal on any section of the Works from existing ground level;
 - c) 'Finished excavation level' - means the level of completed excavation after any trimming, compacting and preparation of the excavation as calculated from the drawings or as instructed by the Engineer;
 - d) 'Construction width' - means the width of the permanent Works measured between the outer extremities of the side drains, cutting or embankment slope as the case may be;
 - e) 'Formation level' - means the level of completed earthworks ready for pavement construction and shall be synonymous with 'Subgrade level';
 - f) 'Formation width' - means the width of the earthworks measured between the points of intersection of side drain or embankment slopes at foundation level.
 - g) 'Finished Road Level' - means the level taken on top of the finished surfacing (i.e., wearing course or seal).
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- h) 'Rock' - shall include all rock material which requires blasting for its removal. Rock materials shall also cover materials that cannot be effectively extracted, removed or ripped by a single tine or ripper operated by a track type tractor of not less than 405 horse power (i.e., Caterpillar D9R or similar).
 - i) L 'Hard' - shall include all rock material that can be effectively extracted, removed or ripped by a single tine or ripper operated by a track type tractor of not less than 200 horse power (i.e., Caterpillar D7G or similar).
 - j) 'Common material' - shall include all materials that cannot be classified as 'rock' or 'Hard'.
 - k) 'Unclassified Excavation' - shall include all materials excavated regardless of type of material encountered, as directed by the Engineer, whether found suitable for incorporation into the permanent works or unsuitable, or spoil.
 - l) 'Borrow Excavation' - shall include all excavation taken for construction of road from borrow pits, drainage borrow ditches and stream channel changes.
 - m) 'Unsuitable materials' - shall include all materials encountered in cut areas and in the foundations of the embankment that are unsuitable for incorporation into the permanent Works (i.e., highly organic clays and silts, peat and soils containing large amounts of roots, grass and other vegetable matter) and shall be excavated and disposed of as directed by the Engineer (i.e. spoil in rehabilitation works). Such materials shall include but not limited to:
 - materials from swamps and marches;
 - logs, stumps, roots, vegetable matter and perishable matter;
 - slurry and mud;
 - anthill material;
 - any material which has excessive moisture content, and which cannot be dried to optimal moisture content within 4 working days of dry weather and frequent scarification and mixing of materials;
 - material classified as A~6 & A-7 in accordance to AASHTO. Standard Specification of Transportation Materials.
 - n) 'Spoil material' - shall include materials which, being obtained from cuttings, are surplus to that required for fill or are defined as unsuitable.
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- o) 'Overburden' - shall include all unsuitable materials to be removed before any material extraction from any borrow pit.

136 Use of Materials

- The use of topsoil shall be restricted to surface layers not subject to loading by pavements or structures;
- No excavated suitable material shall be removed from the Site except on the direction or with the permission of the Engineer;
- Before commencing works on any section of the road, the Contractor shall ensure that he has adequate instructions concerning the use of suitable excavated materials;
- Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, unless otherwise agreed with the Engineer, carry out the excavation of suitable materials separately for use in the Works without contamination by the unsuitable materials.

137 Protection from Water

The Contractor shall keep the whole of the Works free from water and allow in his prices for all dams, cofferdams, pumping, etc., necessary for this purpose and shall clear away and make good, at his own cost and to the satisfaction of the Engineer, all damage caused by ingress of water. No payment will be done for removal of unsuitable material due to water-logging caused by the Contractor's related temporary works.

The Contractor shall, at his own expense, take all necessary precautions to minimize damage due to erosion and siltation during construction. On cessation of earthworks, the surface of the completed layer shall be trimmed such that ponding and concentrations of surface run-off do not occur.

Well in advance of commencing earthworks over swampy or waterlogged ground, the Contractor shall, at his own expense, cut drains and ditches and carry out any other works necessary to effectively drain the original ground. Only if in the opinion of the Engineer, that such works form part of the permanent drainage system, then payment will be made accordingly.

Should any water accumulate on any part of the earthworks, either during construction or after construction until the end of the defective liability period, giving rise to soaking or eroding conditions, the Engineer may order the Contractor to remove and replace at the Contractor's expense any material which has been so affected.

Water shall not be allowed to accumulate at any point in the earthworks. The Contractor shall arrange for the rapid disposal of all water from the Works, whatever the source may be, and shall at his own expense effectively drain and keep dry the whole of the Works during the total period of the construction. From time to time, the Contractor shall clean and trim all drainage ditches during the work and/or when directed by the Engineer, so that there may be a free water flow throughout the duration of the Works.

Such provision shall include carrying out the work of forming the cuttings and embankments in such a manner that their surfaces have at all times a sufficient minimum cross fall and longitudinal gradient to enable them to shed water and prevent ponding.

138 Land Compensation

Prior to handing over of the site to the Contractor, the Employer is expected to have performed the required land acquisition from the concerned parties and the payment of the respective compensations for loss of structures, land and agriculture. In the event that this activity has not been performed whilst construction works are about to start, the Contractor shall not proceed with the removal of any structures or work activities such as clearing and grubbing until clearance has been given by the Engineer.

In the event that the land compensation activity is taking place after the Contractor has received the notice to proceed, the Contractor is required to provide all assistance (labour and equipment) to the Employer / Engineer in performing the said works.

Should the Employer request the Contractor to directly pay compensation to the owners through written instructions from the Engineer, the Contractor shall immediately perform the task. Payment for any paid land acquisition costs shall be reimbursed to the Contractor in the local currency portion of the interim payment certificates.

142 SITE CLEARANCE

143 Scope

This work under this section shall consist of clearing, grubbing, removing and disposing of all vegetation and debris within the areas ordered by the Engineer except such objects as are designated to remain or are to be removed in accordance with other sections of the Specifications. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

Included in this work as well is the stripping or otherwise removal of any unsuitable material encountered below the cleared level such as bush, heavy grass, heavy growth of grass, decayed vegetable matter, rubbish, and any other unsuitable material within the area upon

which embankment is to be placed. In no case shall such objectionable material be allowed in or under

the embankment.

Included in this work also is the preparation of the natural ground prior-to commencement of embankment works.

144 Clearing and Grubbing

212.1 Clearing

Clearing shall consist of the removal of all surface objects and natural obstructions such as trees; stumps; roots; bush; anthills; ant nests; and grass, debris and rubbish of any nature, fences, existing pavement, objectionable material such as old foundations, abandoned pipe lines, existing kerbs and gutters, and other protruding obstructions, not designated to remain. Clearing shall include the removal of unbreakable rocks and boulders up to 0.15 m³ in size and which are exposed or laying on the surface.

Clearing shall also include the removal and disposal of structures that obtrude, encroach upon or otherwise obstruct the work and that can be cleared by means of a bulldozer with a mass of approximately 22 t and flywheel power of approximately 145 kW. Structures that cannot be cleared in this manner shall be broken down and removed in accordance to the requirements of **Section 220**.

212.2 Grubbing

Grubbing includes the removal of all stumps and roots to a depth not less than 1000 mm below the formation! Subgrade level or slope of embankments and! or a minimum of 200 mm below stripped ground level. Other undisturbed stumps and roots and non-perishable solid objects which will be below the stipulated depth shall remain in place.

212.3 Removal of Trees

This work shall include cutting trees 1.0 metre in girth or larger, when measured, at a height of 1.5 metres above the ground, removing their stumps and roots from the ground, and disposing of the material. The consent of the Engineer is to be obtained prior to removal of any tree or shrub. All trees of stumps 2 m in circumference or more are to be left in place wherever possible, and only those specified by the Engineer shall be removed.

Should the trees or shrubs designated to remain carry low hanging, unsound and unsightly branches, then the same branches shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed, in accordance with accepted practice, to provide a minimum clear height of 6 metres above the roadbed surface.

212.4 Limits of clearing and grubbing

Normally the areas to be cleared and grubbed cover the portions of the road reserve that fall within the limits of the road prism, as well as certain borrow areas. When the road reserve is to remain unfenced, the full width of the road reserve shall be cleared and / or grubbed except for such mature trees designated by Engineer to be left standing. The Engineer shall establish the limits of the areas to be cleared and grubbed and such areas shall not necessarily be limited to those mentioned above.

The areas occupied by the existing road prism shall not normally be required to be cleared and grubbed.

212.5 Construction Procedure

- No clearing and grubbing shall be done other than on the written instructions of the Engineer, who shall designate in detail the exact areas to be cleared and grubbed and the time at which it shall be done to avoid re-clearing.
- When portions of the road reserve or other areas have been cleared but in the course of time, vegetation grows again during construction, the Engineer may, if he considers it necessary, order that the area be re-cleared.
- Where anthill material is encountered on Site, the Contractor shall excavate to a depth below existing ground level as directed by the Engineer but not less than 1.0m below the finished road level and the material carted to spoil. The excavated area shall be treated with an approved pesticide and backfilled with approved material and compacted to a density as above stipulated, all to the approval of the Engineer.
- With the exception of areas to be excavated as cuts or other roadway excavation as designated in the drawings, holes resulting from removal of stumps, obstructions or others shall be backfilled with suitable material and compacted to 95% MOD in accordance to AASHTO T 180 Method D.
- Cleared material shall be the property of the Contractor except in the case of materials classified as forest produce under the Laws of the country of the Employer as stipulated in the **Appendix to Tender**.

212.6 Disposal of Cleared Material

Disposal of cleared material shall be done by the Contractor as stated below:

- Material obtained from clearing and grubbing shall be disposed of at locations off site as indicated by the Engineer, in borrow pits or other suitable places and be covered up with soil or gravel. In the event that arrangements were made by the Contractor for the disposal of the material in private lands, the written permission of the property owner should be obtained with all related costs covered by the Contractor at his own expense.
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- Should any perishable material require to be burned, this activity should be done under the constant care of competent watchmen at such times and in such manner that nothing designated to remain on the road reserve area, or other adjacent property will be jeopardized. All burning activities shall be done in accordance with the applicable laws and ordinances of the country or district.
- The forest produce shall be disposed of in the manner approved by the Employer and the concerned authority. The Contractor must hold a Forest License should he propose the removal of the forest produce for his own use or sale.

213 Removal of Topsoil

The top soil together with any grass and other vegetation shall be removed to an average depth of 150 mm, both in fill and cut sections to such widths and areas in accordance with the instructions of the Engineer. No stripping of topsoil shall be performed until the levels of the original ground has been taken and documented pursuant to the relevant section within **Series 100** and fill operations are about to commence in that embankment area. The Engineer shall establish the limits for the areas where top soil is to be removed and replaced with suitable materials.

Such top soil as will be required by the Works shall be transported and deposited in stockpiles within the road reserve for use in agricultural purposes. Surplus topsoil materials shall be deposited within the road reserve and spread and shaped to an even depth not to exceed 250 mm as directed by the Engineer.

214 Preparation of Natural Ground

Upon the completion of the clearing and grubbing operation and removal of top soil and before any subsequent earthworks operations (i.e., embankment fill or excavation), the Contractor shall verify the suitability of the material encountered at the Cleared level.

Where unsuitable soil is encountered, the Contractor is required to remove the unsuitable materials to the depth of 300 mm when the material CBR is above 8 or 500 mm when the material CBR is below 8 or otherwise as directed by the Engineer.

As part of this activity, the Contractor is required to fill the section being prepared for embankment by suitable material pursuant to **Section 244.1** up to the Existing Ground Level.

The re-fill operation shall follow the procedure for embankment fill or as instructed by the Engineer.

Whenever an embankment or fill is to be received, the cleared surface shall be completely broken up by ploughing, scarifying or stepping to a minimum depth of 150 mm. This area shall then be re-compacted in accordance to **Section 246** for the subsequent roadway embankment.

When an embankment is to be constructed over any existing roadway surface, the existing road shall be scarified and re-compacted to the specified compaction requirements.

220 OBSTRUCTIONS

221 Removal of Obstructions

This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings and foundations, stone or masonry fences or walls, concrete or masonry structures such as box culverts, catch pits, retaining walls; pipe culverts and any other obstructions which are not designated or permitted to remain. It shall also include the salvaging of designated materials and back-filling the resulting trenches, holes and pits to specifications.

No obstructions are to be removed before the written approval has been obtained from the Engineer.

The obstructions covered in this section shall be those that cannot be removed by the Clearing and Grubbing operation as specified in **Section 212**.

The content of this section shall be read in conjunction with the **Clause 42 of Division 42 - Conditions of Contract**.

221.1 General

The Contractor shall perform the work described above, within and adjacent to the roadway, on Government land or easement, as shown on the plans or as directed by the Engineer. All designated salvable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places on the project. Perishable material shall be handled as designated in **Section 212**.

Nonperishable material may be disposed of outside the limits of view from the project with written permission of the property owner on whose property the material is placed. Copies of all agreements with property owners are to be furnished to the Engineer. Basement or cavities left by structure removal shall be filled with acceptable material to the level of the surrounding ground and, if within the prism of construction, shall be compacted to 95 percent MDD, in accordance with **Section 246**.

Blasting or other operations necessary for the removal of an existing structure or obstruction shall be completed prior to commencement of construction within that section of the road or as otherwise directed by the Engineer. If blasting is necessary, written permission by the Engineer and the Department of State for Works, Communications and Information shall first be obtained.

Unless waived in writing by the Engineer, all concrete removed which is of suitable size for usage as rip-rap and not needed for such use on the project shall be stockpiled or used as directed by the Engineer.

When fences and gates enclosing pasture land or farm land are to be removed, the Contractor shall notify the Engineer sufficiently in advance to give the property owner reasonable time to construct

alternative fencing or make other suitable arrangements.

Existing wells, abandoned or active, which lie within the limits of the Works, as shown in the drawings, shall be dismantled, backfilled and compacted. Wells shall be filled to the level of the surrounding ground and, if within the prism of construction, shall be compacted after obtaining the Engineer's permission to the type of compaction within the range designated.

All salvageable materials shall be removed and stored at approved locations.

221.2 Removal of Culverts and Other Drainage Structures

Culverts and other drainage structures in road sections in use by traffic shall not be removed until satisfactory arrangements have been made by the Contractor to accommodate traffic. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream and those parts outside of a stream shall be removed down to at least 0.3 metre below natural ground surface.

222 RELOCATION OF SERVICES

222.1 Description

This work shall consist of identification, examination, relocation and reinstatement of all services such as water lines, sewage, storm water, electrical underground and overhead lines and cables, telephone and other communication lines, gas lines that are in the road prism and / or in the road reserve as a whole. All work under this section shall be done in coordination with the respective Utility companies within the Employer's country. No relocation shall proceed prior to the receipt of the written instructions to proceed from the Engineer. The content of this section shall be read in conjunction with the relevant sections within **Series 100** of these specifications.

222.2 Construction Requirements

The Contractor is required to check with the respective utility company on the availability of services on the width of the road prism and the road reserve as a whole throughout the whole length of the road. Once the services were identified, the Contractor, in coordination with the utility company, shall carefully excavate and examine these services. A report on the joint inspection shall be written, signed by both parties (i.e., the Utility company & Contractor) and sent to the Engineer for his approval highlighting the services to be relocated and the cost estimated (inclusive of material, labour and equipment) to perform the work required. The Engineer will thereafter study the report and issue to the Contractor the necessary instructions to proceed with relocating the services as required.

It is recommended that all excavation and backfilling work to be done by hand so as to minimize the possibility of damage to the services.

Throughout the above process, the Contractor shall perform all protection work necessary to prevent damage to the services by his own equipment or others such as coloured markers, barricades, etc. Should any damage incur to the services as a result of construction work or relocation work, the Contractor shall be responsible to remedy the damage at his own expense.

230 ROADWAY EXCAVATION

231 Description

231.1 General

This work shall consist of excavating the roadway and borrow pits, removing and satisfactorily disposing of *all* materials taken from within the limits of the Works. Also included is excavation as is necessary for ditches, and the excavation for changing and completing all channels. The Works shall include *all* excavation, shaping and sloping necessary for the construction as directed by the Engineer and in reasonable close conformity to the alignment, grades and cross section shown on the drawings or established by the Engineer.

The Contractor shall schedule the said work taking into consideration that authorized cross sections shall have to be prepared so that the necessary measurements can be obtained.

231.2 Classification of Excavation

For the purpose of this Contract, all roadway and drainage excavation will be classified as "Unclassified Excavation" as defined in **Section 203**, which classifications shall include *all* materials of whatever nature encountered.

232 Construction Requirements

232.1 General Excavation

The Contractor shall perform the excavation using suitable equipment and in an organized manner as to ascertain the use of *all* materials removed in the formation of the embankment, shoulders, and at such other places as directed, unless otherwise declared unsuitable and ordered to be sent to spoil by the Engineer.

Before proceeding with any excavation of cuts, the Contractor shall inform the Engineer in writing of the locations where the material shall be used.

Any excess depth excavated below the formation level tolerance shall be made good by scarifying and backfilling with suitable material of similar characteristics to that removed and compacted as specified. Where excavation reaches rock, formation level will be established by filling *all* depressions with crushed stone in dry areas.

Where unsuitable soil is encountered upon excavating to the finished grade, this material shall be disposed of as spoil. These unsuitable materials shall be removed to a minimum depth of 300 mm if the material has CBR value greater than 8 or 500 mm if the material has CBR value less than 8 or as otherwise instructed by the Engineer. The Engineer may designate as unsuitable those soils that cannot be properly compacted in embankments or cannot be used for fill layers or side fill. Materials that are soft or unstable merely because they are too wet or dry are not to be classified as unsuitable unless otherwise directed by the Engineer.

No excavated material shall be put to spoil without the written permission from the Engineer and when such material is to be spoiled, it shall be so placed that it will present a neat appearance and not be an injury to abutting property. Stockpiles shall be neatly and compactly constructed in an approved manner at locations approved by the Engineer. Any excavated materials put to waste by the Contractor without the permission of the Engineer shall be replaced by the Contractor at his own expense. The location for dumping of material characterized as spoil is to be approved by the Engineer subsequent to the Contractor securing the prior consent of the landowner for the use of such land. The use of land designated for crops shall be strictly prohibited.

The slopes of cuttings shall be trimmed by hand or by approved mechanical means to uniform batters as shown on the drawings or as directed by the Engineer. Such trimmings shall be completed before the commencement of Subbase construction.

The slopes of cuttings shall be cleared of all rock fragments which move when prised by a crow bar. Where in the slopes of cuttings layers of rock and softer material alternate and the Engineer considers that the slope immediately after dressing will not permanently withstand the effect of weather, the Contractor shall excavate any insecure material to an approved depth and build up the resulting spaces with mass concrete or masonry using rock similar to the adjoining natural rock so as to ensure solid face.

Any rock or boulder appearing in the face of a cutting shall be trimmed back to within the tolerance specified and in addition any such rock or boulder which, in the opinion of the Engineer, is unstable shall be completely removed and the resulting void filled with compacted material to the approval of the Engineer.

In the event that material outside the planned roadway or ditch slopes are, in the opinion of the Engineer, unstable and constitutes potential slides into the roadway or ditches, the same material shall be excavated and removed. Excavation of the above material shall be to designated lines or slopes either by benching or 8S directed by the Engineer. Such material shall be used as embankment or wasted and disposed of in accordance with the written directions of the Engineer. In the event that material outside the planned roadway or ditch slopes are, in the opinion of the Engineer, unstable and constitutes potential slides into the roadway or ditches, the same material shall be excavated and removed. Excavation of the above material shall be to designated lines or slopes either by benching or as directed by the Engineer. Such material shall be used as embankment or wasted and disposed of in accordance with the written directions of the Engineer.

During the construction of the roadway, the achieved formation level shall be maintained in such a condition that it will be well-drained at all times as required in Section 205 or otherwise specified in this Sub-Section. Where water is present or may access through the pavement, mass concrete shall be used. The formation level shall be constructed with a cross - section which enhances water run-off. Side ditches or gutters emptying from cut to embankment shall be so constructed to prevent damage to embankment by erosion. Damage to the Works attributable to wetting or failure to provide adequate drainage shall be immediately repaired by the Contractor at his own expense.

Blasting for road works is not anticipated on this project and will not be permitted except through written permission by the Engineer and the Department of State for Works, Communications and Information.

240 FILL AND EMBANKMENT FORMING

241 Scope

The work in this Section covers the furnishing of suitable material, placement, breaking down, watering, mixing and compaction of fill and embankment to formation level. The Works shall be in accordance with the Specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the drawings or established by the Engineer.

242 Submissions

The Contractor shall submit to the Engineer his proposals for the compaction of each main type of material to be used in the embankments including the types of equipment, the number of passes and the compacted depth of layer. The Contractor shall conduct the site trials for embankments and shall satisfy the Engineer that all the specified requirements regarding compaction can be achieved.

All submissions shall adhere to the relevant section within **Series 0** of these specifications.

243 General Requirements

Where fill material can be obtained from cuttings, the Contractor shall use this material before taking material from borrow pits unless the Engineer instructs its removal to Spoil.

Where materials of differing quality are available for placing in embankments, the Engineer may instruct that certain materials should be excluded from the upper layers of fill. He may also instruct that other materials should be set apart or obtained from borrow areas and used only for these upper layers. The Contractor shall adjust his earthworks program to comply with any such instruction by the Engineer.

The Contractor shall ensure that earthwork proceeds towards completion in an orderly and continuous manner. Final approval of previous work will only be given immediately prior to the placing of each subsequent layer and the Contractor shall submit a written request for approval at least 12 hours before he intends to cover a completed layer. Fill materials shall be placed immediately after approval of the previous layer has been given to ensure retention of moisture content. Should any layer be left unprotected for more than 24 hours subsequent to approval, the Contractor shall request re-approval by the Engineer.

The Contractor shall have in operation a sufficient number of equipment to properly construct each embankment layer. No new layer will be approved to be laid until the previous constructed

layer has been tested and approved. The Engineer shall have full authority to require at any time, the suspension of delivery of material to the embankment until previously delivered materials are properly placed and preceding layers are satisfactorily smooth, uniform and tested. In the case that fill has been laid over untested layer, then the Contractor will be required to remove the said layer to facilitate for the Engineer the testing of the previously completed layer.

The side slopes of the embankment shall be trimmed by hand or by approved mechanical means to uniform batters to the lines and slopes shown on the drawings or as directed by the Engineer and the finished work left in a neat and acceptable condition. Such trimmings shall be completed before the commencement of Sub-base construction.

Any rock or boulder appearing in the face of the layer shall be trimmed back to within the tolerance specified and in addition any such rock or boulder which, in the opinion of the Engineer, is unstable shall be completely removed and the resulting void filled with compacted material to the approval of the Engineer.

When embankment is to be placed and compacted on hillsides of where embankment is built part width at a time, the slopes that are steeper than 4: 1 when measured at right angles to the roadway shall be continuously benched over those areas where it is required as the work is brought up in layers. Benching shall be of sufficient width to permit operation of placing and compacting equipment and/or directed by the Engineer. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be re-compacted along with new embankment material at the Contractors expense, unless the width of the excavation required and approved by the Engineer exceeds 2 m, in which case the excavated material in excess of 2 m will be measured and paid for as roadway excavation.

When constructing embankments up to bridges and over culverts, the Contractor shall raise the embankment equally on each side of such structures. If the embankment can be deposited on one side only of abutments, wingwalls, piers or culvert head walls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent it will cause overturning of, or excessive pressure against the structure.

Suitable means shall be provided for compacting fill adjacent to structures and in other places where heavy equipment cannot operate. Rollers or other heavy equipment may be used in the vicinity of concrete structures only after the concrete has been sufficiently cured and when the Engineer has given permission.

When an embankment is to be constructed over an area previously occupied by an irrigation canal, well, any previous excavation, or other such construction that will not permit the use of normal compaction equipment, the embankment construction shall conform to the compaction requirements specified in **Section 246**, until the normal compaction equipment can be used.

Embankments shall not be constructed by means of a drag line except with the special permission of the Engineer and when special provisions are made to keep the layers uniform and the embankment level well drained at all times.

The Contractor shall be responsible for the stability of a" embankments and shall replace a" sections of same which, in the opinion of the Engineer, have been damaged or displaced due to carelessness or neglect on the part of the Contractor, or due to natural cases, such as storms, but not attributable to the unavoidable movement of the natural ground upon which the embankment is made.

244 Common Material Embankment

244.1 Materials

Materials for fill shall be obtained from areas of the cut and excavations, including side drains, or from approved borrow pits.

Suitable fill material shall meet the following requirements:

- i) The Plasticity Index (PI) shall not exceed 30;
- ii) The percentage passing the 0.075 mm sieve shall not exceed 35%;
- iii) Liquid Limit <50%;
- iv) The CBR shall not be less than 8% at the density required for the layer and with a surcharge not greater than the one which-corresponds- to the load of the pavement structure;
- v) The CBR swell shall not exceed 4% after soaking for 96 hours;
- vi) The maximum laboratory dry density as determined by the AASHTO T99 Compaction Test shall not be less than 1,500 kg/m³;
- vii) The material shall not contain particles with a maximum dimension exceeding two - thirds of the specified layer thickness after compaction except in the case of rock fill.

The Contractor shall use the materials extracted from excavations or borrow pits for the use of embankment except for those materials that fail to meet the above specifications for suitable fill and those materials classified as A.2.6, A.2.7, A.6 and A.7 (AASHTO M-145) or other undesirable materials such as logs, trees, stumps, weeds, heavy grass. On the other hand, rocks, broken concrete, or other solid materials shall not be placed in embankment areas where piling is to be placed or driven.

Soils classified as A3 in accordance to AASHTO M-145 may be permitted for use in embankment layers subject to the approval of the Engineer provided that the layer is properly confined. Confinement of such layer may be achieved by importing of cohesive soil material to be compacted in layers of 20 cm and a minimum width of 2 metres on both sides of the layer all to the approval of the Engineer.

When materials of widely divergent characteristics, such as clay and sand, are drawn from different sources, such materials shall be deposited in alternate layers over the full width of the embankment. The Engineer may, where he deems it advantageous to the work, order such material to be mixed. Rock, clay or other materials shall be broken up and beaten down, and no accumulation, at the foot (toe) of side slopes of embankment, of boulders or lumps will be permitted.

In areas subject to flood and prolonged inundation of the embankment, the material used in the embankments, unless rock, shall be AASHTO Class A-1-a (0) or A-2-4(0) soils. Other soils may be used only with the written consent of the Engineer.

In roadway sections encountered or constructed of materials subject to side-slope erosion or requiring confinement for stabilization purposes such as sand dune materials, the Contractor shall construct the roadway slopes using AASHTO Class A-1-a (0), A-1-b (0), A-2-4(0) soils as specified in AASHTO M 145, or other materials which may be approved by the Engineer, to the shape and dimensions as shown on the drawings, and at locations as directed by the Engineer.

Water to be used shall be clean and fresh, free from salts and shall be obtained from a source approved by the Engineer. The Contractor shall arrange for the analysis of water at his own expense.

Only approved materials shall be used in the construction of embankments and backfills. When unsuitable material has been placed in the embankment, its removal shall be at the expense of the Contractor.

244.2 Construction Requirements

Roadway embankment shall be performed in layers not exceeding 200 mm in loose depth (150 mm in compacted depth). If however and based on results of Site Compaction trials, the Contractor has satisfied the Engineer that his compaction equipment is capable of achieving the specified densities at a greater depth, in which case the depth shall not exceed 300mm in loose depth. Each layer shall extend over the full width of the embankment.

During the construction of embankments, the Contractor shall control and direct constructional traffic uniformly over the full width. Fill materials shall not be stockpiled on embankments unless this is permitted by the Engineer.

Isolated boulders, each within the range 0.025 m³ to 0.1 m³ size may be incorporated more than 500mm below formation level in embankments constructed with material other than rock at the discretion of the Engineer, provided that the specified compaction requirements are met.

The fill layers shall thereafter be scarified and mixed with water. The moisture content of fill material immediately prior to compaction shall be within $\pm 2\%$ of the optimum moisture content for the densities specified and shall be kept within these limits until compaction is complete. If necessary, the moisture content shall be adjusted by mixing and harrowing and leaving to dry if the moisture content is too high or by mixing in water by sprinkler if the moisture content is too low.

The Contractor shall provide all equipment necessary for conveying and distributing water. Water shall be evenly sprinkled on the surface of the fill material by pressurized sprinkling machines of a type approved by the Engineer and capable of distributing water at a predetermined and constant rate.

Once mixing of the material is completed, the fill material shall be compacted in accordance to the requirements of **Section 246** by equipment which is suitable for the purpose. The contribution of the wheels on any roller shall be such that the whole of the ground surface within the width of the roller is loaded during each pass. Each layer of fill material shall be compacted to a dry density at least fulfilling the compaction requirements specified.

245 Rock Fill Embankments

245.1 Scope

Where fill is to be constructed across water-logged or swampy ground that displays excessive movement under normal compaction equipment and haulage trucks, thereby precluding the effective compaction of the bottom layers, the Contractor shall construct a pioneer layer of rock fill material on unstable ground. This layer shall be of sufficient thickness to provide a stable working platform for the construction of further fill layers which are to be compacted to a controlled density.

245.2 Material

The rock material shall have a maximum dimension of any piece of 300mm. The constructed layer shall consist of reasonably well graded rock and shall be blinded with smaller rock fragments and gravel so far as to fill as many of the voids as possible before the next layer is placed. The compacted layer shall contain no rock with a maximum dimension greater than the compacted layer thickness.

245.3 Construction Requirements

The first layer of material shall be placed to a uniform layer of maximum thickness 750 mm or as directed by the Engineer. Light hauling equipment shall be used to off-load the material by means of progressive end tipping. The material shall be spread, pushed and leveled by means of bulldozers or other suitable equipment in such a manner that the fine material is well mixed with the rock. Hauling, spreading and compacting equipment shall be routed uniformly over the full width of the layer to be compacted. The layer shall be compacted using light compaction equipment that will give the most effective compaction until the layer is fully embedded over the whole area instructed without stressing the roadbed. Upon the instruction of the Engineer, the pioneer layer may not be compacted to the controlled density as specified in **Section 246**.

Subsequent layers of rock fill shall be deposited in horizontal layers not exceeding 750 mm loose depth and shall extend over the full width of the embankment except for specified external cover to slopes. The materials shall be spread and leveled by bulldozers weighing not less than 15 tonnes in the means abovementioned. Each layer of rock used as fill in embankments shall be systematically compacted and broken down by means of grid or other suitable rollers and shall finally be compacted by means of vibratory rollers. The material shall be compacted by a minimum combined 8 passes of a vibrating roller with a basic static load of at least 36 kN per 1 meter width of roll or a grid roller with a static load of at least 80 kN per 1 meter width of roll or other equipment approved on site trials.

Rock fill shall not be used for the top 300 mm of the embankment.

246 Compaction Specifications

246.1 Scope

This work shall consist of the compaction of earthwork by rolling or tamping or any combination of these methods in accordance with the requirements specified, on the drawings, in the Specifications or ordered by the Engineer.

246.2 Testing Methods

➤ Moisture-Density Test

A moisture-density test (AASHTO T 180 - Method D) and preliminary study shall be made of each type of soil to be used in the construction of the Works to determine the maximum density, the optimum moisture content and the moisture range required of the soil for satisfactory compaction. The field density and actual moisture content of the compacted embankment shall be determined by field tests according to AASHTO T191.

The "maximum dry density" as determined by the moisture-density test shall be the density to which the field density is referred for comparison of percentage for each type of soil used in the Works.

The "optimum moisture content" shall be the moisture content corresponding to the maximum density on the moisture-density curve.

The "moisture range" shall be the limits of moisture content of each type of soil with the optimum as a reference.

The "field density" shall be the density of the compacted embankment determined by the field density test.

The "moisture content" shall be the actual moisture content of the soil in the compacted embankment at the time of compaction.

➤ **Relative Density Test**

For cohesion less free-draining soil for which impact compaction will not produce a well-defined moisture density relationship curve and the maximum density, the test for the relative density of cohesion less soils (ASTM D 2049) shall be used to determine the relative density.

"Relative density" is defined as the state of compactness of a soil with respect to the loosest and densest states at which it can be placed by the laboratory procedures described in ASTM D 2049. The field density and actual moisture content of the compacted embankment shall be determined by field tests according to AASHTO T191.

The "relative density" as determined by the relative density test shall be the standard to which the field density is referred for comparison for each type of cohesion less soil used in the Works.

The "field density" shall be the density of the compacted embankment determined by the field density test.

The "moisture content" shall be the actual moisture content of the soil in the compacted embankment at the time of compaction.

➤ **Borderline Materials**

In cases where borderline materials are encountered, both methods will be utilized and the method which results in the higher laboratory maximum density shall be used as the standard to which the field density is compared.

246.3 Equipment

Compaction equipment shall be approved by the Engineer and satisfactory performance shall be the basis for such approval.

The weight of the rollers shall be increased as necessary to obtain the type of compaction required by the drawings and Specifications when a minimum density is designated therein.

246.4 Moisture Content Requirements

The moisture content of the soil at the time of compaction shall be uniform and shall be such that the soil can be compacted to the requirements of the type of compaction designated on the drawings or ordered by the Engineer.

246.5 Compaction Requirements

The compaction requirements as controlled by the methods of testing specified above as follows:

- a. 100 MDD, in which case the compacted density of the soil shall be equal to or greater than 100 percent of maximum density;
- b. 96 MDD, in which case the compacted density of soil shall be equal to or greater than 96 percent of maximum density;
- c. 95 MOD, in which case the compacted density of soil shall be equal to or greater than 95 percent of maximum density

Embankments shall be compacted to 95 MOD except for the formation level (i.e., Subgrade layer) where compaction of 96 MOD is required as determined based on AASHTO T 180 Method D.

Where specified on the drawings the embankment shall, in addition to meeting the requirements of a specified type of compaction, be formed of materials meeting a specified CBR (California Bearing Ration) requirement. The materials and methods of compaction shall be as determined from tests in accordance with MSHTO T 193.

246.6 Compaction Trials

Prior to the commencement of embankments, the Contractor shall construct trial *compaction* lengths as directed by the Engineer. The soils used in the trials shall be those encountered along the line of the road and the compaction equipment to be used shall be that which the Contractor intends to use for the work proper. The object of these trials is to determine the best field moisture content of the material and the relationship between the number of compaction equipment passes and density attained. Each trial length will be as directed by the Engineer. The trial length will be incorporated in the Works.

246.7 Construction Requirements

➤ General

This *Sub-Section* shall be applicable to the construction of embankments that are to be compacted except as specifically superseded herein relative to *preparation* for the areas upon which the embankment is to be placed and to the *thickness* of the layers of embankment being placed.

Compacting *operations* shall include adequate blading with motor graders to ensure uniformity of the layers of embankments being compacted. The number of blades and rollers in use shall be sufficient to blade and compact adequately all materials being delivered to the embankment. The Engineer shall have full authority to suspend the delivery of materials to the embankment until previously delivered materials are properly placed and satisfactorily compacted.

➤ Moisture Control Requirements

The moisture content of the soil at the time of compaction will be left to the discretion of the Contractor.

When the Contractor wishes to alter the moisture content of the embankment soil, water shall be added and thoroughly mixed into the soil, or the material shall be aerated by approved methods, whichever is appropriate.

➤ Compaction Control Requirements

As previously mentioned, embankment layers shall be placed in horizontal layers not exceeding 200 mm (loose measurement) and shall be compacted as specified and approved by the Engineer before the next layer is placed. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density. Construction equipment shall be routed uniformly over the entire surface of each layer. A motor grader shall be used on the embankment at all times during the placing and compacting of the earth material.

➤ Tamping

Whenever embankments are placed adjacent to structures or at locations where it is not practicable to

use a roller, the embankment materials shall be tamped by the use of mechanical hammers or tampers. Each layer shall be compacted to a density equal to or greater than that obtained under the above rolling procedure for the type of compaction designated. Each successive layer shall contain only that amount of material which will ensure proper compaction but in no instance shall any layer be greater than 200 mm (loose measurement) in depth. Each layer must be approved by the Engineer before the next layer is placed. When the quantity of work is small, a hand tamper may be used with the permission of the Engineer.

➤ **Special Provisions for Other Rollers**

When special heavy rollers are used, the compacted thickness of the layer may be increased when approved by the Engineer as long as satisfactory compaction is obtained. Satisfactory compaction is defined as compaction which results in a uniform density throughout the entire depth of the layer equal to or in excess of the specified density. The maximum compacted thickness of the layer shall be established by the Engineer for each type of heavy roller used and for the various types of soil encountered. The Engineer reserves the right to vary the compacted thickness of the layer as the work progresses to insure adequate compaction or to rescind approval of the heavy rollers.

250 BORROWEXCAVATION

251 Scope

This Sub-Section covers all works necessary in obtaining borrow materials for work under this Contract, clearing the site, stripping and disposing of excess overburden, excavating selected materials for use in the works, and finishing off the borrow areas. The Employer will provide for free to the Contractor, the land contained within all borrow pits which are approved for use in the works undertaken in the Contract.

252 Negotiations with the Owners and Authorities

The Employer will complete all necessary negotiations with the owners of the land on which any approved borrow pit is situated prior to the opening up of such borrow areas and will compensate the owners directly in respect of royalties or loss of crops to which the land owner may be entitled in accordance with current ordinances.

In the case of alternative sites of borrow areas are selected by the Contractor which are not approved by the Engineer nor the Employer, the Contractor is required to submit a request for the use of the land for borrow area to the Employer with a copy to the Engineer at least two months in advance so that the Employer can approve and assist in the compensation issues. All royalties in the case of alternative borrow sites are to be paid by the Contractor at his own expense.

Prior to the use of any borrow pit, the Contractor shall satisfy himself that all necessary negotiations have been made with the respective owners of the ground on which any borrow pit is situation.

The Contractor is required to notify the land owner both verbally and in writing at least 14 days prior to his intention to enter the property and to remove material. The Contractor shall also make all arrangements for providing protective measures against injury or damage to persons, livestock or property of any character and for the restoration as is defined thereafter. All protective measures shall be to the approval of the Engineer.

253 Borrow Pits Information

253.1 Approved Borrow Pits

The information about the approved borrow pits as included in the Contract Documentation reflects the results of site investigations and laboratory testing conducted by or for the Employer and is supplied in good faith as to the sufficiency in quantity and quality of the material for the due and proper completion of the works. The provision of these borrow pit information shall not be in any way construed as limiting the obtaining of borrow material to the borrow areas indicated or as necessarily limiting the use of the material to that described on the plans.

Before the use of any borrow materials from the approved sources of supply listed, it is the responsibility of the Contractor to verify the accuracy of the results obtained and that they are in agreement with the Consultant's previously obtained results. Only borrow material complying with the requirements of the specifications for the use for which it is intended shall be selected from these approved sources.

If, at any time during construction, it appears that the quality and the quantity of the material available in a borrow pit is insufficient, the Contractor shall make use of other borrow areas approved of by the Engineer whether such borrow pits are included as part of the information provided by the Engineer or not. The Contractor shall submit the results of his investigations of the approved or alternative borrow pits for the Engineer's approval prior for the usage of other borrow areas.

253.2 Alternative Borrow Pits

Should the Contractor elect to obtain materials from sources other than those designated in the 'Information to Tenderers', he shall excavate the necessary trial holes, take such samples and perform or have such tests performed as are deemed necessary by the Engineer.

The Contractor shall submit the results to the Engineer in sufficient detail as to prove the quality and quantity of the material to be extracted from the borrow area is acceptable for its intended use, all at the Contractor's own expense.

Approval of borrow pits shall apply only to those portions of the pit or area from which acceptable material can be obtained or produced. The Contractor shall conduct his operations in any approved pit or borrow area or portions thereof so as to produce acceptable material.

No use of material within the road reserve will be permitted unless the written approval of the Engineer has been obtained.

254 *Method Statement*

Prior to commencement of any works on borrow pits, the Contractor is required to provide to the approval of the Engineer with basis on the available Contract information, a statement highlighting the following:

1. The expected amount of borrow material required to be extracted;
2. The stations of works (i.e., km 5 - km 10) by which the material from each borrow pit will be used;
3. Locations of stockpiled materials;
4. A schedule showing the sequence and durations for the use of the borrow pits including the estimated date for opening of each;
5. The equipment and manpower to be used for each;
6. Procedure for opening of the borrow pit; and
7. Methodology of rehabilitation.

The Contractor shall plan his exploitation of the borrow pits in such a manner that the various materials extracted can be selected and either be loaded directly for use or be pushed to stockpile in the borrow area for later loading. In addition, the Contractor is required to extract the materials from locations with minimum haulage distance from the locations of works.

In the event that the Contractor is required to modify his methodology during construction, (i.e. materials not suitable, or the stockpiling within the borrow area is not possible which requires the Contractor to transport and temporarily stockpile the material in locations outside the borrow area, etc.), a notification of such revision shall be made to the Engineer for his approval highlighting clearly the reasons behind such revision.

The approval of the Engineer of this method statement or any subsequent revisions does not relieve the Contractor from the responsibility towards the quality and timely completion of the works.

255 Documents to be Submitted for Approval of Borrow Pits

Prior to the use of any material source (i.e., cut areas, Fill and pavement material borrow pits and boreholes or other water sources) whether stipulated in the contract documents or proposed by the Contractor, the following documentation is required to be submitted by the Contractor to the Engineer for his approval:

- Approvals from owners for use of the property (if any is required);
- Quantity of material available for use;
- The required test results pursuant to the respective specifications;
- The area of the project road where the material from the submitted source will be incorporated (by km chainages);
- A plan showing the location of the material source, existing levels taken and amount of overburden to be removed; and
- Proposed Haulage route and measured distance.

All costs related to locating of new material sources, making available of all required documentation and to the construction of haul roads shall be at the Contractor's expense.

The Engineer will not approve any material sources or the Employer pay for materials purchased, transported or used in the Works from newly proposed material sources by the Contractor (i.e., other than those stipulated in the documents (if any» before the written approval of the Employer and the concerned governmental agency has been obtained.

256 Opening of Borrow Pits

256.1 Removal of overburden

Prior to the opening of a borrow pit, the Contractor shall ascertain from the Engineer whether the removal of topsoil (overburden) is required and shall remove and stockpile such topsoil as instructed by the Engineer in accordance to **Section 213**.

256.2 Clearing and Grubbing

The Contractor is required to perform the necessary clearing and grubbing operation in accordance to Section 212 if the need is so indicated before excavation is to commence.

256.3 Excess Overburden

Should the Contractor encounter unsuitable material, the Contractor is required to remove the excess unsuitable material as overburden, as instructed by the Engineer, to the outer limits of the proposed borrow area. If the area of the borrow pit has increased, then the excess overburden shall be moved to the new outer limits. The excess overburden shall be used by the Contractor in the rehabilitation of the borrow pits as required by **Section 257**.

256.4 Excavation of Borrow Pits

Borrow material shall be excavated within the limits of depth and area based on the Contractor's material investigation results or as directed by the Engineer in a manner that will not jeopardize the use of the material for its intended use.

Where any borrow pit contains different types of materials in separate layers which require to be mixed in order to produce a suitable product, the materials shall be excavated over the full depth of the approved face in one operation without separation of the different types of materials.

The Contractor shall exercise all reasonable care to avoid contamination of approved borrow material by the inclusion of clayey or otherwise unsuitable material from the floor of the borrow pit or overburden or from unsuitable layers or from areas beyond the approved limits of the borrow pit. During loading, hard oversize material which will not breakdown during processing on the road shall be excluded as far as practicable.

During the course of borrow excavations and especially when excavating near the floor and outer boundaries of borrow area, the Contractor shall plan his operations in such a way that the amount of earthmoving that will be necessary for the finishing off of borrow pits is reduced as far as possible. Indiscriminate excavation without due regard for the desired final shape of the borrow pit will not be permitted.

The material in borrow pits shall be blasted or ripped and excavated in a manner that will ensure the effective breaking down of the material in the borrow pit before it is loaded. Rippable material which tends to break into large blocks shall be cross ripped.

256.5 Material Quality Control

Once the initial approval for the use of the borrow pit was given by the Engineer based on the material tests conducted, it is the responsibility of the Contractor to control his operations at every borrow pit where material is being excavated. He shall carry out sufficient tests on the material being excavated from the borrow pit in order to satisfy himself that the quality of the material complies with the specified requirements for the particular layer for which it is to be used. The results of the subsequent tests carried out by the Contractor shall be submitted to the Engineer upon request.

If there is any doubt concerning the quality of borrow material being excavated at any time, the Contractor shall notify the Engineer immediately and in any case before such material is brought for

use on the road. After further testing and inspection, if necessary, the engineer will Instruct the Contractor regarding the use of the material in the borrow area, or he may order that the borrow pit be rehabilitated and abandoned.

256.6 Dewatering of borrow pits

Borrow pits shall be continuously protected against the ingress of surface water and the Contractor shall construct such temporary banks as may be required to divert surface water and as far as possible his operations shall be planned in such a way that the borrow pit is self draining. Where this is not possible, borrow pits shall be dewatered by pumping. The Contractor shall be solely responsible for keeping borrow areas dry and ensuring that borrow material is sufficiently dry when required for use.

256.7 Access roads

The Contractor shall construct and surface appropriately such access roads as are required and shall provide temporary ditches and culverts in sufficient size to ensure that the existing drainage of the area is not restricted. The Contractor shall obtain the Engineer's prior approval to the siting of junctions of access roads with existing roads and shall comply with the Engineer's conditions of access, particularly regarding clearance of obstructions to provide adequate sight lines, temporary drainage or culverts and the provision of signs and traffic control.

257 Rehabilitation of Borrow Pits

Upon completion of his operations in a borrow area, the Contractor shall reinstate the entire area so that it blends with the surrounding areas and is suitable for the re-establishment of vegetation. For this purpose, the borrow area shall be shaped to even contours with no slopes steeper than 1 in 3, except where this may not be done, with the Engineer's permission, in rocky material.

All material in and around the borrow area, whether spoil from road building operations, excess stockpiled material, oversize material left in the borrow pit, material resulting from clearing and grubbing operations or excess overburden, shall be used or disposed of as directed by the Engineer.

Material not capable of supporting vegetation shall be buried and used in the shaping of the borrow pit and be subsequently covered by soft material. All available soft material shall be spread evenly to the thickness directed and where sufficient material is not available for this purpose to cover the entire area, the remaining portions shall be scarified along the contours so that undue erosion is avoided.

All haul roads shall be obliterated and the surface scarified, earth banks shall be constructed to prevent erosion and all damaged fences and other structures shall be re-instated.

The shaping and rehabilitation of the borrow pit shall be done in such a way that the borrow pit will be properly drained whenever practicable, and where required the Contractor shall place earth banks to divert any surface water away from the borrow area.

If so instructed by the Engineer, the Contractor shall fence off the borrow area with gates and shall be covered with topsoil and / or grassed at the Employer's own expense.

The rehabilitation of the borrow pit shall be to the satisfaction of the Engineer and in adherence to the environmental regulations stipulated and enforced. The Contractor shall submit to the Engineer a signed certificate from the landowner or the Department of Lands and the NEA stating that they are fully satisfied with the rehabilitation of any borrow pit.

258 Disposal of Borrow Material

The Contractor shall not have the right to use material obtained from borrow pits for any purpose other than for the execution of this Contract. He shall not dispose of any borrow material, whether processed or not, either by sale or donation to any person without the written authority of the Employer.

260 SUB-GRADES

261 Materials

For the Sub-grade layer forming the last 300 mm embankment layer, the Contractor shall use AASHTO Class A-1 and A-2 soils as specified in AASHTO M 145, or other materials which may be approved by the Engineer. Materials used must, in all cases, meet the minimum CBR requirements specified for sub-grade layer (Le., a minimum 4 day soaked CBR value of 15 when compacted) or as otherwise indicated in the drawings or instructed by the Engineer and should not include soils of Class A-6 and A-7.

Care shall be exercised to use the designated and specified materials in AASHTO, M 145, or other materials which may be approved by the Engineer, for the Sub-grade layer thickness. If unsuitable material is placed, it shall be removed and replaced at the Contractor's expense.

In the absence of suitable materials from cut sections, the Contractor shall use borrow materials pursuant to **Section 250** of these specifications.

262 Construction

Construction of Sub-grade layers in the case of embankment fill shall be pursuant to **Section 240** of the Project Specifications.

Construction of Sub-grade in the case of earth cuts and unless otherwise directed by the Engineer, the soil below the sub-grade level shall be scarified to a depth of only 150 mm, broken up, mixed, levelled and compacted, all within the limits shown on the drawings or directed by the Engineer. However if the soil encountered is found by test to be unstable and/or require more ballast than is indicated on the drawings or does not adhere to the material requirements for Subgrade as specified in **Section 261**, the unsuitable soil shall be removed to the depth directed by the Engineer, and replaced with suitable stable material as specified.

The width of the Sub-grade layers shall be as specified in the drawings or otherwise directed by the Engineer.

Sub-grade layers shall be compacted to 96% of MDD in accordance to the requirements of **Section 246** of these specifications.

Any areas that are found to be inadequately compacted or, in the opinion of the Engineer, exhibit instability, and such defects are due to the failure of the Contractor to comply with the requirements of the specification, the Contractor shall, at his own expense, carry out such further work as the Engineer may consider necessary for compliance with the terms of the specifications.

270 OVERHAUL

271 Scope

This section covers the haulage of overhaul material as defined herein from the place of excavation to the position of placement, where such haul distance is in excess of the free haul distance as defined herein.

a. Overhaul material

Overhaul material shall be transported material to which overhaul shall apply when hauled in excess of the free haul distance and shall include only the following:

- Gravel, soil or rock material used in the construction of fills, pavement layers.
- Spoil material resulting from the authorized excavations of the road prism, drains, and culverts.
- Sub-base and base materials.
- Sand for stabilization purposes.

b. Haul distance

The haul distance for cut to fill shall be the distance between the center of volume of the overhaul material in the cut before excavation and the center of volume of the portion of the fill constructed with the overhaul material.

The distance between the centers of volume shall be measured along the center line of the road and any additional distance of haul ascribed to the following of a different haul route will not be considered. Cut and fill volumes for ramps, road approaches and connections on either side of the road shall be considered as concentrated at the center line of the main roadway under construction for computing overhaul quantities for payment.

The haul distance for borrow material and cut to spoil material shall be measured along the shortest route determined by the Engineer as being feasible and satisfactory. Should the Contractor choose to haul material over some other longer route, computations for payment shall nevertheless be based on the haul distance measured along the shortest route designated by the Engineer. The haul distance for borrow materials and cut to spoil shall be measured to the nearest 0.1 km.

c. Free haul distance

The free haul distance shall be the distance up to which overhaul material may be hauled before overhaul becomes payable.

d. Overhaul distance

The overhaul distance applied shall be the haul distance as defined above, less the free haul distance as defined measured to the nearest 0.1 Km.

290 METHOD OF MEASUREMENT AND PAYMENT

291 Site Clearance

Measurement and Payment for Site Clearance shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to this section shall be made under the item heading "Site Clearance" in the Bills of Approximate Quantities.

The unit of measurement for clearing and grubbing shall be the hectare. The quantity shall be taken as the plan area in hectare (to the nearest 0.1 ha) designated by the Engineer and cleared and grubbed in accordance with these specifications.

The unit of measurement for tree removal is the number of removed trees whose girth measurement equal to or greater than the specified size and limited to those specified and directed by the Engineer. The girth of trees or stumps shall be measured at the narrowest point of the tree stump at 1.5m of its height above ground level.

Removal of smaller trees or stumps is considered incidental to the work or included as part of the clearing and grubbing operation.

No other measurements than those specified shall be made for any work included in this section.

The contract pay unit for Clearing and Grubbing is hectare which rate is in full compensation for clearing of the surface, grubbing of tree stumps, the removal of anthills, backfilling of cavities, preparation of natural surface, the removal, transporting and disposal of unsuitable material, removal and replacement with suitable material of top soil, and labour, equipment, surveying, tools necessary for the proper completion of the designated works. This pay unit shall exclude all widths of existing roads to the approval of the Engineer.

The contract pay unit for Removal of Trees is number which rate is in full compensation for all work necessary for the removal of trees, cutting of branches, backfilling of cavities, the removal, transporting and disposal of the broken trees, labour, equipment, surveying, tools necessary for the proper completion of the designated works.

No separate measurement or payment shall be made for work under the removal of top soil and preparation of natural surface section as it is deemed to be included in the clearing and grubbing pay item.

Any unsuitable material removed shall be paid for as part of the excavation works.

No other payments shall be made separately other works included in this section.

Bill Item Description Pay Unit

B.1 Clearing and Grubbing ha
B.2 Removal of Trees (circumference $\geq 1\text{m}$) No.

292 Obstructions

292.1 Removal of Obstructions

Measurement and Payment for removal of obstructions shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to this section shall be made under the Item heading "Removal of Obstructions" in the Bills of Approximate Quantities.

The elements designated to be removed shall be either measured in cubic metre to the limits shown on the plans and/or ordered and approved by the Engineer as in the case of existing bridges, box culverts and retaining walls; or per square metre to the limits shown on the plans and/or ordered and approved by the Engineer as in the case of the removal and disposal of existing buildings, dwellings or huts and stone or masonry fences; or in linear metre as in the case of Pipe Culverts inclusive of its encasement, wingwalls and headwalls.

The contract pay unit for Removal of Obstructions is cubic meter in the case of structures, square meter in the case of buildings and dwellings and linear meter in the case of number which rate is in full compensation for all items necessary for the proper completion of the work inclusive of excavating for removal of structures and obstructions and/or for back-filling and compacting the remaining cavity.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
B.3.1	Structures	m ³
B.3.2	Buildings, Dwellings, or Huts	m ²
B.3.3	Pipe Culverts	m

293 Relocation of Services

Measurement and Payment for Relocation of Services shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to this section shall be made under the item heading "Relocation of Services" in the Bills of Approximate Quantities.

Measurement of relocated services shall be in terms of submitted invoices to the Engineer pursuant to the relevant section in **Series 100** of these specifications and **Clause 58 in Division 4 - Conditions of Contract**.

The contract pay unit for Relocation of Services is Provisional Sum which rate is in full compensation for furnishing of material, labour, equipment, excavation, protection of the services concerned, backfilling, transportation, supplies and all other items necessary for the proper completion of the work.

Bill Item Description Pay Unit

B.4.1 Relocation of services	Provisional Sum
B.4.2 O/H and Profit on total sum of Item B.4.1%	

294 Roadway Excavation

Measurement and Payment for Roadway Excavation shall be as below unless specified 'otherwise in the Appendix to Specifications.

All measurement and payments related to this section shall be made under the item heading "Unclassified Excavation" in the Bills of Approximate Quantities.

Measurement of roadway excavation shall be made in terms of cubic meter of Unclassified excavation as defined pursuant to Section 203.

The limits of any excavation are determined by the grades and sections as shown in the drawings or as directed by the Engineer with a tolerance for excavation in cuts of +/- 25 mm from the authorized profile grade for the formation level (Subgrade). The final construction slopes, lines and grades shall be true, correct, and accurate, and according to approved cross sections.

Measurements will be made for unsuitable materials actually excavated and removed to obtain proper compaction in cut section and in foundations for fill sections.

Excavation quantity computations shall be based on the original cross sections, taken jointly by the Contractor and the Consultant before clearing and grubbing operations, which is observed by and attested to by the Engineer and final cross sections developed from the typical sections in the drawings and/or actual final levels achieved on site (if different) based on the Contractor's staking notes as checked and attested to by the Engineer. The Engineer may at any time direct the Contractor to take additional cross sections within an area in order to more accurately delineate the quantity of excavation. Any materials removed or excavated before the abovementioned cross sections have been taken and approved by the Engineer will not be paid for.

The volume of roadway excavation shall be computed by the Contractor and checked by the Engineer. The

Engineer will check all or any part of the work, as he deems necessary, to determine conformance to the approved lines, grades, elevations and cross sections with the Contractor lending the necessary assistance at his own expense via the provision of any required equipment, labour and field staff. Where discrepancies are found in the work performed (i.e., over excavation below the depth required) and those discrepancies are outside the tolerances set, no consideration of these discrepancies shall be taken in any quantity measurement conducted and the Contractor shall make the necessary corrections at his own expense.

Where it is impractical to measure material quantities by the cross section method due to the erratic location of isolated deposits, acceptable methods involving three-dimensional measurements may be used, when approved by the Engineer.

The pay quantity for unclassified excavation shall be the total roadway excavation volume calculated from the "cleared level" to the top of the formation level (subgrade) plus the volume of authorized excavation resulting from the removal of unsuitable material plus any material volume obtained from excavation of standard side ditches pursuant to **Section 360**.

The end area method will be used or the calculation of the of cut by adding the end areas of two successive cross sections. dividing by two and multiplying by the distance between the two sections.

The contract pay unit for Unclassified Excavation is cubic meters which rate is in full compensation for all excavation work, de-watering, trimming of slopes, preparation of sub-grade, clean-up, haulage and disposal of surplus materials to the free haul distance pursuant to **Section 270**, all work required for the proper formation of embankments as specified in **Section 240** including sub-grade layer, replacement of the removed unsuitable material with suitable stable material, testing, surveying and quantity computations, labour, equipment and all other items necessary for the completion of the work as specified but excluding any rock fill work.

Bill Item Description Pay Unit

B.5 Unclassified Excavation m³

295 *Fill and Embankment Forming*

Measurement and Payment for Fill and Embankment shall be as below unless specified otherwise in the **Appendix to Specifications**.

No work item within this Section is a measurable or a pay item with the exception of Rock Fill.

All measurement and payments related to rock fill shall be made under the Item heading "Rock Fill" in the Bills of Approximate Quantities.

Rock fill embankment shall be measured by the cubic metre of compacted material measured in the completed embankment. The compacted volume of rock fill used in the pioneer layer shall be determined by taking 70% of the loose volume in trucks. The compacted volume of rock fill used in the subsequent layers shall be based on the specified levels and cross-sections.

The contract pay unit for Rock Fill is cubic meters which rate is in full compensation for provision of the material, selecting, handling, haulage to the free haul distance pursuant to **Section 270**, stockpiling, processing, depositing in position, spreading, watering, and special compacting in layers, trimming of slopes to profiles, surveying works, and all other items necessary for the proper completion of the work. The tendered rate shall take into consideration the effect of consolidation, settlement within and beneath the fill including any additional material required to be placed.

Bill item Description Pay Unit

B.6 Rock Fill m3

296 Borrow Excavation

Measurement and Payment for Borrow Excavation shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to borrow excavation shall be made under the item heading "Borrow Excavation" in the Bills of Approximate Quantities.

Measurement of borrow material shall be that quantity resulting from subtracting the total volume of unclassified excavation as measured under **Section 294** less the volume of material obtained from cut section and decided by the Engineer to be unsuitable material from the total volume of embankment.

The total volume of embankment shall be computed from the approved cross sections from on the "Cleared level". The end area method will be used for the calculation of the volumes of embankment by adding the end areas of two successive cross sections. dividing by two and multiplying by the distance between the two sections.

Any gates or fences requested by the Employer as part of the rehabilitation of borrow pits shall be paid by the Employer in day works.

The contract pay unit for Borrow Excavation is cubic meters which rate is in full compensation for material haulage to the free haul distance given pursuant to **Section 270**, all work related to the opening, material extraction and rehabilitation borrow pits and all work required for the proper formation of embankments as specified in **Section 240** including Sub-grade layer but excludes any rock fill work, testing, surveying and quantity computations, labor, equipment and all other item necessary for the completion of the work as specified.

Bill Item Description Pay Unit

B.7 Borrow Excavation m³

297 Subgrades

No item within this section is measured or paid as the cost of performing the work shall be deemed to form part of the Roadway Embankment and Excavation works.

298 Overhaul

Measurement and Payment for Overhaul shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to material overhaul shall be made under the item heading "Overhaul" in the Bills of Approximate Quantities.

The quantity of material overhauled shall be measured in cubic meter of material hauled over the free haul distance as defined in **Section 270**.

Overhaul of materials in excess of that required or for a further distance as may be necessary for the completion of the works or otherwise not authorized by the Engineer will not be measured for payment purposes.

The contract pay unit for Overhaul is kilometer which rate is in full compensation for material transportation and dumping in the required areas for distances in excess of that stipulated as free haul distance pursuant to **Section 270**.

SERIES 300

DRAINAGE WORKS

SERIES 300 – DRAINAGE

301 EXCAVATION AND BACKFILL

302 Description

This work shall consist of the excavation, backfill or disposal of all materials required for the construction of concrete drains, repair of existing masonry drains and pipe culverts, construction of corrugated pipe, pipe arch and reinforced concrete pipe culverts, manholes and other structures for which excavation is not otherwise provided, in accordance with the specifications and in reasonably close conformity with the lines, grades and typical cross sections shown on the Drawings or established by the Engineer. The works includes all necessary baling, drainage, pumping, sheeting and the construction of all material obtained from such excavation and backfilling to the level of the original ground or finished surface.

303 Construction Requirements

303.1 General

The contents of this Sub-Section shall be read in conjunction with the relevant section within **Series 1200** of these specifications. Should any discrepancies arise, the works as described in this section shall prevail.

The excavation works shall be carried to the elevation shown on the Drawings or as established by the Engineer. No concrete shall be poured prior to the approval of the excavated surfaces by the Engineer. Over depth excavation below the foundation elevation approved by the Engineer and over width excavation beyond the lateral limits for the structure shown on the drawings or directed by the structure and shall be poured monolithically with the cast-in-place structure. No payment will be made for unauthorized over depth and over width excavation and the concrete backfill shall be at the Contractor's expense.

The foundation pits shall be excavated according to the outlines of the structure shown on the Drawings and shall be of sufficient size to permit the placing of the full width and lengths of the structure. Rounded or undercut corners and edges of foundation excavation will not be permitted.

When unstable material or other unsuitable material is encountered within the designated excavation limits the Contractor, at the direction of the Engineer, the Contractor shall excavate such unstable

material and replace it with suitable and stable backfill material or Class "C" Concrete. The stabilization of the excavated surfaces, including the degree of instability of the existing material, the necessary depth of excavation and suitability of the proposed backfill material, shall be approved by the Engineer.

➤ **Reinforced Cast-in-Place Drains**

The excavation width shall be no greater than the external dimensions of the drain plus 300 mm on each side when the Contractor elects to use external forms, or the external dimensions of the drain plus 80 mm each side when he elects not to use external forms. If the Contractor elects to use forms and the permissible excavation limits are exceeded, the entire backfill of the drain to the top of the drain shall consist of bedding concrete backfill as specified in **Sub-Section 303.3**. The concrete backfill shall be at the Contractor's expense and no additional payment will be made.

If the Contractor has elected not to use forms and the excavation is wider than that specified or shown on the Drawings, he shall either use forms or increase the thickness of the side walls of the drain. Over depth excavation shall be compensated for by increasing the thickness of the concrete base of the drain or as otherwise directed by the Engineer. Provided that the Engineer does not direct the Contractor otherwise, the additional concrete required shall be at the Contractor's expense.

303.2 Scheduling of Excavation

The Contractor shall so schedule the work that no excavation will be left in an exposed condition for a period greater than 30 days unless otherwise approved by the Engineer. If the Contractor fails to meet this requirement, the Engineer will order the Contractor to suspend further such excavation until the Contractor's construction progress enables him to meet the requirement.

The Contractor shall schedule roadway excavation, embankment work and drainage work so that they complement each other. If the Contractor's earth work progress exceeds the progress of the drainage work to the point where the roadway becomes a dam to cross drainage, the Engineer will order the contractor to open adequate waterways through the roadway to provide positive drainage at all times. Any damage to the roadway caused by water passing through these openings shall be repaired at the Contractor's expense.

All excavation shall be watered and all concrete work shall be performed in the dry. The cost of all piping off or drainage or water shall be the responsibility of the Contractor and no additional compensation will be made to the Contractor therefor.

No special payment will be made for the provisions of positive drainage nor shall the Contractor's conformance to these provisions form the basis for a claim for additional payment.

303.3 Bedding Concrete

Bedding concrete shall comply with the following requirements:

- Plasticity Index of aggregates: zero (0)
- Maximum size of aggregate: 50mm
- Minimum cement content:
by volumetric measure 3 sacks (50 kg per sack) per m³
- Ultimate compressive strength of
152 mm dia. cylinders at 28 days: not less than 7 MPA (70 kg/cm²)

The slump shall be as directed by the Engineer to suit the field conditions of various aggregates in order to ensure proper placement and bedding.

303.4 Backfilling

All drainage and incidental structures shall be backfilled in accordance with the below requirements.

- Only approved granular materials that will produce a dense, well-compacted backfill shall be used for backfilling existing or new drainage structures and incidental work. Materials such as sod, debris and soil containing organic matter shall not be used. Rocks may be used in the backfill only with the express permission of the Engineer and only when voids between the rocks are filled with fines and properly densified.
- The selected approved material shall be placed in layers and compacted by tamping with mechanical tampers or hand tampers; heavy equipment shall not be used for compacting the backfill. Each layer shall be compacted to 95% MOD as determined by AASHTO T 180 (Method D).

Each successive layer shall contain only that amount of material which will ensure proper compaction, but in no case shall any layer be greater than 150 mm (loose measurement) in depth. The moisture content of the solid to be used for backfill shall be uniform.

- No backfill shall be placed against any structure without permission of the Engineer. In general, no cast-in-place or precast component of the Works shall be subjected to the pressures of backfilling or to live loads until after the expiration of the period designated for the removal of forms as stipulated in the applicable Sections of the Specifications. At the direction of the Engineer, this period may be extended if subnormal curing conditions exist. Backfill, placed around drains and manholes shall be deposited on both sides to
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approximately the same elevation at the same time. Special care shall be taken to prevent any wedging action against the structure. The slopes bounding the excavation shall be stepped when necessary, to prevent such wedge action.

310 REINFORCED CONCRETE DRAINS AND COVERS

311 REINFORCED CONCRETE DRAINS

311.1Description

Reinforced concrete drains shall be constructed in accordance with the Specifications and in reasonably close conformity with the lines, grades and dimensions shown on the Drawings or established by the Engineer.

311.2Materials

Concrete shall conform to the requirements of **Series 900** of these specifications.

Reinforcing steel shall conform to the requirements of **Series 800** of these specifications.

Joint sealing and joint filler shall conform to the requirements of the relevant section within **Series 1200** of these specifications.

311.3Construction Requirements

Removal of existing drainage structures shall conform to the requirements of the relevant sections within **Series 200** of these specifications. Excavation and backfill for concrete drains shall conform to the requirements of **Section 301**.

Forming, fabrication and placement of reinforcement, expansion joints placement at locations as shown in drawings, concrete placement, finishing and curing shall adhere to the requirements of **Series 700, 800, 900 and 1200** of these specifications.

The area adjacent to drains shall be backfilled with approved material to the top edges of the drain walls to the elevation shown on the Drawings. The backfill shall be placed and compacted to a density equal to or greater than the adjacent undisturbed ground. If the drain backfill falls within an area which is designated on the Drawings or in the Specifications to be compacted, the drain backfill shall be compacted in accordance with the compaction provisions for the adjacent materials.

311.4 Connection to Existing Drains

Where drains constructed under this Contract are to be connected to existing drains, neat openings of the size necessary to accommodate the new drain shall be made in the masonry or concrete of the existing drain and a junction shall be constructed with cast-in-place concrete work in accordance to this Sub-Section.

The ends of the new drain walls and the invert slab shall be finished flush with the inside walls and the invert of the existing drain. All joints shall be paged with cement mortar and troweled smooth.

312 PRECAST CONCRETE DRAIN COVERS

312.1 Description

This work shall consist of the construction of precast concrete covers for drains in accordance with the Specifications and in reasonably close conformity with the lines, grades, sizes, shapes and typical sections shown on the Drawings or established by the Engineer.

312.2 Materials

Precast concrete work shall conform to the requirements of the relevant sections within Series 900 of these specifications.

312.3 Construction Requirements

Precast concrete drain covers shall be installed on previously constructed concrete drains at locations shown on the Drawings or established by the Engineer.

Units shall be installed level with adjacent units, with tight joints and be stable. Uneven bearing surfaces shall be corrected to prevent the unit from rocking by grinding down high points and/or building up low points with cement mortar bedding. The use of small stones, metal or wood wedges, or other materials not integral with the concrete structure will not be permitted.

320 DRAINAGE PIPES

321 Galvanized Corrugated Steel Pipe & Pipe Arch Culverts

321.1 Description

This work shall consist of furnishing and installation of Galvanized Corrugated Steel Pipe and Pipe Arches of the various types and sizes shown on the Drawings at such places as indicated on the Drawings or decided by the Engineer in accordance with these Specifications and within reasonable close conformity with the lines and grades given. The works shall include all necessary excavation, bedding,

backfilling, bituminous coating, construction of concrete surround where required, construction of headwalls and wingwalls, construction of steel end sections and mortared rip-rap slope protection at the ends of the culverts.

321.2 Materials

A. Pipes

Galvanized corrugated steel pipe, galvanized corrugated steel pipe arch, galvanized coupling bands and fittings and rubber gaskets, shall all conform to AASHTO M 36M.

Pipes and pipe arches shall have helical corrugations with a continuous lock seam extending from end to end of each length of pipe. To facilitate field jointing, the ends of pipe lengths with helical corrugations may be rerolled to form at least 2 annular corrugations or to form upturned flange or both.

Alternatively, pipes and pipe arches shall have annular (circumferential) corrugations with lap joints fastened with rivets or resistance spot welds.

The use of multi-plate pipes and pipe arches, furnished in separate panels and bolt assembled on Site, shall be subject to approval. Plates and accessories shall conform to AASHTO M 167.

Sheet thickness pipe and pipe arch shall be in accordance with Table 5 of AASHTO M 36M and as shown on the drawings for each separate installation, depending on the pipe size and on the type and height of fill around and over the pipe.

Coupling bands shall have helical or annular corrugations to match the corrugations of the pipe being jointed.

Unless shown otherwise on the Drawings, rubber gaskets shall be fitted to couplings to ensure water tightness. Gaskets shall be either the closed cell expanded rubber type or O-ring type as appropriate and dimensioned to suit the pipe size.

Bituminous coating shall consist of an on Site coating of either a hot applied bituminous material conforming to AASHTO M 190 or ASTM A 849 or a cold applied, approved proprietary mastic material specifically formulated for corrugated pipe application. The coating shall be Type A (full internal and external coating). The ASTM A849 equivalents are Type A-1.

Concrete for cradles, haunching and pipe encasement shall be class "B" concrete and shall conform with the relevant requirements of **Series 900** of these specifications.

Headwalls, wingwalls and aprons shall be to Class "A" concrete and shall conform to the requirements of **Series 900** of the Project Specifications.

Steel reinforcement shall conform to the requirements of **Series 800** of the Project specifications.

Granular material used as bedding for pipes shall consist of sand or sandy soil essentially from clay or organic material and with 90-100% passing 4.75 mm sieve and 0-5% passing 0.075 sieve.

The backfill material around and over the pipes shall conform with the relevant requirements of **Sub-Section 303.4**.

The selected pipe thicknesses and specifications should conform to HB 45 loading.

Pipes not available for testing and inspection during manufacture will be tested on the job site in accordance with the Specifications.

321.3 Submissions

The Contractor must submit for the approval of the Engineer the following:

- The manufacturers literature and recommendations for use of the particular material;
- A list of previous projects in which the manufacturer supplied the material for;
- Complete inventory of physical properties, standard drawings & specifications of all elements which the Contractor proposes to use and has included in the pricing.

All submissions shall adhere to the requirements of the relevant section within Series 0 of these specifications.

321.4 Construction and Installation

Below are guidelines for the installation of Corrugated Metal Pipes. In the case that the manufacturer's requirements for installation differ, the manufacturer's documentation shall take precedence.

➤ Excavation and Forming Bed for Pipe

Notwithstanding the contents of **Sub-Section 331.1**, the Contractor shall cut channels into the previously constructed and compacted embankment measured at embankment height from the top of fill or twice the nominal span of the pipe whichever is less.

Unless otherwise noted on the plans, the excavated channel shall not be wider than the external diameter or span of the pipe plus thirty (30) centimeters on each side.

Any excess excavation in depth of width channel shall be filled with the same grade the pipe bedding concrete as specified in **331.3** at the Contractor's own expense.

➤ Pipe Installation

No pipe culverts shall be placed until the excavations and foundations have been approved by the Engineer.

Provision for pre-camber by the Contractor for any pipe to allow for possible future settlement shall on no account be attempted unless precise details and instructions in respect of such pre-camber are issued by the Engineer.

The inside of each pipe shall be cleaned and brushed out and the pipe inspected for any major or minor damage immediately prior to laying. Pipes with major damage shall be rejected.

Prior to bituminous coating, the pipes shall be inspected by the Engineer for any damage to the galvanizing. Repairs to damaged areas shall be carried out as instructed by the Engineer. The application of bituminous coating (type A) shall be in accordance with the requirements of AASHTO M190 or ASTM A849 for hot application or in accordance with the manufacturer's instructions for cold application of approved bituminous materials.

All pipes shall be fully and firmly bedded over the entire length of each pipe and shall be laid true to line, level and grade, commencing at the downstream end unless otherwise approved. Inverts shall be properly matched to form a continuous line free of appreciable irregularities.

Bedding for corrugated steel pipes shall be flat or slightly v-shaped, to facilitate subsequent placing and compacting of backfill under the pipe haunches.

Where any section of the pipeline is left temporarily unconnected to manholes or other terminal points

or otherwise uncompleted for more than 12 hours, the ends of the pipeline shall be temporarily plugged in an effective manner to prevent ingress of water, soil or debris.

The tolerance on horizontal alignment shall be plus or minus 20 mm between manholes or other terminal points. The tolerance on invert elevations shall be plus or minus 20mm for gradients of 0.4% or steeper, and $50 \times S$ for gradients less than 0.4%, where S is the slope of the pipe expressed as a percentage.

Pipes shall be installed and jointed in accordance with the relevant requirements of ASTM A 798 (for corrugated pipes furnished in one piece and jointed on site) or ASTM A 807 (for pipes furnished in corrugated plate form and bolted on site, and in accordance with the manufacturer's instructions.

To ensure adequate water tightness in the case of bolted construction, a suitable seam sealant tape of sufficient width, thickness and consistency shall be installed in the bolted seams to cover all rows of holes and fill all voids in plate laps.

Assembly of corrugated plates shall be such that, for installations proceeding upgrade, each successive plate shall lap on the outside of the previous plate and for installations approved to proceed downgrade each successive plate shall lap on the inside of the previous plate. Longitudinal laps shall, wherever practicable, be along the sides.

Transverse joints shall be installed in accordance with the appropriate requirements for each type and diameter of pipe and shall provide a watertight connection between adjoining pipe lengths.

Minor damage to galvanized and bituminous coatings occurring during handling and installation, shall be repaired on site in accordance with the requirements of AASHTO M36M or ASTM A849 as relevant as recommended by the pipe manufacturer in each case.

Prior to commencing of backfilling, the larger pipes shall be internally strutted by means of approved temporary timber sills, caps and struts placed vertically at regular intervals along the line of pipe, as recommended by the manufacturer.

Backfills between pipe culverts shall be placed and compacted in equal layers not exceeding 150mm such that the difference in backfill levels on either side of individual pipes does not exceed 150 mm at any time.

The tolerance on pipe structure dimensions shall be $\pm 2\%$ of design dimensions, after installation and during and after completion of backfilling.

The pipe which, after installation or after backfilling, is found to be misaligned or has unduly settled or does not conform to the 2% tolerance on pipe shape, shall be removed and reinstalled as directed.

Any pipe which is not in alignment or which shows any undue settlement after laying, but before the fill is placed, shall be taken up and relaid at the Contractor's expense. When shown on the plans, or as

directed by the Engineer, sufficient camber shall be built into the pipe structure to allow for settlement from fill loads.

Prefabricated steel end sections where approved for use at the ends of the corrugated steel pipe culverts, shall be the proprietary flared or other steel sections fabricated by the manufacturer. Sections shall be beveled to suit the skew and embankment slope as appropriate. Each end section shall be securely bolted in position in accordance with the manufacturer's instructions.

Embankment slopes at inlet and outlet steel end sections shall be protected by construction of mortared stone rip-rap as shown on the drawings and in accordance to Series 1400 of Project Specifications. Slope protection shall be constructed between, around and over the steel end sections to a distance of at least 1.5 m from the edges of the single or multiple end sections as appropriate.

➤ **Bedding**

The concrete bedding of pipe culverts shall conform to the requirements of **Sub-Section 331.3** of these specifications.

➤ **Backfilling**

Notwithstanding the contents of **Sub-Section 331.4**, the Contractor shall complete the backfill around these culverts to the level of the original ground line for the full width of the excavation area. If the top of the culvert extends above the original ground line, the Contractor shall continue the compacted backfill to the top of the Culvert for a width of 1.5 times the maximum external width of the culvert on each side of the centerline of the culvert for the full width of the roadway embankment. If the roadway embankment is in place at the time of backfilling, the Contractor shall backfill around the culvert, as outlined above, to the top of the culvert.

322 Reinforced Concrete Pipe Culverts

322.1 Description

This work shall consist of furnishing and installing reinforced concrete pipes in the types, sizes and locations as shown on the Drawings or ordered by the Engineer in accordance with these specifications and in reasonable close conformity with the lines and grades given. The work shall include all necessary excavation, bedding and backfilling for such installations.

322.2 Materials

Reinforced concrete round pipes shall meet all applicable requirements of the standard specification for Reinforced Concrete culverts, Storm drain, and Sewer Pipe - AASHTO M 170. Unless otherwise shown on the plans or specified in the Contract documents, Class V pipes shall be furnished.

322.3 Acceptance and testing

Acceptability of pipes in sizes less than one and eighty three hundredth (1.83) meters in diameter shall be based on one or more of the below requirements as may be deemed necessary by the Engineer:

- a. The results of three edge bearing tests for the load to produce a twenty five hundredth (0.25) millimeter crack and the ultimate load performed on not less than three (3) percent of all pipes furnished (AASHTO M 170).
- b. The loading to destruction of selection pieces of pipe to determine ultimate strength, area and placement of steel and absorption characteristics of the concrete (AASHTO M 170).
- c. Absorption tests on selected samples from the wall of the pipe (AASHTO M 170).
- d. By inspection of the finished pipe to determine its conformance with the design prescribed in this specification and its devoid from defects.
- e. Pipes not tested during manufacture will be tested on the job site in accordance with the specifications.

322.4 Construction Requirements

All excavation, bedding and backfilling shall adhere to the contents of **Sub-Section 321.4**.

➤ Pipe Laying

No pipe culverts shall be placed until the excavations have been approved by the Engineer. Variations in the laying lengths of two (2) or more pipes forming a multiple culverts shall not exceed two (2) centimeters. The laying length of any pipe shall not under-run the theoretical design length by more than two (2) centimeters.

The pipe shall be carefully laid true to lines and grades given, with hub, bell, or groove ends upstream and with the spigot or tongue end entered the full length into the adjacent section of pipe. If the pipe is to be laid below the round line, a trench shall be excavated to the required depth and a width sufficient to permit thorough tamping of the backfill under the haunches and around the pipe. Any pipe which is not in alignment or which shows any undue settlement after laying, but before the fill is placed, shall be taken up and relaid at the Contractor's expense.

When shown on the plans, or as directed by the Engineer, sufficient camber shall be built into the pipe structure to allow for settlement from fill loads. All joints, shall be sealed with an approved cement mortar. The jointing mortar shall be 1:2 Cement: Sand by volume. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar, but shall in no case exceed twenty seven (27) liters per fifty (50) kilogram sack of cement. The sand shall conform to AASHTO M 45 and cement shall conform to AASHTO M 85. When approved by the Engineer, air entrained Portland cement conforming to AASHTO M 154 may be used. Rubber gasketed joints when approved by the Engineer, may be used at no additional cost to the Employer. Where permissible lift holes have been used, the holes shall be carefully filled with an approved expansive mortar to provide a water tight section. The mortar shall be finished flush on the inside of the pipe and shall be properly cured on the outside. Lifting devices shall have sufficient bearing on the inside of the pipe to avoid damage resulting from a concentration of stresses around the lift holes.

330 DROP INLETS

331 Description

This work shall consist of the construction of drop inlets in accordance with the Specifications, and in reasonably close conformity with the lines and grades shown on the Drawings or established by the Engineer.

332 Materials

Concrete shall conform to the requirements of **Series 900** of these specifications.

Reinforcing Steel shall conform to the requirements of **Series 800** of these specifications.

333 Construction Requirements

333.1 Excavation

The method of excavation for inlets shall be classified as structural excavation and shall conform to the requirements of relevant section of **Series 1200** of these specifications.

333.2 Concrete

The composition, consistency, proportioning, batching, mixing, and transportation of the concrete shall conform to the requirements of **Series 900** of these specifications.

The formwork for, and the placing, curing, and protection of the concrete shall conform to the requirements of **Series 700** of these specifications.

Class "A" Concrete shall be used unless otherwise shown on the Drawings or ordered by the Engineer.

333.3 Reinforcement

The method of reinforcing shall conform to the requirements of **Series 800** of these specifications.

333.4 Backfilling

Backfilling shall conform to the requirements of **Sub-Section 303.4**.

333.5 Cleaning

All inlets shall be thoroughly cleaned of any accumulations of silt, debris, or foreign matter of any kind, and shall be free from such accumulations at the time of final inspection.

340 Cast Iron Covers and Frames for Manholes and Inlets

341 Description

The works shall include but not be limited to the supply, rust protection and installation of cast iron manhole covers and frames and inlet grating and frames of the approved types all as per drawings, specifications and instructions of the Engineer.

342 Materials

- Cast iron covers and frames for manholes and inlets shall be made of cast iron heavy duty solid. They shall be of sound manufacture and free from projections or voids and shall be treated with two heavy coats of an approved tar compound (Inertol thick 49 or equal). Thereafter, the covers shall be fixed on to the previously installed frames after lining from inside with grease and sand mix.
- Frames shall be single seal, square and covers shall be of the type and of the dimensions shown on the drawings.
- Prior to transporting any of the material to site the Contractor shall submit two samples of each type of cover and frame to be used for the approval of the Engineer and shall carry out the required tests as per approved international specifications. The submission of samples shall be in adherence to the requirements of **Series 0** of Project Specifications. All cover and frames used shall conform to the approved samples. The approved samples shall be retained by the Engineer until the completion of the Project.
- After erection all rust and scale loose paint shall be entirely removed by means of sand blasting or if the Engineer considers it sufficient by the steel wire brushing or another approved means.
- All surfaces shall immediately thereafter be coated with two coatings of bituminous paint, thick Inertol 49 or with similar approved product. The coating shall be applied in absolutely dry weather. Prior to the second coating the first coating should be dry.

Except as otherwise specified on the Drawings, the grades and qualities of materials under this Sub-Section shall conform to the applicable standards of AASHTO and ASTM.

343 Construction Requirements

It is not allowed to cast the frame of the manhole cover together with the roof slab of manhole. Covers and frames shall be fixed in such a way to match adjacent surface levels with tolerances not exceeding plus or minus 3mm. Before the maintenance period expires, the Contractor shall check all manhole covers and readjust them if they were in excess of above-mentioned tolerances.

350 EXISTING DRAINAGE ELEMENTS

351 Clean & Maintain Existing Drains and Culverts

351.1 Description

This work shall consist of the cleaning and maintaining of existing drains and pipe culverts as directed by the Engineer.

351.2 Construction Requirements

This work shall include the checking of all inlets and outlets, removal and satisfactory disposal of all materials of whatever nature encountered to the original floor invert, and maintain the protection works, all to the lines and grades specified on the Drawings or as directed by the Engineer.

352 Manhole and Catch Basin Adjustment

352.1 Description

This work shall consist of adjusting the level of existing manholes and catch basins in accordance with the Specifications to match road final level and conform with the Works as shown on the Drawings or as indicated by the Engineer. Adjustments shall be achieved through the addition or removal of cast-in-place concrete, precast concrete sections, grade rings, adjustment units or bricks.

352.2 Materials

➤ Concrete

Concrete for cast-in-place structures shall conform to the requirements of **Series 900** of these specifications and shall have a 28-day minimum compressive strength of 35 MPa.

➤ Reinforcing Steel

Steel reinforcement shall conform to the requirements of **Series 800** of these specifications.

➤ Precast Concrete Components for Manholes

Precast Units shall conform to the requirements of **Series 900** of these specifications.

➤ **Frames and Covers, Frames and Grates**

Frames and covers or grates shall be carefully removed from the existing structures and reused in the completed work.

➤ **Brick**

Brick shall be precast concrete brick meeting the requirements of **Series 900** of these specifications. Clay bricks will not be permitted.

➤ **Masonry Mortar**

Masonry mortar shall consist of one (1) part Portland Cement to one (1) part hydrated lime (ASTM C-207) and six (6) parts masonry sand.

352.3 Construction Requirements

A. General

All structures shall be adjusted or rebuilt plumb and true to alignment and grade.

During the progress of the work and until completion and final acceptance, all structures shall be kept clean and free of all foreign material. Prior to adjusting a structure, the existing frame and grate or cover shall be carefully removed and salvaged. Once a structure has been adjusted the salvaged frame and grate or cover shall be set to the correct elevation on the adjusted structure.

The existing frame and grate or cover shall be set to new grade using concrete brick and mortar, precast concrete adjustment units, grade rings and/or precast concrete components.

B. Excavating, Backfilling and Compacting

Excavating, backfilling and compacting for the adjustment of existing drainage elements shall conform to **Sub-Section 301**.

C. Adjusting

➤ **General**

Where structures are to be extended using bricks, the total height of bricks shall not exceed 600mm. All existing mortar and brickwork shall be removed from the top of the existing structures prior to adjusting with precast concrete adjustment units.

When structures are to be extended using precast concrete adjustment units, the total height of adjustment units shall not exceed 1.0 m.

➤ **Cast-In-Place Structures**

Where the top is to be lowered the concrete shall be carefully removed to the required elevation and exposed steel reinforcement shall be cut off as required.

The upper section of the structure shall then be rebuilt to its original configuration using cast-in-place concrete and steel reinforcement as required.

To raise the top of structures with a tapered upper section, the concrete in the structure shall be removed for the entire depth of the taper. The upper section, including straight walls and taper shall then be rebuilt to the original configuration using cast-in-place concrete and steel reinforcement as required.

To raise the top of straight walled structures, the existing roof section, if any, shall be removed. The existing walls shall then be extended upward and the roof section, if any, rebuilt to the original configuration using cast-in-place concrete and steel reinforcement as required.

Where cast-in-place units are to be raised with cast-in-place concrete, the top surface of all existing walls shall be roughened before the walls are extended upwards. Concrete shall be placed in accordance with **Series 900** of these specifications.

All inside wall protuberances shall be removed once the forms are stripped.

➤ **Precast Concrete Structures**

Where structures having either a tapered or flat slab top section are to be raised or lowered, the top section shall be carefully removed and salvaged and riser sections of suitable height shall be carefully removed, substituted for, or added, to the existing riser sections. The top section shall then be replaced.

To lower the top of structures other than described above, the concrete shall be removed, exposed steel reinforcement cut off as required and the concrete refinished.

➤ **Backfilling**

The area adjacent to the adjusted structure shall be backfilled with approved materials to the top of grate elevation. Backfill materials shall match the quality of adjacent materials and shall be compacted in accordance with the Specifications for the adjacent materials.

361 Description

This Sub-Section covers all work in connection with the excavation and construction and maintenance throughout the contract duration of ditches (open ditches, cut-off ditches, side ditches, etc.) at locations an to the sizes, shapes, grades and dimensions as shown on the drawings or directed by the Engineer.

362 Excavation

The ditch excavation is classified as follows:

➤ Standard ditches excavation

Standard ditches excavation shall consist of excavating ditches and channels inside or outside road prism of whatever shapes required, all contiguous with the subgrade slope line as shown in the cross - sections or as directed by the Engineer. The material removed shall be classified as "Unclassified Excavation" as defined in the relevant sections within Series 200 of these specifications.

➤ Drainage borrow ditches

The drainage borrow excavation shall be construction to the grade line and cross - section shown on the drawings or as directed by the Engineer. The materials removed shall be classified as "Borrow excavation" as defined in the relevant sections within **Series 200** of these specifications.

All materials excavated regardless of source shall be used for the construction of embankments or fill unless otherwise directed by the Engineer.

Care shall be exercised to avoid excavation below the required grade for ditches as any excavation below grade shall be backfilled with suitable material and compacted to the density instructed by the Engineer.

363 Shaping

Upon completion of the excavation, ditches of all types shall be trimmed and shaped neatly in conformity with the specified grade and cross - sections by the use of suitable equipment. All projecting rock, stumps, roots or similar shall be removed.

364 Lining

When applicable and as instructed by the Engineer, the ditches shall be lined with 25 cm mortared rip-rap protection to avoid excessive erosion.

Mortared rip-rap lining shall follow the requirements stated under **Series 1400** of the Project Specifications.

370 GEO-TEXTILES

371 Description

This Sub-Section covers the supply and installation of the Geo-textiles fabric in position as specified or instructed by the Engineer. The material will serve as a separator/filter/capping layer as well as provide certain reinforcement to the soil.

372 General Properties

The material shall be composed of strong, rot proof polymeric yarn or fibers oriented into a stable network which retains its relative structure during handling, placement and in service. It shall have satisfactory resistance to deterioration by ultraviolet light, heat exposure, acid and alkali action and shall be indestructible by micro-organisms and insects.

372.1 *Strength Requirements*

This material should be made of a non-woven fabric of moderate strength with a high hydraulic capacity and high elongation at breaking point. Typical physical strength properties for the fabric are given below:

	Newtons	LBS	%
Grab Tensile Strength N (lbs) as per ASTM D 1682	890	(200)	
Elongation at Breaking % as per ASTM D 1682			100
Burst Strength N (lbs)	1330	(300)	

Seams - strength shall not be less than 90% of the tensile strength in any principal direction.

372.2 Hydraulic Requirements

In this specification, the general principles necessary for the material to meet the hydraulic requirements are explained. Details depend on the soil properties for the individual project. Filter fabric shall meet both the equivalent opening size and permeability requirements.

➤ Pore size

Filter fabrics shall have an equivalent opening size between sizes 030 and 085 of the soil being filtered.

➤ Permeability

The coefficient of permeability (k) of the filter fabric shall be at least twice the coefficient of permeability of the soil being filtered, $k(\text{fabric}) = 2k(\text{soil})$, provided that the soil has a uniformity coefficient of $D_{60}/D_{10} < 5$, i.e., is uniformly graded.

The coefficient of permeability (k) of the filter fabric shall be at least five times the coefficient of permeability of the soil being filtered provided that the soil has a uniformity coefficient of $D_{60}/D_{10} > 5$, i.e., is well graded.

➤ Seams

Seams of the fabric shall be sewn with thread of a material having the same chemical requirements as the material forming the fabric or shall be bonded by cementing or by heat.

373 Shipment and Storage

373.1 Protection During Shipment and Storage

The bales or rolls of fabric shall be protected against deterioration from the sun, mud, dirt, dust and any other deleterious conditions at all times until their use. The minimum protection shall be an opaque polyethylene sheet (0.006" or 0.1524 mm min.) or approved equivalent. The material shall be protected from temperatures higher than 60°C.

373.2 Identification

Each bale or roll shall be marked with a tag or similar identification label showing the type of fabric material.

373.3 Mill Certificate

Two copies of the mill certificate signed by a legally authorized official from the company manufacturing the fabric supplied with each consignment. The mill certificate shall attest that the fabric meets the requirements stated in the specification.

374 Quality Control

A competent laboratory shall be maintained by the fabric producer at the point of manufacture. The Engineer may require additional testing to be carried out if considered necessary.

375 Inspection

The Engineer's representative shall have free access to such parts of the suppliers of manufactures plant as may be necessary to assure him that the products supplied conform to the specification requirements.

376 Approval of Source

Filter fabric for use in the project shall be supplied from a manufacturer approved by the Engineer. Not to unduly restrict the source of supply for this material, the specifications provided are quite general outlining only the basic properties and intended purpose. Many manufacturers of acceptable material exist in both North America and Europe.

The material which the Contractor proposes to use for this project must be manufactured by a recognized company highly experienced in this field. In addition the manufacturer shall possess the required production and quality control facilities and shall submit production samples and a certificate of mill test report containing current test results for material for which approval is sought.

Continued approval of the source of supply shall be based upon compliance of production samples with the specification requirements. Subsequent changes in formulations, dimensions, production procedures, the inability to maintain quality production or failure to comply with the requirements of this specification shall be cause for cancellation of approval and shall necessitate application for approval.

377 Placement

The material shall be placed in accordance to the instructions and recommendations of the supplier.

The Contractor must provide with his Tender Documents the following:

- a. The manufacturers literature with samples and recommendations for use of the particular material;**
- b. A list of previous projects in which the manufacturer supplied to material for;**
- c. Complete inventory of physical properties for the geotextile he proposes to**

390 METHOD OF MEASUREMENT AND PAYMENT

391 Excavation and Backfill

No measurement or separate payment will be made for any work covered under this section. The costs thereof shall be deemed to be covered by other pay items within this Section in the Bills of Approximate Quantities.

392 Reinforced Concrete Drains and Covers

392.1 Concrete Drains

Measurement and Payment for all Concrete Drains shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to these works shall be made under the item heading "Reinforced Concrete Drains" in the Bills of Approximate Quantities.

The types of reinforced concrete drains of each specified size shall be measured by the linear meter, along the centerline of the finished in-place section.

Connections to existing drains shall be measured per each junction of the drains regardless of size and shall be limited to those locations shown on the Drawings or established by the Engineer.

Removal of existing concrete drains, excavation, backfilling and compacting for drains shall not be measured for separate payment but will be considered as subsidiary work.

The contract pay unit for the reinforced concrete drains is linear meter which rate shall be in full compensation for removal of existing structures, excavation, furnishing and placing all materials, including reinforcement, concrete, expansion joint material, backfilling, and for all

labour, equipment, forms, tools and other items necessary for the proper completion of the work.

The contract pay unit for the connection to existing drains is number which rate shall be in full compensation for furnishing all labour, equipment, forms, tools and other items necessary for the proper completion of the work.

392.2 Precast Drain Covers

Measurement and Payment for all Precast Drain Covers shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to these works shall be made under the item heading "Precast Concrete Drain Covers" in the Bills of Approximate Quantities.

The types of precast concrete drain covers shall be measured per linear meter of specified size of the finished in-place cover section.

The contract pay unit for Precast Concrete Drain Covers is linear meter which rate shall be in full compensation for all furnishing and placing of all materials, including reinforcement, concrete, mortar bedding material, and for all labour, equipment, forms, tools and other items necessary for the proper completion of the work in accordance to the Specifications.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
C.1	Reinforced Concrete Drains	m
C.2	Precast Concrete Drain Covers	m

393 Drainage Pipes

393.1 Corrugated Metal Pipes

Measurement and Payment for Corrugated Metal Pipes shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to these works shall be made under the item heading "Corrugated Metal Pipes" in the Bills of Approximate Quantities.

This work covering round and arch type pipe culverts shall be measured by the linear meter, to the nearest centimeter, of the various types, classes and sizes of pipe culverts appearing in the Bills of Approximate Quantities. No measurement or payment shall be made for pipes

ordered removed because of faulty construction. No other separate measurement shall be made under this item.

The contract pay unit for Corrugated Metal Pipes is linear meter which rate shall be in full compensation for furnishing and placing all materials, for all labour, structural excavation, shoring, draining water, jointing, concrete surround if any, headwalls, wingwalls and aprons, drop inlet, prefabricated steel end sections, mortared stone riprap protection for embankment slopes at inlet and outlet, all concrete bedding materials, backfill, including concrete backfill, increased cement content, labour, equipment, tools, and all other items necessary for the proper completion of the Work.

393.2 Concrete Pipes

Measurement and Payment for Concrete Pipes shall be as below unless specified otherwise in the Appendix to Specifications.

All measurement and payments related to these works shall be made under the item heading "Reinforced Concrete Pipes" in the Bills of Approximate Quantities.

This work covering under this Sub-Section shall be measured by the linear meter, to the nearest centimeter, of the various types, classes and sizes of pipe culverts appearing in the Bills of Approximate Quantities. No measurement or payment shall be made for pipes ordered removed because of faulty construction.

No other separate measurement shall be made under this item.

The contract pay unit for Reinforced Concrete Pipes is linear meter which rate shall be in full compensation for furnishing and placing all materials, for all labour, I excavation, shoring, draining water, jointing, concrete surround if any, headwalls, wingwalls and aprons, drop inlet, end sections, mortared stone riprap protection for embankment slopes at inlet and outlet, all concrete bedding materials, backfill, including concrete backfill, increased cement content, equipment, tools, and all other items necessary for the proper completion of the Work.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
C.3	Corrugated Metal Pipes	m
C.4	Reinforced Concrete pipe	m

394 Drop Inlets

No elements under this section are measurable or pay items as all works related to the construction of drop inlets form part of pipe culvert works and the cost of its construction is covered by the unit price for Drainage Pipes pursuant to Section 393.

395 Cast Iron Covers and Frames for Manholes and Inlets

Measurement and Payment for Cast Iron Covers and Frames shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to the works under this section shall be made under the item heading "Cast Iron Covers and Frames" in the Bills of Approximate Quantities.

The method of measurement shall be by unit of a set of frame and its corresponding cover in accordance with the drawings.

The contract pay unit for Cast Iron Covers and frames is number which rate shall be in full compensation for the supply and installation of the frame and cover described and protecting with approved tar compound, etc., all in accordance with specifications, drawings and instructions of the Engineer.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
C.5	Cast Iron Covers & Frames	No.

396 Existing Structures

396.1 Clean & Maintain Existing Drains and Culverts

No separate measurement nor payment shall be needed for the work included under this sub-section as the work forms part of the works necessary for the handover to the Employer and therefore are deemed to be included in other pay items.

396.2 Manhole and Catch Basin Adjustment

Measurement and Payment for Adjustment of existing structures shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to the works under this section shall be made under the item heading "Manhole and Catch Basin Adjustment" in the Bills of Approximate Quantities.

Adjustment of existing manholes shall be measured per number of each structure adjusted regardless of size or height of adjustment and shall be limited to those locations shown on the Drawings or established

by the Engineer.

The contract pay unit for Adjusted Manholes and Catch Basins is number which rate shall be in full compensation for furnishing and placing all materials, including reinforcement, concrete, precast concrete components, concrete brick, mortar, for excavation and backfilling, and for all labour, equipment, forms tools and all other items necessary for the proper completion of the work in accordance to the Specifications.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
C.6	Adjusted Manholes & Catch Basins	No.

397 Ditches

Measurement and Payment for Ditches shall be as below unless specified otherwise in the **Appendix to Specifications**.

The measurement and payment for the performance of activities such as excavation and shaping of all side ditches is to be calculated as part of **Series 200** of these specifications.

The measurement and payment for the rip-rap lining should be in accordance to the relevant section within **Series 1400** of these specifications.

No separate measurement and payment will be made for cut-off ditches at the toe of fill slopes or top of cut back-slopes. Prices of these type of ditches should be included in the unit rates of the Contractor.

398 Geo-textiles

Measurement and Payment for Geo-Textiles shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to the works under this section shall be made under the item heading "Geo-Textiles" in the Bills of Approximate Quantities.

The area in square meters of geotextile fabric will be that actually measured in the field including any required overlap at seams.

The contract pay unit for Geo-Textiles is square meters which rate shall be in full compensation for the supply and placement of the fabric including all surveying and quantity computations and all requirements thereof.

Bill Item	Description	Pay Unit
C.7	Geo-textiles	m ²

SERIES400

PAVEMENTLAYERS

SERIES 400 – PAVEMENT LAYERS

401 GENERAL REQUIREMENTS

402 Construction

Construction of the pavement in any section of the Works shall not commence until the drainage works have been completed in respect of that section, unless directed otherwise by the Engineer.

403 Materials

403.1 Sources of Aggregate Materials

All aggregates for use in the construction of the Sub-base, Base, roadway widening and leveling and shoulder shall be obtained only from sources approved by the Engineer. The actual quarry pits or granular deposits shall be in all cases approved by the Engineer. The sourcing of the materials shall adhere to the requirements of the relevant section within **Series 200** of these specifications.

The Contractor shall provide the Engineer, at least 30 days prior to the scheduled start of the work, with a complete statement of the origin and composition of all aggregates to be used in the work. All materials shall comply with the specified requirements for the various aggregates.

The Contractor shall be solely responsible for locating aggregates which will meet the requirements of the Specifications. It is also the Contractor's sole responsibility to locate and produce such aggregates at the rates and in the quantities required to complete the Works within the specified Contract Time.

The Contractor shall commence crushing and screening of aggregates for Sub-base, Base, and surfacing, or as otherwise may be required, immediately after the Contractor receives approval of his aggregate sources.

403.2 Testing

Prior to starting quarry or pit operations, collecting of samples and conducting tests necessary to ascertain the properties and obtain the Engineer's approval of all aggregate materials intended for incorporation in the Works, shall be performed by the Contractor's Materials Engineer in the presence of the Engineer.

Collection of Samples, transporting to the laboratory or testing facility and testing shall be the Contractor's responsibility and at his own expense.

403.3 Approval and Inspection

All sources of materials shall be approved by the Engineer, prior to procuring material from such sources. Tests performed by the Contractor prior to exploiting the sources, are intended to assist the Contractor in his estimate of the location, extent and quantities which will comply with his estimate of the location, extent and quantities which will comply with the Specifications when properly extracted, and will in no way obviate the need for further acceptance testing. Only materials from approved sources shall be incorporated into the Works. Approval of specific sources of materials shall not be construed as final approval and acceptance of material from such sources.

All materials shall be tested and approved before being stored on the Site or incorporated in the Works and may be inspected and tested at any time during the progress of their preparation and use.

Questionable materials, pending laboratory testing and subsequent approval, shall not be unloaded and incorporated with materials previously approved and accepted. If, however, the grading and quality of the material delivered to the Site do not conform to the grading and quality as previously inspected and tested, or do not comply with the Specifications, the Engineer shall be entitled to reject such materials at the Site. Only materials conforming to the requirements of the Specifications shall be used in the Works.

Samples must meet all test requirements as specified under the Specifications. The Contractor shall permit the Engineer or his designated representative to inspect any and all material used or to be used, at any time during the process of the work or after the work has been completed. All such materials not complying with the required Specifications, whether in place or not, shall be rejected and shall be removed promptly from the Works. The Contractor shall supply all necessary materials, labor, tools and equipment for such inspection.

403.4 Storage

Materials shall be stored so as to ensure preservation of their specified quality and fitness for the Works. They shall be placed on hard, clean surfaces and, when required by the Engineer, they shall be placed under cover. Stored materials shall be located so as to facilitate prompt inspection and control. Private property shall not be used for storage purposes without the prior written consent of the owner.

The center of the storage area shall be elevated and sloped to the sides so as to provide proper drainage of excess moisture. The material shall be stored in such a way as to prevent segregation and to ensure proper control of gradations and moisture.

The equipment and methods used for stockpiling aggregates and for removing aggregates from the stockpiles must be approved by the Engineer and shall be such that no detrimental degradation of the aggregate will result and no appreciable amount of foreign material will be incorporated into the aggregate.

The stockpile site shall be prepared by clearing and smoothing and must be approved by the Engineer. Prior to any stockpiling of aggregates, cross-sections of the stockpile site shall be taken and control point established for use in determining the quantity of subsequently stockpiled material.

404 Compaction Trials

Prior to the commencement of any pavement layer operations, the Contractor shall construct trial lengths as directed by the Engineer. The materials used in the trials shall be that approved for use on the respective layer (i.e. Sub-base and base) and the equipment used shall be that which the Contractor intends to use for the work proper.

The object of these trials is to determine the adequacy of the Contractor's equipment, the loose depth measurements necessary to result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the material.

The Contractor may proceed with the respective work only after the methods and procedures established in the compaction trials have been approved by the Engineer. Trial sections will be as directed by the Engineer and will be incorporated in the Works.

410 SUB-BASE WORKS

411 Description

This work shall consist of furnishing and placing one or more courses of selected natural laterite on a prepared surface in accordance with these Specifications, and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the Drawings or established by the Engineer.

412 Materials

The materials for the Sub-base shall be selected natural laterite gravel which shall comply with the following grading requirements:

<u>AASHTO Sieve (mm)</u>	<u>Percent Passing</u>
50.8	100
25	75-95
9.5	40 -75
4.75	30-60
2	20 -45
0.425	15 - 30
0.075	05 - 20

The amount of the fraction passing the 0.075 mm sieve shall not be greater than two-thirds of the fraction passing the 0.425 mm sieve.

The grading is based on aggregates of uniform specific gravity, and the percent passing the various sieves are subject to rejection by the Engineer when aggregates of varying specific gravities are used.

All Sub-base materials shall be free from organic matter or other deleterious matter and shall be of such quality that it will bind readily to form a firm, stable Sub-base.

The material for Sub-base shall also comply with the following requirements:

Liquid Limit (AASHTO T 89) - Max Value	30%
Plasticity Index (AASHTO T 90) - Max. Value	12%
California Bearing Ratio (AASHTO T 193) - Min. Value after 4 days soaking, at 97% of MOD and water content close to optimum.	40%

These specifications, however, may be amended at the discretion of the Engineer considering the characteristics of the available laterite gravel.

The laboratory tests to verify that the above requirements are complied with shall be carried out at a Rate of one test for each 600 m of Sub-base laid or as directed by the Engineer.

413 Construction Requirements

413.1 Spreading

After the existing pavement has been prepared and after the shoulders have been raised to the level of the existing pavement, the Sub-base and leveling aggregates shall be laid over the entire width of the roadbed in sufficient thickness to obtain the required elevations.

Sub-base and leveling aggregates shall be evenly spread on the surface which has been approved by the Engineer. Sub-base which has been placed on a surface not approved by the Engineer shall be removed at the Contractor's expense.

Sub-base and leveling aggregate may be spread on the approved surface in one or more layers of varying thicknesses. Spreading shall be done by means of approved mechanical spreaders.

The materials shall be handled so as to avoid segregation. Segregated materials shall be remixed until uniform. Suitable precautions shall be taken to prevent rutting of the approved surface during the spreading of the Sub-base material. No hauling or placement of material will be permitted when, in the judgement of the Engineer, the weather or road conditions are such that the hauling operations will cause cutting or rutting of the approved surface or cause contamination of the Sub-base material.

413.2 Compaction

The moisture content of the Sub-base material shall be adjusted prior to compaction, by watering with approved sprinkler trucks or by drying out, to obtain the specified density for Sub-base. Sub-base shall be compacted to 97% MOO as determined according to AASHTO T 180, Method O. Field density and actual moisture content of the compacted Sub-base shall be determined by field tests according to AASHTO T 191 and T 238. Compaction shall be tested at a rate of one test for each 1,000 m² or as directed by the Engineer.

The Sub-base and leveling aggregate shall be compacted by means of approved compaction equipment progressing gradually from the outside towards the center with each succeeding pass uniformly overlapping the previous pass. Rolling shall continue until the entire thickness of each layer is thoroughly and uniformly compacted to the specified density. Rolling shall be accompanied by sufficient blading, in a manner approved by the Engineer, to ensure a smooth surface free from ruts or ridges and having the proper section and crown.

Any areas inaccessible to normal compaction equipment shall be compacted by means of mechanical tampers until satisfactory compaction is obtained.

Each layer of Sub-base and leveling course must be completely compacted and approved by the Engineer prior to the delivery of materials for a succeeding layer of Sub-base or base.

413.3 Finishing

The Contractor shall program operations to avoid the drying out of the Sub-base during construction. If any layer of Sub-base material or part thereof, is permitted to dry out after compaction, or does not conform to the required density or finish, the Contractor shall, at his own expense, re-work water or re-compact the material, as directed by the Engineer, to the density specified, before the next layer of Sub-base or Base course is superimposed thereon.

Immediately prior to the placing of the first layer of Base on the Sub-base, the final layer of Sub-base shall be at the specified density and to the required grade and section. In order to maintain these requirements while placing the next course, it may be necessary to water and reshape the surface of the Sub-base, which work shall be at the Contractor's expense.

The surface of the finished Sub-base will be tested with a 3 m straight-edge by the Engineer at selected locations. The variations of the surface from the testing edge of the straight-edge between any two contacts with the surface shall at no point exceed 10 mm when placed on or parallel to the centerline or 10 mm when placed perpendicular to the centerline of the roadway.

The Sub-base shall be compacted to the thickness and cross section shown on the Drawings. The tolerances on elevations of the finished surface shall be +10 mm to -20 mm where the minus tolerance shall be compensated by the proceeding layer. Any variation exceeding the specified tolerances shall be corrected by removing the defective work or by adding new material as directed by the Engineer.

No material for Base shall be placed until the Sub-base has been approved by the Engineer.

413.4 Stabilization

The Contractor is advised to achieve the specifications of Sub-base through the use of the natural granular material available. However and in the event of the Contractor's inability to do so, the Contractor is to use stabilization after receiving the approval of the Engineer at no extra cost to the Employer. In the case of stabilization, the work shall conform to the content of Section 430 of these specifications.

420 BASE WORKS

421 Scope

This work shall consist of furnishing and placing of one or more layers of selected natural laterite gravel materials, constructed on a prepared Sub-base and between prepared shoulders in accordance with these specifications and the lines, levels, grades, dimensions and cross sections on the Drawings and as required by the Engineer.

422 Materials

422.1 Natural Gravel (Laterite)

Materials for Base shall be selected natural gravel (laterite) which shall comply with the following grading requirements:

AASHTO Sieve (mm)	Percent Passing
40	100
25	80 - 95
9.5	50 - 85
4.75	35- 65

2	25 - 50
0.425	15 - 30
0.075	5 -15

The amount of the fraction of material passing the 0.075 mm sieve shall not exceed one-half the fraction passing the 0.425 sieve.

The material for natural base shall also comply with the following requirements:

Liquid Limit (AASHTO T 89) - Max Value	25%
Plasticity Index (AASHTO T 90) - Max. Value	6%
Loss of Abrasion (AASHTO T96) - Max Value	45%
California Bearing Ratio (AASHTO T 193) - Min. Value after 4 days soaking, at 98% of MOD	80%

The above results, including the results for grading, concern the samples taken after mixing and spreading of materials on site.

These specifications, however, may be amended at the discretion of the Engineer considering the characteristics of the available laterite gravel.

The laboratory tests to verify that the above requirements are complied with shall be carried out at a Rate of one test for each 300 m of base laid or as directed by the Engineer.

422.2 Crushed Stone

In case the Base material shall comprise of crushed stone, the following characteristics shall be applicable:

1) Grading

AASHTO Sieve (mm)	Percent Passing
37.5	100
25	75 -100
19	60-90

12.5	45 -80
9.5	40 -70
4.75	30 - 65
2	20-40
0.425	8 - 20
0.075	5 -10

The material for crushed stone base shall also comply with the following requirements:

Organic Matters - Max. Value	1%
Maximum Dry Density - Min. Value	2.10 gm/cm ³
Liquid Limit (AASHTO T 89) - Max. Value	25%
Plasticity Index (AASHTO T 90) - Max. Value	6%
Loss of Abrasion (AASHTO T96) - Max Value	30%
Sand Equivalent - Min. Value	30%
California Bearing Ratio (AASHTO T 193) - Min. Value after 4 days soaking, at 98% of MDD	80%
CBR swell - Max. Value	1%
Flakiness index - Max. Value	35%
The average loss after 5 cycles of the Sodium Sulphate Soundness Test - Max. Value	12%

423 Construction Requirements

423.1 *Spreading*

After the Sub-base layer has been prepared, the Base material shall be laid evenly over the entire width of the roadbed in sufficient thickness to obtain the required elevations.

Base material shall be spread on the Sub-base surface which has been approved by the Engineer. Base material which has been placed on a Sub-base surface not approved by the Engineer, shall be removed at the Contractor's expense.

Base material may be spread on the approved surface in one or more layers of varying thicknesses. Spreading shall be done by means of approved mechanical spreaders.

The materials shall be handled so as to avoid segregation. Segregated materials shall be remixed until

uniform. Suitable precautions shall be taken to prevent rutting of the approved surface during the spreading of the Base material. No hauling or placement of material will be permitted when, in the judgement of the Engineer, the weather or road conditions are such that the hauling operations will cause cutting or rutting of the approved surface or cause contamination of the Sub-base material.

423.2 Compaction

The moisture content of the Base material shall be adjusted prior to compaction, by watering with approved sprinkler trucks or by drying out, to obtain the specified density for Base layer.

Base material shall be compacted to 98% MOD as determined according to AASHTO T 180, Method D. Field density and actual moisture content of the compacted Base shall be determined by field tests according to AASHTO T 191 and T 238. Compaction shall be tested at a rate of one test for each 1,000 m² or as directed by the Engineer.

The Base material shall be compacted by means of approved compaction equipment progressing gradually from the outside towards the center with each succeeding pass uniformly overlapping the previous pass. Rolling shall continue until the entire thickness of each layer is thoroughly and uniformly compacted to the specified density. Rolling shall be accompanied by sufficient balding, in a manner approved by the Engineer, to ensure a smooth surface free from ruts or ridges and having the proper section and crown.

Any areas inaccessible to normal compaction equipment shall be compacted by means of mechanical tampers until satisfactory compaction is obtained.

Each layer of Base material must be completely compacted and approved by the Engineer prior to the delivery of materials for a succeeding layer of Sub-base.

423.3 Finishing

The Contractor shall program operations to avoid the drying out of the Base material during construction. If any layer of Base material or part thereof, is permitted to dry out after compaction, or does not conform to the required density or finish, the Contractor shall, at his own expense, re-work water or re-compact the material, as directed by the Engineer, to the density specified, before the next layer of Base course is superimposed thereon.

Immediately prior to the placing of the first layer of Base on the Sub-base, the final layer of Sub-base shall be at the specified density and to the required grade and section. In order to maintain these requirements while placing the next course, it may be necessary to water and reshape the surface of the Sub-base, which work shall be at the Contractor's expense.

The surface of the finished Base layer will be tested with a 3 m straight-edge by the Engineer at selected locations. The variations of the surface from the testing edge of the straight-edge between

any two contacts with the surface shall at no point exceed 10 mm when placed on or parallel to the centerline or 10 mm when placed perpendicular to the centerline of the roadway.

The Base layer shall be compacted to the thicknesses and cross section shown on the Drawings. The tolerances on elevations of the finished surface shall be +10 mm to -10 mm where the minus tolerance shall be compensated by the proceeding layer. Any variation exceeding the specified tolerances shall be corrected by removing the defective work or by adding new material as directed by the Engineer.

423.4 Stabilization

The Contractor is advised to achieve the specifications of Base through the use of the natural granular material available. However and In the event of the Contractor's inability to do so, the Contractor is to use stabilization after receiving the approval of the Engineer at no extra cost to the Employer. In the case of stabilization, the work shall conform to the content of **Section 430** of these specifications.

430 STABILIZATION WORKS

431 Description

This work shall consist of sand or cement stabilized Base and / or Sub-base, constructed on a prepared Sub-base or Sub-grade respectively and between prepared shoulders in accordance with these Specifications and the lines, levels, grades, dimensions and cross sections shown on the Drawings and as required by the Engineer.

432 Materials

432.1 *Aggregate*

The material to be stabilized shall consist of laterite from selected material sources. The aggregate shall be free from contamination by topsoil, vegetation and organic matter, and any deleterious materials.

The aggregate shall comply with the following requirements:

(a) Grading

1. Base

AASHTO Sieve (mm)	Percent Passing
40	100
25	80 -95
9.5	50 -85
4.75	35 -65
2	25 - 50
0.425	15 - 30
0.075	5 -15

2. Sub-base

AASHTO Sieve (mm)	Percent Passing
50.8	100
25	75 - 95
9.5	40-75
4.75	30 - 60
2	20-45
0.425	15 - 30
0.075	5 - 20

The amount of the fraction of material passing the 0.075 mm sieve shall not exceed one-half the fraction passing the 0.425 sieve for Base nor two-thirds the fraction passing the 0.425 sieve for Sub-base.

The material for stabilized layers shall also comply with the following requirements:

Liquid Limit (AASHTO T 89) - Max Value	25%
Plasticity Index (AASHTO T 90) - Max. Value	6%
Loss of Abrasion (AASHTO T96) - Max Value	45%
California Bearing Ratio (AASHTO T 193) - Min. Value after 4 days soaking, at 98% of MOD	80%

The laboratory tests to verify that the above requirements are complied with shall be carried out at the rate of one test for each 250 m³ of aggregates used.

432.2 Clean Sand

The sand used shall be clean and free from any deleterious material and with percentage passing 0.075 mm sieve not more than 5%. The sources of sand are to be approved by the Engineer prior to usage.

432.3 Cement

Cement shall conform to all requirements of AASHTO M 85 Standard Specification for Portland Cement.

432.4 Water

Water shall be clean and free from harmful matter and may be tested in accordance to AASHTO T 26 at the Engineer's discretion. Water thus tested and found to have a PH value less than 5.0 or more than 8.5 shall not be used. Furthermore, water shall not contain more than 400 parts per million by weight of sulphate.

Any indication of unsoundness, marked change in time of setting or a reduction of more than 10% in strength of mortar mixture made with the water; as compared with mixtures made with distilled water shall be cause for rejection.

432.5 Mix Design

The quantity of Cement or sand by weight to be used with the aggregate and water shall be determined by tests as approved by the Engineer.

Normally, the quantity of stabilizing material shall be as follows:

- Sand Stabilized Base and Sub-base 20% - 30%
- Cement stabilized Base and Sub-base (low cement content) 2%-4%
- Cement stabilized Base (high cement content) 5%-7%

Prior to commencement of any type of stabilization, the Contractor is to conduct laboratory testing of specimen with different proportions of the stabilizing agent and moisture content required in order to determine the ideal mix design based on the type of available type of aggregates. Samples of the sand stabilized Base and Sub-base shall be compacted in the laboratory to 98% MDD (MSHTO T 180, Method D) for Base and 97% MDD for Sub-base.

After the initial approval of the Engineer has been obtained on the mix design, trial sections are to be performed. These testing areas shall be prepared by the Contractor at locations and dimensions determined by the Engineer. Based on the results of the trial section, the final approval will be given by the Engineer for the commencement of the related works.

In the case of cement stabilization, the mix will be so selected that the strength shall be at least equal to the required strength as indicated below and the weight loss in the wet - dry test is within the specified limit.

The unconfined compressive strength of the cement stabilized Base with high cement content shall be 40 kg/cm² at seven days tested in accordance with AASHTO T 208. The samples shall be prepared in standard AASHTO compaction molds (100 mm diameter x 115 mm high). Preparation methods shall be in accordance to AASHTO T 180, Method D.

The prepared soil cement samples shall be subject to the Wetting and Drying Test in accordance with AASHTO T 135. The maximum weight loss shall be 14%. Samples prepared in the molds shall be sealed in moistened plastic bag for one (1) day and then removed from the molds and resealed.

Prior to performing the unconfined compressive strength test, the samples shall be removed from the plastic bags, capped in accordance with AASHTO T 231, and soaked in water for four (4) hours before testing.

The compressive strength of the cement stabilized Base with the low cement content and the cement stabilized Sub-base shall be at least 20 kg/cm² at 7 days and 30 kg/cm² at 28 days and tested in accordance with the above.

The Contractor under the direction of the Engineer will make and test trials mixes using different proportions of cement and will select mix proportions that give strengths of test cylinders, made and

cured in the laboratory, not less than 105% of the required strength nor greater than 125% of the required strength indicated in this section. This will be called the required mix.

433 Construction Methods

433.1 Equipment

Equipment shall be suitable for the work specified, and shall comprise, at minimum and depending of the methodology system to be implemented, of a proper mixing equipment (e.g., RM 350 for in-situ mixing), motor graders, water tankers, pneumatic tired rollers, vibrating rollers, together with dump trucks and shall have met with the approval of the Engineer 8S to type, capacity design and manufacture before construction is permitted. The equipment shall be capable of constructing the stabilization tasks within the requirements specified and to permit the measurements required.

433.2 Mixing materials

The mixing methodology is to be proposed by the Contractor and presented to the Engineer for his approval. Road mixing in place is only allowed by using suitable equipment as stated in **Subsection 433.1**.

Regardless of the methodology to be proposed by the Contractor, the Engineer shall be able to verify the amount of stabilizing agent, aggregates and moisture at any given time during the mixing operation. Samples will be collected before compaction in order to determine, through laboratory testing, the MDD and CBR (MSHTO T 180 and AASHTO T 193).

The Contractor shall assist the Engineer in all ways to sample the aggregates and the agents (i.e., sand or cement) for stabilizing at least fourteen (14) day in advance of their use so that necessary adjustment to the mix design may be made. To ensure good sampling it will normally be necessary to remove overburden and stockpile sufficient aggregates for construction fourteen (14) days ahead at all times. Failure to do so will make the Contractor responsible for replacing at his own expense any sections of work that are unsatisfactory on account of an unsuitable mix.

433.3 Spreading

Materials shall be placed evenly and mixed on the approved section of Sub-grade or sub-base at a quantity per linear meter, which will provide the compacted thickness for the width being spread without any spotting, picking up or otherwise shifting the material. Segregation shall be prevented and the mixture shall be free from pockets of coarse or fine material.

433.4 Compaction

After spreading the material, it shall be compacted to the required lines, grades, cross section and specified compaction degree by means of pneumatic rollers, or with vibrating rollers. Heavy static steel wheel rollers are prohibited.

Compaction of the layer shall consist of at least 2 separate operations, initial compaction and final compaction after trimming. Initial compaction shall follow the spreading operation immediately and shall consist of at least one complete coverage of treated material. When the finished surface after initial compaction is outside the tolerance specified hereinafter, all high spots shall be trimmed off to within the specified tolerance. Filling of low areas by drifting or hauling of trimmed material is prohibited. Following such trimming, the finished surface shall be thoroughly compacted so that the entire layer of stabilized Base conforms to the compaction requirements. Final compaction shall be accomplished in such a manner that no loose material remains on the surface and all tear marks are eliminated.

The compaction of stabilized Base or Sub-base shall not be less than 97% of MOD for Sub-base & 98% for Base as determined by AASHTO T 180 Maximum Dry Density.

The surface of the finished Base or Sub-base will be tested by the Engineer with a 3 m straightedge and a rigid template at selected locations. The variations of the surface from the testing edge of the straight-edge between any two contacts with the surface shall at no point exceed 10 mm when the straight-edge is placed on or parallel to the centerline or 10 mm when the rigid template is placed perpendicular to the centerline of the roadway. The Base or Sub-base shall be compacted to the thickness and cross section as shown on the Drawings. The tolerances on elevations of the finished surface shall be +10 mm for both Base and Sub-base layers to -10 mm for the Base and Sub-base layer where the minus tolerances shall be compensated by the proceeding layer. Any variation exceeding the specified tolerances shall be corrected by removing the defective work or by adding new material as directed by the Engineer.

The relative compaction and the thickness of the road Base and Sub-base shall be verified at the rate of one test for each 500 m² of Base or Sub-base course.

433.5 Determination of Thickness

After final compaction, test holes shall be dug in the completed work at intervals not greater than 100m. Any part of the completed work which fails to meet the Specification or which originally having met the Specification subsequently suffers damage or deformation shall be rebuilt to Specification to the full depth of the course at the Contractor's expense. The addition of thin layers to raise the level of low areas is prohibited.

490 METHOD OF MEASUREMENT AND PAYMENT

491 General Requirements

No separate measurement or payment shall be made for any part of this section. The cost of performing these works shall be covered with in other Items of work appearing in the Bills of Approximate Quantities.

492 Sub-base Works

Measurement and Payment for all Sub-base works shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to these works shall be made under the item heading "Sub-base Layer" in the Bills of Approximate Quantities.

Sub-base Layer shall be measured by the cubic meter for the completed works in accordance to the theoretical dimensions of the Sub-base layer shown on the Drawings or as otherwise specified by the Engineer. The Completed works are defined as those areas of Sub-base completed by the use of natural material or stabilization and approved by the Engineer for laying of Base.

No measurement for over depth shall be made when such over depth of material is permitted to remain in place by the Engineer. Unauthorized over depth of Sub-base shall be at the Contractor's expense and shall not form the basis of a claim for additional compensation.

No separate measurement of any other items mentioned in under this section shall be made.

The contract pay unit for the Sub-base works is cubic meters which rate shall be in full compensation for furnishing all materials, haulage in excess of free haul distance, placing and preparation of the materials on the road, the mixing of the material with water, stabilization (when required), the spreading, compacting and finishing of the material, the maintenance of the completed Sub-base course and the dressing of shoulders and slopes, all labour, equipment, tools, and other items necessary for the proper completion of the work.

Bill Item Description Pay Unit

D.1 Sub-base Layerm³

493 Base Works

Measurement and Payment for all Base works shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to these works shall be made under the item heading "Base Layer" in the Bills of Approximate Quantities.

Base layers shall be measured by the cubic meter for the completed works in accordance to the theoretical dimensions of the Base shown on the Drawings or as otherwise specified by the Engineer. The Completed Base is defined as those areas of Base completed by the use of natural material or through stabilization and approved by the Engineer for laying of prime coat and surfacing.

No measurement for over depth shall be made when such over depth of material is permitted to remain in place by the Engineer. Unauthorized over depth of Sub-base shall be at the Contractor's expense and shall not form the basis of a claim for additional compensation.

No separate measurement of any other items mentioned under this section shall be made.

The contract pay unit for the Base works is cubic meters which rate shall be in full compensation for furnishing of material, unlimited haulage, placing and preparation of the materials on the road, the mixing of the material with water, stabilization (when required), the spreading, compacting and finishing of the material, the maintenance of the completed Base course and the dressing of shoulders and slopes, labour, equipment, tools, and other items necessary for the proper completion of the work.

Bill Item Description Pay Unit

D.2 Base Layer	m ³
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494 Stabilization Works

No separate measurement or payment shall be made for works included under this section. All related costs are deemed to be included under C.1- Sub-base Layer and C.2 - Base Layer.

SERIES 500

SURFACING

SERIES 700

FORMWORK

701 GENERAL

702 *Applicable Codes and Tests*

➤ AMERICAN CONCRETE INSTITUTE (ACI)

ACI347R (1988) Concrete Formwork

➤ AMERICAN HARDBOARD ASSOCIATION (AHA)

AHAA135.4 (1982; R 1988) Basic Hardboard

➤ DEPARTMENT OF COMMERCE (DOC)

DOC PS 1 (1983) Construction and Industrial Plywood

703 Submissions

It is required for the Contractor to submit the following before proceeding with any works:

- Forms, form work and false work shall be designed by the Contractor following pertinent codes of practice and submitted to the Engineer with full structural calculations, detailed drawings, material specifications and test certificates for his approval, which approval shall not relieve the Contractor from his responsibilities under the Contract.

710 DESIGN

- Formwork shall be designed in accordance with the methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete. Consideration shall be given to higher pressure resulting from use of superplasticizers in concrete.
- Formwork assigned camber shall be calculated by the Contractor as per pertinent codes. However, the following values may be applied as general rules for common practice:
 1. Bottom form for beams of span 8 (eight) meters and over shall be given a camber of $1/300 - 1/500$ of the span.
 2. Cantilevers of span more than 2 (two) meters shall be given a camber of $1/150$ of the span.
- False work design shall be in accordance with BS 5972 "Code of Practice for FALSE WORK".
- If the Contractor intends to use ready-made proprietary type of false work, he shall submit all relevant data, including independent test certificates, which will enable the Engineer to determine whether or not the Contractor's proposed false work is acceptable.

720 FORMED SURFACES, CLASSES OF FINISH

721 Formed Finishes

➤ Class F1

This class of surface finish denotes a special finish required from aesthetic considerations. In addition to the requirements of class F2 finish, the following requirements shall apply:

- It is of major importance that the special finishes required on F1 surfaces are uniformly and consistently maintained with no variations in the color or consistency of the concrete within the same structure. In order to achieve this, the Contractor shall make trial panels of the formed finishes specified. These panels shall be not less than 1.5 m high and 1 m wide and 250 mm thick and shall be cast in the manner and with materials as proposed for the actual work. These panels are for the approval of the liners and are preliminary to the test samples carried out on site.
 - The Contractor shall provide at his own expense as many panels as required by the Engineer until a satisfactory trial panel has been accepted by the Engineer. In addition, the Engineer will require samples of pier, part of a deck, section of retaining wall and/or underpass wall
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and typical precast edge unit to be cast on site in the same manner as proposed for the prototypes.

- The Contractor shall submit to the Engineer and obtain his approval for all details before commencement of trials. These samples, when approved, will form the standard against which the corresponding finishes on the actual work will be judged.
- Where forms and form-liners to be used for the special finishes specified are manufactured outside the country of the Employer, the forms and form-liners shall not be permitted on site until the Engineer has inspected the forms and form-liners and is satisfied that they are suitable for the works. Samples and trial panels carried out at the place of manufacture to demonstrate to the Engineer that the forms and form-liners and the methods of assembling and de-shuttering them are acceptable, shall not be paid for and will not relieve the Contractor of the requirement for carrying out trial panels on site as described above.
- If the required finish in the opinion of the Engineer, has not been obtained in the works, the Contractor shall promptly carry out at his own expense all measures required by the Engineer to obtain the specified finish. These may include grit blasting followed by the application of polyester or epoxy paint. Where such remedial action is ordered by the Engineer, the entire exposed surface shall be so treated irrespective of whether or not the defective areas are localized.

➤ **Class F2**

- Form work shall be lined with material approved by the Engineer to provide a smooth finish of uniform appearance. This material shall leave no stain on the concrete and shall be so joined and fixed to its backing so that it imparts no blemishes. It shall be of the same type and obtained from only one source for anyone structure.
- The Contractor shall make good any imperfections in the finish as directed by the Engineer. Internal ties and embedded metal parts will not be permitted unless otherwise approved by the Engineer.

➤ **Class F3**

- Irregularities in the finish shall be no greater than those resulting from the use of wrought thick square edged boards arranged in a uniform pattern. The finish is intended to be left as struck. Imperfections such as fins and surface discoloration shall, however, be made good as and when required by the Engineer.
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➤ **Class F4**

No special requirements.

722 Unformed Finishes

➤ **Class U1**

The concrete shall be uniformly leveled to produce a plain or ridged surface as described in the Contract. No further work shall be applied to the surface unless is used as the first stage for Class U2 or Class U3 finish.

➤ **Class U2**

After the concrete has hardened sufficiently, the concrete U 1 surface shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

➤ **Class U3**

When a moisture film has disappeared and the concrete has hardened sufficiently to prevent latence from being worked to the surface, the concrete U1 surface shall be steel-troweled under form pressure to produce a dense, smooth uniform surface free from trowel marks.

The material shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type obtained only from one source throughout one structure. The Contractor shall make good any imperfections in the resulting finish as required by the Engineer. Internal ties and embedded metal parts will be allowed only with the Engineer's specific approval. The Contractor shall ensure that permanently exposed surfaces are protected from rust marks, spillage, and stains of any kind.

730 PREPARA TION BEFORE CONCRETING

The inside surfaces of forms shall, except for permanent formwork, or unless otherwise agreed with the Engineer, be coated with an approved material to prevent adhesion of the concrete. Release agents shall be applied strictly in accordance to the manufacturer's instructions and shall not come into contact with the reinforcement or prestressing tendons and anchorages. Different release agents shall not be used in formwork to concrete which will be visible in the finished works.

All forms and false work shall be inspected by the Engineer after assembly on the work area and immediately before concreting. No concrete placement shall commence until the forms and False work have been approved by the Engineer.

740 PLACEMENT

741 Formwork Placement

All formwork shall be tight and sufficiently rigid and so constructed that there shall be no loss of material from the concrete. Formwork shall not distort (i.e., warp) due to environment effects and shall be designed so as to be strong and rigid enough to resist the pressure of the fresh concrete and to be readily assembled, stripped and transported without distortion to panels and members of the form work. After hardening, the concrete shall be in the position and of the shape, dimensions and surface finish described in the Contract.

The formwork supports shall be arranged in such a way as to enable the forms to be stripped without causing undue shocks or vibrations to the structure and without damaging the concrete or special textured surface finish. The method of stripping shall be fully considered in the design.

The formwork posts should be supported on a firm base according to the load to be supported so as to avoid undue settlement. In such cases, necessary posts should continue in the lower floors.

If form liners are to be used to achieve the specified surface finish, samples of a size as directed by the Engineer shall be submitted for approval.

Form lining shall not bulge, warp or blister, nor shall it stain the concrete. Form lining shall be used in the largest practicable panels to minimize joints. The use of small panels of the lining material not permitted.

The joints in the lining shall be tight and smoothly cut. Adjacent panels of form lining shall be so placed that the grain of the wood will be in the same direction (all horizontal or all vertical). Thin metal form lining will not be permitted.

Undressed lumber of uniform thickness, which is properly supported to meet the above requirements, may be used in lieu of the lined forms specified herein.

Metal forms, when used, shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk. Clamps pins or other connecting device shall be designed to hold the form rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease or other foreign matter.

The continued use of the metal forms will depend upon satisfactory performance and their discontinuation at any time shall be instructed by the Engineer. Steel panels or panels with metal frames and wood or combination shall be so designed as to leave no lipping or ridges in the finished

concrete.

The width and thickness of the lumber, the size and spacing of studs and wales shall be determined with due regard to the nature of the work and shall be sufficient to ensure rigidity of the form and to prevent distortion due to concrete pressure.

Form bolts, rods or ties and removable ties through plastic (PVC) pipes shall be made of steel. They shall be of type which permit the major part of the tie to remain permanently in the structure or removed entirely. They shall be held in place by devices attached to the wales capable of developing the strength of the ties. The Engineer may permit the use of wire ties on irregular sections and incidental construction if the concrete pressure is nominal and the form alignment is maintained by other means. Form ties will not be permitted through forms for handrail.

Pipe, wood or metal spreaders shall not be used unless they can be removed upon placement of concrete to the satisfaction of the Engineer. The use of cofferdam braces or struts will not be permitted except in unusual situations and only with the approval of the Engineer.

Where the bottom of the forms is inaccessible, the lower form boards shall be left loose or other provisions made so that extraneous material may be removed from the forms immediately before concrete placement.

If directed by the Engineer, the exterior side of only metal forms shall be painted with approved, good quality high gloss white oil base enamel paint prior to placing concrete. When complete coverage is not obtained with one coat, the Engineer will order additional coats as he deems necessary to obtain complete coverage. Forms shall be repainted when directed by the Engineer.

Unless provided otherwise on the drawings or directed by the Engineer, all exposed edges shall be beveled by using dressed, millcut, triangular moulding, having 20 millimeter sides.

742 *False Work Placement*

False work and cantering shall be designed to provide the necessary rigidity to support all loads placed upon it without settlement or deformation of the structure in excess of the permissible tolerances given in the Specifications.

False work columns shall be supported on hardwood, concrete pads or metal bases to support all false work that cannot be founded on rock, shale or thick deposits of other compact material in their natural beds. False work shall not be supported on any part of the structure, except the footings, without the written permission of the Engineer. The number and spacing of false work columns, the adequacy of sills, caps and stringers and the amount of bracing in the false work framing shall be subject to approval of the Engineer.

All timber shall be of sound wood, in good condition and free from defects that might impair its strength. If the vertical members are of insufficient length to cap at the desired elevation for the horizontal members, they shall preferably be capped and frames constructed to the proper elevation. Ends of the vertical members shall be cut square for full bearing to preclude the use of wedges. If vertical splices are necessary, the abutting members shall be of the same approximate size, the ends shall be cut square for full bearing, and the splice made in a manner approved by the Engineer.

The Contractor shall compute false work settlement and deflection for bridges so that when the final settlement is complete, the structure will conform to the required camber, section and grade as shown on the drawings.

The Contractor shall provide means for accurately measuring settlement in false work during placement of concrete, and shall provide a competent observer to observe and correct the settlement.

Screw jacks, if used, shall be designed for use with a slenderness ratio not exceeding 60. The slenderness ratio shall be taken as the ratio of the clear distance between effective bracing in both horizontal directions to the diameter of the screw jack measured at the root of the thread. The manufacturer's certificate showing the ultimate load capacity of the screw jack shall be submitted with the design calculations for the False work. If directed by the Engineer, the Contractor shall furnish a test certificate carried out at an approved independent laboratory.

Props and towers supporting forms or partially completed structures shall be interconnected in plan orthogonally at levels to be determined in the design. They shall also be interconnected by diagonal bracings in orthogonal vertical planes.

743 Tolerances

- a. The tolerances in the forms and form work shall be such that members formed shall be within the tolerances for the size and type of the member specified elsewhere in the specification.
- b. False work shall be fixed such that the completed structure shall be within the required tolerances in plan, elevation and slope for the size and type of structure specified elsewhere in the specification.

750 REMOVAL OF FORMWORK & FALSEWORK

To facilitate finishing, forms on vertical surfaces that require a rubbed finish shall be removed as soon as the concrete has hardened sufficiently that it will not be damaged as determined by the Engineer.

In determining the time for the removal of forms, consideration shall be given to the location and character of the structure, weather and other conditions influencing the setting of the concrete.

Form work shall be removed in a manner as not to damage the concrete, and at times to suit the requirements for its curing and to prevent restraints that may arise from elastic shortening, shrinkage or creep.

Where the concrete compressive strength is confirmed by tests on concrete cylinders stored under conditions approved by the Engineer that simulate the field conditions, form work supporting concrete in bending may be removed when the strength is 10 N/sq.mm or three times the stress to which it will be subjected, whichever is the greater.

Forms shall be removed in a manner that will ensure the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads. In no case will supporting forms or shores be removed before the concrete strength has reached 70 percent of design strengths as determined by field cured cylinders or other approved methods on the condition that no loading of the structural element occurs. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

Unless otherwise directed by the Engineer, forms shall remain in place for the following minimum specified periods of time in normal climate conditions as indicated in codes on the condition that no loading of the structural element occurs:

a) Centering under beams	15 days
b) Culvert Roof and Bridge deck Slabs	15 days
c) Ground Slabs and aprons	4 days
d) Abutment Walls	15 days
e) Wing walls	4 days

The Engineer shall be informed in advance when the Contractor intends to strike any formwork.

The time at which the formwork is struck shall be the Contractor's responsibility. Only if the Contractor submits to the Engineer, for his approval, methods enabling the earlier stripping of formwork such as using high early strength cement, will a reduction of the time limits be accepted as determined by the Engineer.

Formwork shall be constructed so that the side forms of members can be removed without disturbing the soffit forms and, if props are to be left in place when the soffit forms are removed, these props shall not be disturbed during the striking.

For prestressed units, the side forms shall be eased as early as possible and the soffit forms shall permit deformation of the member when the prestress is applied.

All formwork shall be removed without damage to the concrete.

Where it is intended that formwork is to be re-used, it shall be cleaned and made good to the satisfaction of the Engineer.

Immediately after the removal of the forms, all fins caused by form joints and other projections shall be removed and all pockets cleaned and filled with cement mortar composed of 1 part by volume of Portland cement and 2 parts sand. Sufficient white Portland cement shall be mixed with the cement in the mortar, so that the color will match the surrounding concrete when dry. Patches shall be moistened prior to mortaring to obtain a good bond with the concrete. When directed by the Engineer, the Contractor shall at his own expense, substitute an approved epoxy grout for the Portland cement mortar or provide an epoxy bonding agent to be used in conjunction with the Portland cement mortar. If, in the judgement of the Engineer, pockets are of such extent or character as to materially affect the strength of the structure or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of that portion of the structure affected. The resulting surfaces shall be true and uniform.

Portions of the structure which cannot be finished or properly repaired to the satisfaction of the Engineer shall be removed.

If the finish of the exposed formed surfaces does not comply with the requirements of uniformity of texture, appearance and colour, the Contractor shall when instructed to so by the Engineer, rub down the exposed surfaces of the entire structure or any part thereof as specified below.

The surface shall be saturated with water for at least one hour. Initial rubbing shall be carried out with a medium coarse carborundum stone, using a small amount of mortar on the face. Rubbing shall be continued until the form marks, projections and irregularities are removed and a uniform surface is obtained. The paste produced by the rubbing shall be left in place. The final rubbing shall be carried out with a fine carborundum stone and water. The rubbing shall continue until the entire surface is of a smooth, even texture and is uniform in colour. Thereafter the surface shall be washed with a brush to remove surplus paste and powder.

Where the concrete surfaces formed by sliding formwork require treatment in order to achieve the surface finish specified for the member, the concrete shall, as soon as the surfaces are exposed under the formwork, be floated with rubber - lined floats to the desired finish.

790 METHOD OF MEASUREMENT & PAYMENT

No separate measurement or payment shall be made for any part of **Series 700** as all costs related to these works shall form part of the concrete pay items.

SERIES 800

REINFORCEMENT

SERIES 800 – REINFORCEMENT

801 GENERAL

802 Scope

This Clause covers the furnishing and placing of steel reinforcement in concrete structures according to the Drawings and Specification.

803 Applicable Codes and Tests

The AASHTO and BS standards relating to this paragraph shall be taken as basic requirements. In addition, the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. In the event of a discrepancy between the different codes, the AASHTO shall prevail.

➤ AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318 (1989; 318R-89) Building Code Requirements for Reinforced Concrete

➤ AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82 (1988) Steel Wire, Plain, for Concrete Reinforcement

ASTM A 184 (1988) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement

ASTM A 185 (1988) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

ASTM A 497 (1989) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement

ASTM A 499 (1981; R 1988) Steel Bars and Shapes, Carbon Rolled from "T" Rails

ASTM A 615 (1989) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM A 675 (1988) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

ASTM A 767, Class II (2.0 oz. zinc psf) hot-dip galvanized after fabrication and bending.

ASTM A775 (1990) Standard Specification For Epoxy-Coated Reinforcing Steel Bars.

➤ AMERICAN WELDING SOCIETY (AWS)

AWS 01.4 (1979)

Structural Welding Code - Reinforcing Steel

➤ CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI DA4 (1990; 25th Ed)

Manual of Standard Practice

Copies of the applicable codes shall be made available by the Contractor for the use of the Engineer on site.

804 Submissions

All submissions shall adhere to the requirements of the submission procedure included in **Clause 145** of the Project Specifications.

804.1 Drawings

Detail drawings showing reinforcing steel layouts inclusive of sizes, grades, splicing and bending details. Drawings shall also show support details including types, sizes and spacing. Each reinforcement drawing is to be supported with its respective bar bending schedule.

804.2 Certificates

The Contractor is to provide certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified, prior to the installation of reinforcing steel.

804.3 Qualifications

Welders shall be qualified in accordance with AWS 01.4. Qualification tests shall be performed at the work site and the Contractor shall notify the Engineer 24 hours prior to conducting tests. Welding procedures qualified by others and welders qualified by another Employer may be accepted as permitted by AWS 01.4.

805 Storage and Handling

The steel reinforcement shall be stacked off the ground and, in case of aggressive environments, protection provided in the form of sheds or tarpaulins.

Immediately before the concrete is placed around the reinforcement, the reinforcement shall be clean, free from mud, oil, grease, paint, loose rust, loose mill scale or any other substance that can have an adverse effect on the steel or concrete, or reduce the bond.

810 MATERIALS

811 Steel bars

Reinforcing steel shall be deformed bars conforming to ASTM A 615 and sizes as indicated with High yield-stress steel grade 600 to be specifically called for on the drawings. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82 and Steel reinforcing deformed bars shall comply with BS 4449 for hot rolled reinforcement of grades 410 and 460 or BS 4461 for cold worked reinforcement.

The use of cold-worked bars shall be subject to the approval of the Engineer. The type of bar required shall be identified on the drawings by the symbols in accordance with the appropriate standards.

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI DA4 and shall be steel or precast concrete blocks. Precast concrete blocks shall be not less than 4 inches (10 cm) square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch (i.e., 1.27 cm) of concrete surface shall be plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

812 Welded Steel Fabric

Welded steel fabric shall comply with AASHTO M 55. Welded wire fabric shall conform to ASTM A 185.

813 Mechanical Couplers

The tensile properties determined on a test specimen of maximum gauge length of 610 mm, consisting of reinforcing bars that have been butt-jointed with a mechanical coupler, shall comply with the following requirements:

1. The tensile properties shall be at least 10% better than those required for corresponding steel bar.
 2. When the test specimen is subjected to a load equal to 0.58 of the specified minimum yield stress of the bar, the elongation measured on the gauge length shall not exceed the calculated theoretical elongation for a 610 mm length of bar, based on the same stress level and a Young's Modules of 200,000 MPA.
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The Contractor shall submit tests certificates from a recognized testing authority to the Engineer certifying that the couplers offered comply with the specified requirements. All mechanical couplers used shall be subject to the approval of the Engineer.

814 Tying Wire

Tying wire shall be either:

- a. No. 16 gauge iron wire (1.6 mm) soft annealed; or
- b. No. 18 gauge (1.2 mm) stainless steel wire.

820 BENDING OF REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown on the drawings and shall conform to the requirements of ACI 318M.

Bending shall be done slowly, with a steady even pressure being applied without jerk or impact.

Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. If approved, hot bending of bars of at least 32 mm diameter will be permitted, provided that the strength of the bars will not depend on cold working. When hot bending is approved, the bars shall be heated slowly to a cherry-red heat (not above 840°C) and after bending shall be allowed to cool slowly in air. Quenching with water shall not be permitted.

All reinforcement shall be bent at temperatures in the range of 5° C and 100° C.

Cold worked and hot rolled bars shall not be straightened or re-bent at the location of the original bend once having been bent.

Reinforcement shall be cut using the approved methods (i.e., manual cutters, mechanical cutters, etc ...). No flame-cutting of high-tensile steel bars shall be permitted, except with the approval of the Engineer.

830 PLACING OF REINFORCEMENT

Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety.

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318M at

locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318M. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

Splices of reinforcement shall conform to ACI 318M and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical connection. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6-inches (15 cm). Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

Reinforcement shall be positioned as shown on the Drawings and be accurately secured in these positions within the tolerance given by tying with 1.6 mm or 1.25 mm diameter annealed wire or by the use of suitable clips or, where permitted by the Engineer, by tack welding. Cover and spacer blocks required to support the reinforcement shall be as small as possible consistent with their use and be of approved design and material. Projecting ends of ties or clips shall not encroach into the concrete cover.

Where protruding bars are exposed to the elements for an indefinite period, the bars shall be adequately protected against corrosion and damage and shall be properly cleaned before being permanently encased in concrete.

In members that are formed with sliding form work, spacer "ladders" for the placing and fixing of the wall reinforcement shall be used at spacings indicated on the drawings or as directed by the Engineer. The ladders shall consist of two 3.7 m long bars with lateral ties of 4 mm diameter welded to them in the form of a ladder. The ties shall be spaced at multiples of the horizontal bar spacing in the wall, and be used to secure the horizontal reinforcement. The laps in the horizontal reinforcement shall be staggered to ensure that no part of two laps in any four consecutive layers lie in the same vertical plane.

Laps, joints, splices and mechanical couplings shall be made only by the methods specified and at the positions shown on the drawings or as agreed by the Engineer.

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost cross wires plus 2 inches (5.1 cm). Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet (1.2 meters). Fabric shall be positioned by the use of supports.

Dowels shall be installed in foundations, grade walls, and slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately aligned parallel to the finished concrete surface and rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

Where directed to use epoxy coated reinforcement as protection against Chemicals, epoxy coating shall conform to ASTM 775.

840 COVER BLOCKS

Cover blocks required for ensuring that the reinforcement is correctly positioned, shall be as small as possible consistent with their purpose, of a shape acceptable to the Engineer, and designed so that they will not overturn when the concrete is placed. They shall be made of concrete with 5 mm maximum aggregate size and the mix proportions shall comply with the relevant Clauses in Series 900 to produce the same strength as the adjacent concrete. The blocks shall be formed in specially manufactured molds and the concrete compacted on a table vibrator, all to the approval of the Engineer. Tying wire shall be cast in the block for the purpose of fastening it to the reinforcement.

850 WELDING OF REINFORCEMENT

Reinforcement in structures shall not be welded except where permitted in the Contract. All welding procedures shall be subject to the prior approval of the Engineer in writing.

Flash-but welding shall be carried out only with the combination of flashing, heating, upsetting and annealing to the Engineer's approval, and only those machines that automatically control this cycle of operations shall be used. Whereas Metal-arc welding shall be carried out in accordance with BS 5135 and the recommendations of the reinforcement manufacturers, subject to the approval of the Engineer and the satisfactory performance of trial joints, Other methods of welding, e.g. resistance welding, may be used subject to the approval of the Engineer and to their satisfactory performance in trial joints.

Welded joints shall be full-strength welds, and their strength shall be assessed by destruction tests on samples selected by the Engineer.

Cold worked steel bars shall not be welded. If epoxy coating is required to be applied to the reinforcement, specific instruction will be given by the Engineer taking into account the particular design conditions which apply.

890 Method of Measurement and Payment

Measurement and Payment for reinforcement works shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to these works shall be made under the item heading "Steel Reinforcement" in the Bills of Approximate Quantities.

The measurement of reinforcing steel will be based on the theoretical number of metric tons complete in place as shown on the drawings or placed as ordered in writing by the Engineer. No allowance will be made for the clips, wire or other fastening devices for holding the steel in place, and no measurement will be made of splices not shown on the Drawings.

The Cross Section Area and Weights of reinforcing bars whose diameter is stipulated in accordance with AASHTO M31 shall be calculated from the table below:

Dia (mm)	Area (cm ²) Weight (Kg/m)	Dia (mm)	Area (cm ²) Weight (Kg/m)	Dia mm	Area (cm ²) Weight (Kg/m)
5	0.197	18	2.545	34	9.080
	0.154		2.000		7.130
6	0.283	20	3.142	36	10.179
	0.222		2.470		7.990
7	0.385	22	3.802	38	11.342
	0.302		2.980		8.900
8	0.503	24	4.524	40	12.567
	0.395		3.555		9.870
10	0.786	26	5.310	45	15.905
	0.617		4.170		12.500
12	1.131	28	6.158	50	19.635
	0.888		4.830		15.400
14	1.540	30	7.069		
	1.210		5.550		
16	2.011	32	8.043		
	1.580		6.310		

The Cross section Area and Weights of reinforcing bars whose diameter is stipulated according to other codes shall be as shown in the Drawings or specified elsewhere. No allowance will be made for the weight of weld metal used in the fabrication of bar trusses. No measurement will be made for mesh reinforcement which shall be considered subsidiary to the construction of the item in which it is placed.

The contract pay unit for reinforcement works is ton in which the rate shall be in full compensation for furnishing, fabricating (i.e., cutting and bending), transporting, delivering, erecting, and placing all materials, for all labour, equipment, tools, and all other items necessary for the proper completion

of the work as per specifications.

Bill Item Description Pay Unit

H.1	Steel Reinforcement	Ton
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SERIES 900

CONCRETE WORKS

SERIES 900 – CONCRETE

901 GENERAL

902 Scope

The work covers the concrete construction of bridges, box culverts with its corresponding headwalls and wing walls, foundations any other activity that concrete will be required.

These specifications shall cover concrete materials including sampling, testing and storage of these materials, strength of concrete requirements, procedures for testing, job mixes, the requirements for cast-in-place concrete materials, mixing, placement, finishes and the requirements for Ready Mix and Precast Concrete. This guide specification is to be used for Concrete structures including, but not limited to, concrete bridges, culverts, foundation structures except where it has been mentioned otherwise in the Specifications or on Design Drawings.

903 Submissions

All submissions shall adhere to the requirements of the submission procedure included in the relevant section within **Series 0** of these specifications.

903.1 Statements

The Contractor is required to submit at least 14 days prior to commencing concrete placing operations, a statement covering concrete mix proportions, the results of trial mixes along with the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of each strength of concrete. Aggregate weights shall be based on the saturated surface dry condition. The abovementioned statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated.

No Substitutions shall be made in the materials used in the work without the prior approval of the Engineer and conducting additional tests to show that the quality of the concrete is approved.

903.2 Reports

The Contractor is required to submit reports covering sampling and testing in the form of certified

copies of laboratory test reports, including all test data, for cements, aggregates, admixtures, curing compound, and shelf angle inserts. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

903.3 Certificates

The Contractor is required to submit the manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished for cement, pozzolan and admixers. No cement, pozzolan or admixers shall be used until notice of acceptance has been given by the Engineer. Cement and pozzolan, may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site.

904 APPLICABLE CODES AND TESTS

The AASHTO standards relating to this paragraph shall be taken as basic requirements. In addition, the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. In the event of a discrepancy between the different codes, the AASHTO specifications shall prevail.

Copies of the applicable codes shall be made available by the Contractor for the use of the Engineer on site.

➤ AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117 (1990)	Standard Tolerances for Concrete Construction and Materials
ACI 211.1 (1989)	Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301 (1989)	Structural Concrete for Buildings
ACI304R (1989)	Guide for Measuring, Mixing, Transportation, and placing Concrete
ACI 305R (1989)	Hot Weather Concreting
ACI 309R (1987)	Guide for Consolidation of Concrete
ACI318 (1989)	Building Code Requirements for Reinforced Concrete
ACI 318 Supplements	(318R-89;318M-89;318RM-89)
ACI 350R (1989)	Environmental Engineering Concrete Structures

➤ AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31(1990)	Making and Curing Concrete Test Specimens in the Field
ASTM C 33 (1990)	Concrete Aggregates
ASTM C 39 (1986)	Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42 (1987)	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 78 (1984)	Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 94 (1990)	Ready-Mixed Concrete
ASTM C 109 (1990)	Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)
ASTM C 143 (1990)	Slump of Hydraulic Cement Concrete
ASTM C 150 (1989)	Portland Cement
ASTM C 171 (69-R 86)	Sheet Materials for Curing Concrete
ASTM C 172 (1990)	Sampling Freshly Mixed Concrete
ASTM C 173 (1978)	Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192 (1990a)	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 227(1990)	Potential Alkali Reactivity of Cement-Aggregate Combinations
ASTM C 231 (1989a)	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260 (1986)	Specification for Air-Entraining Admixtures for Concrete
ASTM C 289 (1987)	Potential Reactivity of Aggregates (Chemical Method)
ASTM C 295 (1990)	Petrographic Examination of Aggregates for Concrete
ASTM C 309 (1989)	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494 (1986)	Chemical Admixtures for Concrete
ASTM C 586 (1986)	Potential Alkali Reactivity of Carbonate for Concrete Aggregates (Rock Cylinder Method)
ASTM C 595 (1989)	Blended Hydraulic Cements
ASTM C 597 (1983)	Pulse Velocity Through Concrete
ASTM C 618 (1989a)	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 803 (1990)	Penetration Resistance of Hardened Concrete
ASTM C 805 (1985)	Rebound Number of Hardened Concrete
ASTM C 1017 (1985)	Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1107 (1989a)	Packaged Dry, Hydraulic-Cement Grout (Nonshrinkable)
ASTM E 96 (1990)	Water Vapor Transmission of Materials
ASTM E 488 (1990)	Strength of Anchors in Concrete and Masonry Elements

➤ FEDERAL SPECIFICATIONS (FS)

FS CCC-C-467 (Rev C) Cloth, Burlap, Jute (or Kenaf)

➤ NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA-QC3 (84-R4)

Quality Control Manual: Section 3, Plant Certifications Checklist:
Certification of Ready-Mixed Concrete Production Facilities

NRMCA-CPMB100 (90-R9) Concrete Plant Standards

NRMCA TMMB1(89; R13) Truck Mixer and Agitator Standards

➤ AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS

AASHTOT260

Sampling and Testing for Chloride Ion in Concrete and Concrete
Raw Materials

905 Testing and Sampling

905.1 Materials

All aggregate, cement and water shall be sampled and tested during construction for adherence to **Section 910** of these specifications as frequently as deemed necessary by the Engineer and at the Contractor's own expense.

Samples shall be obtained in accordance with AASHTO T23, T141, T2, T127 and T26. All costs connected with manufacturer's certificates of guarantee, laboratory analysis, and all subsequent testing for material acceptance shall be borne by the Contractor.

905.2 Mix Design

In meeting the strength requirements specified, the selected mixture proportion shall produce an average compressive strength exceeding the specified strength by the amount indicated in the table below:

Item	Specified Strength (kg/cm ²)	Ave. Compressive Strength
1	Less than 210	specified strength plus 70 kg/cm ²
2	210 - 350	specified strength plus 85 kg/cm ²
3	Greater than 350	specified strength plus 99 kg/cm ²

The ultimate compressive strength of the concrete shall be determined on test specimens obtained and prepared in accordance with AASHTO T 126, except that only 152mm by 300mm cylinders shall be used for compression tests. Test cylinders shall be capped prior to testing in accordance to AASHTO T231. The Contractor shall furnish reusable vertical molds made from heavy gauge metal.

The concrete mix shall be redesigned if the average of the strength test of the specimens falls below the minimum allowable compressive strength at 7 or 28 days. In the determination of the average compressive strength of the specimens, no cylindrical specimen shall have a strength less than 85% of the allowable strength.

Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 1000 psi (70 kg/cm²) of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

➤ **Test Records >29**

Required average compressive strength used as the basis for selection of concrete proportions shall be the larger of the specified strengths plus the standard deviation multiplied by 1.34 or the specified strength plus the standard deviation multiplied by 2.33 minus 500 psi (35 kg/cm²).

➤ **Test Records ≤ 29 but ≥ 15**

Where a concrete production facility does not have test records meeting the above requirements but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following table below:

No. of tests (1)	Modification factor for standard deviation
Less than 15	Refer to interpolation of results
15	1.16
20	1.08
25	1.03
30 or more	1

➤ **Test Records <15**

When a concrete production facility does not have field strength test records for calculation of standard deviation or the number of tests is less than 15, the required average strength shall be as stipulated in the table above.

905.3 Site

➤ **Strength**

The Contractor will make and cure at least a total of 6 cylinders from concrete as mixed at each structural element in the presence of the Engineer. The test specimens shall be made and cured in accordance with AASHTO T23 with capping of the cylindrical concrete specimens made according

to AASHTO T231.

All specimens are to be taken from the same batch of concrete used. The frequency of collecting testing samples for each class of concrete placed each day shall not be less than once a day, nor less than once for each 118 m³ of concrete, nor less than once for each 465 m² of surface area for slabs or walls. If this sampling frequency results in less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected trucks or batches or from each batch or truck if fewer than 5 batches or truck loads are used.

Once prepared, the Contractor shall, when directed by the Engineer, transport the cylinders from the structure site to the laboratory. The Contractor shall take every precaution to prevent injury or damage to the test cylinders during handling, transporting and storing. He will be held solely responsible for any test failures caused by improper handling and transportation or any other cause which may be detrimental to the test cylinder.

In order that the test cylinders may be transported from field to laboratory undamaged, the Contractor shall provide a minimum of two metal boxes (i.e., one for the Contractor's use and the other for the Engineer's use) of such size as to receive a minimum of 6 test cylinders and leave space for sawdust packing around all surfaces of the cylinders. The metal boxes shall be approved by the Engineer before usage and the Contractor shall, when directed by the Engineer, provide as many additional boxes as may be required.

The Engineer may ask the Contractor to make additional test cylinders to ascertain the effectiveness of the method by which the structure is being cured, and also to determine when the structure may be placed in service. These cylinders shall be cured in the field in the same manner as the concrete placed in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the element represented by the samples.

These cylinders shall be tested by crushing after 7 days (3 no. cylinders) and 28 days (3 no. cylinders) in accordance with AASHTO T22. These specimens will be the basis for acceptance of the concrete in the structure and provide means for checking the adequacy for laboratory mixture proportions for strength.

In the event that test cylinders fail to meet minimum strength requirements, the Engineer may require core samples to be taken to determine the strength acceptance of such structures.

The contractor shall, at his own expense, furnish all equipment required for such core samples.

➤ **Slump Tests**

The Contractor shall conduct slump tests on the batches according to AASHTO T119. The consistency

of concrete at the time of delivery will be designated by the Engineer and shall be determined as specified in AASHTO T119.

910 MATERIALS

911 Aggregates

911.1 Fine Aggregates

Fine aggregates for concrete shall conform to ASTM C-33 and shall consist of natural sand or crushed rock having hard and durable particles or, if approved by the Engineer, of the inert materials having similar characteristics. It shall not contain harmful materials such as iron pyrites, coal, mica, shale or similar laminated materials such as flat and elongated particles, or any materials which may attack the reinforcement in such a form or in sufficient quantity as to adversely affect the strength, durability and texture of the concrete.

The Contractor shall, when directed by the Engineer, wash and sieve the fine aggregates to remove deleterious substances or for consistency of concrete color. Sea water shall not be used for such washing. If the locally available sand is out of the grading limits, the Engineer may adjust the specified limits and accept the use of such sand.

Fine aggregate for concrete shall meet the following additional requirements:

- Fineness modulus, AASHTO M6: 0.20% of approved value which shall be not greater than 3.1 or less than 2.3. Sieve analysis to AASHTO T27. If the fineness modules varies by more than 0.2 from the value assumed in the concrete mix design, the use of such fine aggregate shall be discontinued until suitable adjustments can be made in the mix proportions to compensate for the difference in gradation.
- Maximum Sodium sulfate soundness of 10% in accordance to AASHTO T104.
- Minimum Sand equivalency of 75% in accordance to AASHTO T176.
- Organic Impurities in accordance to AASHTO T21 to be not darker than standard.
- Maximum content of clay lumps and friable particles is 3% according to AASHTO T112.

When tested according to AASHTO T27, fine aggregates for concrete shall meet the following grading limits:

AASHTO Sieve (mm)	Percent Passing
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9.5	100
4.75	95 - 100
1.18	45 - 80
0.3	10 -30
0.15	2 -10
0.075	0 - 4

911.2 Coarse Aggregate

Coarse aggregate for concrete shall conform to AASHTO M80 and shall consist of gravel, crushed gravel, or crushed stone free from coating of clay or other deleterious substances. It shall not contain harmful materials such as iron pyrites, coal, mica, laminated materials, or any materials which may attack the reinforcement, in such a form or in sufficient quantity to affect adversely the strength and durability of the concrete. If necessary, coarse aggregate shall be washed to remove deleterious substances or for consistency of concrete color.

Coarse aggregate for concrete shall meet the following additional requirements:

- Maximum Sodium soundness according to AASHTO T1 04 - 5 cycles is 10%.
- Maximum Abrasion according to AASHTO T96 is 40% loss.
- Maximum Content of clay lumps friable particles according to AASHTO T112 is 3% by weight.
- Maximum Soft fragments and shale according to AASHTO M80 is 5% by weight.
- Maximum Flakiness Index according to 6.S 812 is 40 for 40 mm stone and above, and 35 for 20 mm stone and below.
- The aggregates, when tested according to ASTM C289, shall be non-reactive.
- Coarse aggregates, when tested according to AASHTO T27, shall meet the gradation requirements and shall be uniformly graded within the limits specified in the table below for the various classes of concrete.

AASHTO sieve mm	Class A	Class B	Class C
63	-	-	-
50	-	-	-

37.5	-	-	-
25	100	100	100
19	95 -100	95-100	95 -100
12.5	-	-	-
9.5	20 - 55	20-55	20 - 55
4.75	0-10	0-10	0-10
2.36	0-5	0-5	0-5
0.075	0-1	0-1	0-1

Type and quality of the coarse aggregate are subject to the approval of the Engineer prior for its use to achieve the minimum specified concrete strengths. Local laterite aggregates may not be used for any structural concrete, or where so noted on the drawings or in the specifications.

911.3 Combined Aggregates

Approved coarse and fine aggregates in each batch of concrete shall be combined in proportion as approved by the Engineer with the weight of materials passing the 0.075 mm Sieve not exceeding 3% of the weight of combined aggregate.

The combined concrete aggregate gradation used in the works shall be as specified. Only upon the approval of the Engineer, a class C concrete gradation may be used for sections or members with reinforcement spacing too close in order to permit proper placement and consolidation of the concrete. Changes from one gradation to another shall not be made during the progress of the work.

Tests on coarse and fine aggregates shall be conducted prior to commencement of any concrete works according to AASHTO standards.

911.4 On Site Storage of Aggregates

Adequate stocks of tested and approved aggregates shall be kept on site and the capacity of the storage bins for each type and grading of aggregates shall be sufficient to hold the respective quantities required for the maximum amount of concrete the Contractor is obliged or intends to place in any continuous daily operation.

Stockpiles shall be built in layers of 1.50 meters maximum height to prevent segregation of aggregates with totally separate stockpiles assigned for the different grades of aggregates. Dense concrete or bituminous slabs shall be laid with sufficient falls to cover all aggregate stockpile areas or bins and shall extend to cover all surrounding areas where aggregates are likely to be discharged or handled. Stockpile areas shall be swept and kept clean at all times to ensure that the aggregates are not

contaminated by the adjacent ground through trafficking or otherwise, and shall be constructed with adequate drainage for surplus water.

Wind breaks shall be provided where aggregates might suffer excessive contamination by windblown materials and tarpaulins or other approved means shall be used during periods of heavy rain.

911.5 Rejection of Aggregates

The general or localized buildup of fines in aggregate stockpiles shall not be allowed and any material which, in the opinion of the Engineer, is so affected will be rejected after testing.

Aggregates which have segregated or contaminated during processing, handling at source, transportation to the site, stockpiling and handling on site, or which otherwise do not conform with requirements of the specifications, either locally or generally, will be rejected and shall be removed promptly from the site regardless of any prior approval of the source which may have been given by the Engineer.

911.6 Washing and Processing Aggregate

The Contractor may be required to carry out on Site supplementary processing or effective washing of coarse and fine aggregates where the aggregates producer's methods, in the opinion of the Engineer, may not result in end products which consistently conform with all requirements of the specifications, or where aggregates suffer unacceptable changes during loading at source or during subsequent transportation to the site, or otherwise.

912 Cement

Cement shall be Portland type originating from manufacturers approved by the Engineer. The quality of the Portland cement shall be equivalent to AASHTO M85 or ASTM C 150, Type I; II; III and V.

Portland blast furnace cement complying with the requirements of B.S. 146, Sulphate Resisting Portland cement and Portland Pulverized fuel ash complying with BS 6588 shall be used in concrete structures subjected to aggressive water and soils in accordance to the test results conducted on the surrounding soils and water and as instructed by the Engineer.

All cement bag consignments shall be subject to the approval of the Engineer and shipments of cement shall be accompanied by a manufacturer's certificate of guarantee and/or laboratory test certificate. Approval of any cement sample shall not relieve the Contractor of the responsibility to produce concrete of the specified strength. The Contractor shall bear all costs in connection with the Certificate

of Guarantee and laboratory tests.

When tests at the factory or field tests subsequent to the original approval tests show that the cement does not comply with the specifications, the entire consignment from which the sample was taken shall be rejected and the Contractor shall immediately remove the rejected material from the site and replace it with cement which meets the required specifications.

If no local test certificate is available, the contractor shall obtain from each proposed manufacturer a typical sample of cement which shall be fully and independently tested in accordance with the appropriate standards and the results submitted for approval. The Contractor shall bear all costs in connection with these tests.

In case of bulk cement consignments, the manufacturer's bulk average test certificate for each consignment of cement shall be submitted, showing the results for chemical compositions and physical properties determined according to relevant standard. Samples shall be taken for each consignment of cement and tested as directed by the Engineer in an approved independent laboratory at the cost of the Contractor. In addition, the Contractor shall provide all information required by the Engineer concerning off-site storage and loading arrangements and shall provide all necessary assistance for the Engineer to inspect these arrangements for approval purposes. Consignments shall be used in the order in which they are delivered.

Cement shall be stored in moisture-proof storage sheds. Neither stale, caked, nor reclaimed or re-sacked cement shall be used.

The Contractor shall not store cement in areas subject to flooding. Storage capacity shall be sufficient to meet the schedule of work so that continuous work is achieved.

Cement remaining in bulk storage at the mill, prior to shipments, for more than 6 months or cement stored in bags in local storage by the Contractor or a vendor for more than 3 months after shipments from the mill, may be retested before use and will be rejected if it fails to meet any of the requirements of these specifications.

Cementitious materials shall conform to one of the following:

➤ **Type**

The type of cement shall adhere to AASHTO M85 or ASTM C 150, of type indicated. Only one type or brand of cement shall be used in anyone structural member or for concrete which will have surfaces exposed in the finished structure. Mixing of types or brands will not be permitted.

Location of Use

Type

Concrete having any surface in contact with soil or moisture	V
All other concrete	II or V

➤ **Reactivity**

Cement shall be tested with the aggregate per ASTM C 227 to determine acceptable reactivity.

➤ **Alkalies**

Maximum alkalies ($\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}$): 0.60% by weight of cement.

➤ **Cement Content**

Minimum cement content is 450 kg per cubic metre of concrete.

913 **WATER**

Water for concrete mixing shall be free from sufficient concentrations of oils, grease, sodium chlorides (i.e., salts), acids, alkalis, organic matters, fine-dissolved or suspended and any other substances that reduce the strength of concrete or are harmful in the short or long run on the placed concrete. Any source of water found to have such concentrations will be

rejected. The water used in the mix design shall be the same as the water approved for site use.

Potable water is suitable for concrete mixing if it satisfies the requirements of AASHTO T26 and BS 3148.

If water for the works is not available from a public utility, a report shall be presented by the Contractor detailing the new proposed source of water, test results of the sample which is collected jointly with the Engineer from the new proposed source, and the manner of its use. Only upon the Engineer's approval of the report, and the satisfaction of the Engineer that the test results adhere to the requirements of AASHTO T26 and BS 3148 and the impurities don't exceed the acceptable values, shall the permission for the use of such water be granted.

If at any time during construction the water from an approved source becomes unsatisfactory, the Contractor will be required to provide satisfactory water from other alternative sources.

914 **ADMIXTURES FOR CONCRETE**

The quantity and method of using admixtures shall be in accordance with the manufacturer's recommendations and in all cases shall be subject to the approval of the Engineer.

Admixtures shall conform to the following:

- ASTM C 260 in the case of Air-Entraining Admixtures.
- ASTM C 1017, Type 1 or 2 in the case of Flowing Concrete Admixtures.
- ASTM C 494, Type A, B, or G in the case of Water-Reducing or Retarding Admixtures.

Before using any type of admixtures, the Contractor shall provide, for the Engineer's approval, the following information:

- The detrimental effects caused by adding a greater or lesser quantity in kilograms per cubic meter of concrete;
- The chemical name(s) of the main active ingredient(s);
- Whether or not the admixture lead to the entrainment of air;
- The Contractor shall demonstrate the action of an admixture by means of trial mixes if required by the Engineer.

The use of Calcium Chloride in any form is prohibited.

920 DESIGN REQUIREMENTS

921 Concrete Strength and Slump Requirements

The ultimate compressive strength of Structural concrete as tested at 28 days shall not in any case be less than the values given in the table below:

Concrete Class	Min compressive strength (Kg/cm^2)	Use
A	350	Structural Concrete
B	210	Mass Concrete
C	150	Blinding

The 7-day compressive strengths shall not be less than 75% of the required 28 day strength.

It is to be noted that no follow up work shall be performed on the cast structural element (i.e., backfilling, surfacing, or loading) prior to performing the 28 day concrete crushing strength test and only upon the instruction of the Engineer.

If for any reason, the Engineer finds it necessary to use cubic molds for testing of concrete, then the contractor has to provide sufficient no. of 15 cm - cube molds. The concrete compressive strength results will be converted to cylindrical strength mentioned in this section using appropriate conversion

factors.

With respect to slumps, the following results shall be obtained:

Class of concrete	Slump (mm)
A	75-125
B	75-125
C	None required

922 Concrete Composition

922.1 Mix Proportions

The Contractor shall consult with the Engineer as to the mix proportions at least 45 days prior to beginning concrete work. The Contractor shall be responsible to design the concrete mixes in order to achieve the minimum compressive strengths as stipulated in **Section 921**. The actual mix proportions of cement, aggregates, and water shall be determined in the laboratory by the Contractor under the supervision of the Engineer.

The Contractor shall, in the presence of the Engineer, prepare trial-mixes for each class of concrete required for the project, made with the approved materials to be used in the works. The proportions of the trial-mixes shall be such as to produce a dense mixture containing the specified cement content and meeting the plasticity requirements and 115 percent of the strength requirements designated for each class of concrete. If the materials supplied by the Contractor are of such a nature, or are so graded, that proportions based on minimum cement content cannot be used without exceeding the maximum allowable water content, the proportions will be adjusted so as to require the least amount of cement which will produce concrete of the required plasticity and workability without exceeding such allowable water content. No additional payment will be made for increased quantity of cement.

It is important to note that in case of high concentration of steel reinforcement, the maximum size of aggregates could be reduced to 12.7 mm upon the direction of the Engineer.

Test cylinders shall be made from the above trial-mixes. A review of the Contractor's trial mixes shall be made by the Engineer after breaking test cylinders at 7 and 28 days. Based on the trial mix results, the Engineer will then determine which of the trial-mixes shall be used. If none of the trial-mixes for a class of concrete meets the specifications, the Engineer will direct the Contractor to prepare additional trial-mixes. No work with any class of concrete shall be permitted until its job-mix proportions have been approved by the Engineer.

The approval of the job-mix proportions by the Engineer, or his assistance to the Contractor in establishing those proportions, in no way relieves the Contractor of the responsibility of producing concrete which meets the requirements of these specifications.

All costs connected with the preparation of trial-mixes and the design of the job-mixes shall be borne by the Contractor.

922.2 Design Limits

The actual concrete mix proportions will be determined after evaluating test results of the trial concrete mixes in accordance to **Section 905**.

The following data shall be provided to the Engineer upon the successful testing completion:

- The minimum cement content in sacks per cubic meter of concrete;
- The maximum allowable water content in liters per sack of cement, or equivalent units, including surface moisture, but excluding water absorbed by the aggregates;
- The ratio of coarse and fine aggregates; and
- Slumps designated at the point of delivery.

Changes requested by the Contractor in Mix proportioning previously approved, pursuant to **Section 922.1** shall be made only with the approval of the Engineer.

Failure of the mixed concrete to meet specifications determined by the Engineer under **Section 922.1** will be grounds for the Engineer to reject the concrete.

When, in the opinion of the Engineer, cement is being lost due to windy conditions or temperature rise, the Contractor shall include additional amounts of cement as directed by the Engineer and at the Contractor's own expense.

In the event that a laboratory design mix is not available, the Contractor shall use Tables 1 and 2 only after approval has been obtained from the Engineer and after testing of the said mix designs has been conducted.

Table 1: Design requirements using rounded coarse gravel aggregate

Class of concrete	Coarse Aggregate Size range (mm)	Sacks of cement (No) min	Weight of Agg. (Kg) Per sack cement		Maximum Water content (liters) per sack cement	Slump (mm)
			Fine	coarse		
A	19 - 2.36	10	95	175	25	75-125
B	19 - 2.36	7	120	119	26	75-125
C	19 - 2.36	6	108	136	25	N.R.

Table 2: Design requirements using angular coarse gravel aggregate

Class of concrete	Coarse Aggregate Size range (mm)	Sacks of cement (No) min	Weight of Agg. (Kg) Per sack cement		Maximum Water content (liters) per sack cement	Slump (mm)
			Fine	coarse		
A	19-2.36	10	120	119	26	75 - 125
B	19-2.36	7	131	103	28	75 -125
C	25 -.2.36	6	120	119	26	N.R.

*In case of high concentration of steel, the size of aggregates is % inch (12.7 mm) as directed by the Engineer.

922.3 Limiting Values for Concrete

The cement content specified shall be determined from a yield test in accordance with AASHTO T 121.

Maximum limits shown for liters of water per sack of cement shall include free water in aggregates. Slumps shall be tested in accordance with AASHTO T 119.

922.4 Changes in Proportion

As the work progresses, the Engineer reserves the right to require the Contractor to change the proportions from time to time, if conditions warrant such changes to produce satisfactory results. Any such changes may be made within the limits of the Specifications at no additional compensation to the Contractor.

930 CONSTRUCTION REQUIREMENTS

931 Assembly and Handling of Materials

931.1 Assembly

Aggregates shall be assembled in such quantities that sufficient material approved by the Engineer is available to complete any continuous pour necessary for structures. The batching site shall be of adequate size to permit the stockpiling of sufficient, unsegregated materials, having proper and uniform moisture content to ensure continuous and uniform operations. Aggregates shall enter the mixer in a manner approved by the Engineer and in such a manner as to ensure that no foreign matter to the concrete, or matter capable of changing the desired proportions, is included. If two or more sizes or types of coarse or fine aggregates are used in the same project, only one size or type of each

aggregate may be used on one continuous concrete pour.

931.2 Segregation

Segregated aggregates shall not be used until they have been thoroughly remixed and the resultant pile is of uniform and acceptable gradation at any point from which a representative sample is taken. The Contractor shall remix aggregate piles when ordered by the Engineer.

931.3 Transporting of Aggregates

If aggregates are to be transported from a central proportioning plant to the mixer in batchboxes or dump trucks, such equipment shall be of sufficient capacity to carry the full volume of materials for each batch of concrete. Partitions separating batches shall be approved by the Engineer and shall be adequate and effective to prevent spillage from one compartment to another or dumping while in transit.

931.4 Cement

Cement in storage or stockpiled on the site shall be protected from any damage by climatic conditions. Methods of storing or stockpiling shall be approved by the Engineer. Cement shall be transported to the mixer in the original sacks. Each batch shall contain the full specified amount of cement for the batch. Batches where cement is placed in contact with the aggregates may be rejected unless mixed within 90 minutes.

932 Handling and Mixing

Concrete shall be mixed in quantities required for immediate use. Concrete which has developed initial set or is not in place 30 minutes after the water has been added shall not be used. Re-tempering concrete by adding water or by other means will not be permitted. Concrete that is not within the specified slump limits at the time of placement shall not be used and shall be disposed of as directed by the Engineer.

The concrete may be mixed at the work site via site mixers, in a central-mix plant or in transit mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are in the drum. Ready mixed concrete shall be mixed and delivered in accordance with requirements of **Section 940** of these specifications.

When mixed at the site of the work or in a central-mixing plant, the mixing time shall not be less than 50 seconds nor more than 90 seconds. Four seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the

discharge chute opens. Transfer time in multiple drum mixer is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The mixer shall be operated at a drum speed as shown on the manufacturer's nameplate on the mixer. Any concrete which, in the opinion of the Engineer, is mixed more or less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic meters, as shown on the manufacturer's standard rating plate on the mixer; except that an overload up to 10 percent above the mixer's nominal capacity may be permitted when approved by the Engineer, provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

The batch shall be so charged into the drum that a portion of mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

933 Measurement for proportioning Materials

➤ Cement

The cement shall be measured as packed by the manufacturer, a sack of cement shall weigh 50 kilograms. Measurement shall be accurate to within 0.5 percent throughout the range of use.

➤ Water

The mixing water shall be measured by weight or by volume. In either case the measurement shall be accurate to within 1.0 percent throughout the range of use.

➤ Aggregates

The aggregates shall be measured by weight. The measurement shall be accurate to within 0.5 percent throughout the range of use.

934 CONCRETE PLACEMENT AND COMPACTION

934.1 Scope

These operations shall consist of placing, compacting and curing of concrete of mass concrete, reinforced concrete and prestressed concrete structures.

934.2 Concrete Placement

1. Pouring of concrete shall not commence without the written approval of the Engineer.
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Such approval shall be sought in writing by the Contractor at least 24 hours in advance.

2. The method and sequence of pour, the equipment to be used, the method of compaction and curing procedures shall be approved by the Engineer, prior to concrete pour.
 3. The free-drop height of concrete shall be not greater than 1.5 m and the method of placement shall be such as to suit the available conditions and prevent segregation.
 4. Concrete placement shall be continuous between predetermined points (i.e., construction joints and expansion joints).
 5. The slopes of chutes, when used, shall be not greater than 1 vertical to 2 horizontal or smaller than 1 vertical to 3 horizontal. The slopes of the chute shall be constant along its length. The capacity of the chute shall be adequate to deliver the required volume of concrete at the required rate.
 6. Aluminum pipes shall not be used for delivering concrete. The internal diameter of delivery pipes, if used, shall be not less than 8 times the maximum aggregate size. At the point of delivery, pipes shall be vertical.
 7. Where bucket and hopper is used for delivery of concrete, the discharge opening shall be not less than 5 times the maximum aggregate size. The sides of hoppers shall be sloped at not less than 60 degrees to the horizontal.
 8. When buggies are used to transport fresh concrete, they shall be run on level tracks which are securely fixed. The buggies shall be run smoothly without sudden jerks and the distance shall be not greater than 60 m.
 9. All chutes, buckets and hoppers, buggies and pipes shall be kept clean and free from coating of hardened concrete by thorough flushing with water after each run. The water used for flushing shall be discharged clear of the concrete already in place.
 10. The external surface of all concrete shall be thoroughly worked during placement by means of tools of an approved type. The working shall be such as to force all coarse aggregate from the surface and to bring mortar against the forms to produce a smooth finish, substantially free from water and air pockets, or honeycomb.
 11. Concrete shall be deposited in water only with the permission of the Engineer and under his supervision. The minimum cement content of the class of concrete being deposited in water shall be increased by 10 percent without further compensation and the slump shall be approximately 15 cm.
 12. When depositing in water is allowed, the concrete shall be carefully placed in the space in which it is to remain in a compact mass, by means of a tremie, bottomdumping bucket or other approved means that does not permit the concrete to fall through the water without
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adequate protection. The concrete shall not be disturbed after being deposited.

No concrete shall be placed in running water, and forms which are not reasonably watertight shall not be used for holding concrete deposited under water.

13. When casing is used in drilled shafts, the casing shall be smooth and properly oiled in accordance with the manufacturer's manual and shall extend sufficiently above the grade of the finished shaft to provide excess concrete to be placed for the anticipated slump due to the casing removal. When the casing is to be pulled, the concrete placed in the casing shall have such a slump and be of such workability that vibrations of the concrete will not be required.
 14. No concrete work shall be stopped or temporarily discontinued within 45 cm of the top of walls and columns unless such work is finished with a coping having a thickness of not less than 45 cm in which case the joint shall be made at the under edge of the coping.
 15. Concrete in simple slab spans shall be placed in one continuous operation for each span, unless otherwise directed on the drawings or directed by the Engineer.
 16. Concrete in-situ beam and slab construction shall be placed in one continuous operation. However concrete placement can be made in two separated operations, each of which shall be continuous with the first placement made to the top of the girder stems, and the second to completion, when so shown on the drawings or approved by the Engineer. Where a construction joint is permitted between the girder stem and the roadway slab, complete details of key or other methods of bonding will be as shown on the drawings or directed by the Engineer and such joints must be constructed strictly in accordance therewith. When such a joint is permitted, deck concrete shall not be placed until the concrete in the girder stem has hardened sufficiently so as not to be damaged by the concreting operations of the deck pour.
 17. Concrete in arch rings shall be placed in such a manner as to load the centering uniformly. Arch rings shall be divided into section such that each section can be cast for the full cross-section in one continuous operation. The arrangement of the section and the sequence of placing shall be as approved by the Engineer, and shall be such as to avoid the creation of initial stress in the reinforcement. The section shall be bonded together by suitable keys or dowels. When permitted by the Engineer, arch rings may be cast in a single continuous operation.
 18. In case of concrete placement by pumping, the following is to be noted:
 - a. Before concrete can be placed, the Contractor shall obtain the Engineer's approval in writing for the pumping machine to be used, the trunking arrangements and method of pumping.
 - b. The mix design shall be checked for its suitability for pumping and the concrete shall
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be tested regularly during pumping for its uniformity and that its properties have not been altered by pumping. If changes to slump, water-cement ratio, consistency or any other characteristics occur, corrective measures shall immediately be taken to ensure that concrete delivered by the pump complies in full with the requirements of the specification. Samples shall be taken at discharge from the mixer/agitator truck, from the pump and at discharge from the pump.

- c. The internal diameter of delivery pipe of the pump shall be not less than 3 times the maximum aggregate size. The pipes shall not rest on any part of the form work and shall be supported independently and securely and be readily accessible so that sections can easily be detached to remove any blockage.

934.3 Compacting

➤ Poker Vibrators

1. The type and size of poker vibrators shall suit the pour size, density of reinforcement and member dimensions. Unless otherwise authorized by the Engineer, the vibrator shall be selected pursuant to the table below:

Size of pour (m/h)	Poker Diameter (mm)	Speed (Vibration/min)
2-4	20-45	9000
5-10	50-65	9000
10-20	60-75	7000
20-30	80-115	7000
30-40	140-170	6000

2. Poker vibrators shall be inserted into the concrete vertically at regular intervals which shall be no greater than 0.45 m. They shall be inserted quickly and withdrawn slowly. The withdrawal rate shall be not more than 75mm/sec. A cycle of insertion and withdrawal shall be between 10 and 30 seconds.
 3. Poker vibrators shall be kept clear of form work and concrete previously cast.
 4. Vibrators shall be so manipulated as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to cause concrete to flow or run into position in lieu of placing. Vibration of any point shall be of sufficient duration to accomplish compaction, but shall not be prolonged to the point where segregation occurs.
 5. Compaction shall be sufficient to achieve maximum density without segregation in the fresh
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concrete.

6. Standby pokers of the same type shall be provided at all times. The standby vibrators shall be not less than half the number of pokers used for compacting the pour.
7. Vibrations shall only be carried out by professional technicians having experience of the type of work.

➤ **Other Vibrators**

1. Form vibrators, vibrating tables and surface vibrators, when required, shall first be approved by the Engineer and they shall conform to the requirements of ACI-309.
2. Where form vibrators are used, the form shall be adequately designed so that the vibration will not cause joints to leak and dimensions and geometry to alter.
3. Unless otherwise permitted by the Engineer, the use of form vibrators shall be limited to members whose thickness does not exceed 150 mm.

934.4 Construction of Expansion Joints

Wherever the work of placing concrete is delayed or when concrete work is interrupted by weather or other similar type of delay long enough for the previously partially placed concrete to take its initial set, the point of stopping shall be deemed a construction joint, location and type of construction joint of which shall be subject to approval of the Engineer. So far as possible the location of construction joints shall be as shown on the Drawings and the concrete placement shall be carried out continuously from one joint to another. The joints shall be perpendicular to the principal lines of stress and in general be located at points of minimum shear. Where dowels, reinforcing bars or other adequate ties are not required by the Drawings, keys shall be made by embedding water-soaked beveled timbers in soft concrete. The key shall be sized as directed by the Engineer, and shall be removed when the concrete has set.

Once work is resumed, the surface of the concrete previously placed shall be thoroughly cleaned of dirt and other soft materials with stiff wire brushes, and if deemed necessary by the Engineer, shall be roughened with a steel tool. The surface shall then be thoroughly washed with clean water and painted with a thick coat of neat cement mortar, after which the concreting may proceed.

Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled.

Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete is no longer plastic, before placing concrete for beams, girders, or slabs thereon. In walls having door, window, or other openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details.

Where horizontal construction joints are required, a strip of 1-inch square-edge lumber, bevelled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch (2.5 cm) above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be repaired, and all laitance shall be removed.

Expansion joints shall be constructed at the locations, of the materials, and to the dimension shown on the Drawings.

934.5 Construction of Cold Joints

When the continuous placement of concrete in any structural member is interrupted or delayed, for any reason, for a period long enough for the previously partially placed concrete to take its initial set, the Engineer shall declare such joint a cold joint and the Contractor shall immediately remove the previously partially placed concrete from the forms.

No extra payment will be made for the initial placement or the removal of concrete which is washed because of a cold joint. The Engineer may suspend all or any part of a subsequent concrete work until he deems the Contractor has corrected the cause for the cold joint occurrence.

934.6 Concreting in hot Weather

Unless otherwise directed, when concrete is placed in any part of the works in hot weather where the temperature is expected to reach 33°C or higher, the Contractor shall schedule his operations to place and finish the concrete during the hours that the air temperature in the shade are below 33°C; or as approved by the Engineer.

The Contractor shall use a retarding admixture, when directed by the Engineer, to facilitate placing and finishing of concrete. This admixture shall conform to AASHTO M 194, Type D.

934.7 Night Concreting

No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated, and such night work is approved by the Engineer.

935.1 Materials

➤ **Hessian or Burlap**

They shall be clean and free from harmful materials. Their unit weight shall be not less than 230g/sq.m.

➤ **Impermeable membranes**

The following impermeable membranes may be used upon the approval of the Engineer:

- 1) Clear polyethylene film with no holes, tears, scratches and contamination of any type.
- 2) Hessian coated with white polyethylene of density not less than 300 g/sq.m. The coating may be one side only but shall be not less than 0.1 mm thick and shall not peel during and after use.

➤ **Curing Compounds**

Using of curing compounds shall conform to AASHTO M148 (ASTM-C 309).

➤ **Sand**

Only natural sand, free of harmful contaminants such as silt and clay, can be used.

➤ **Water**

Water to be used for curing shall be potable and shall not contain any substance injurious to concrete, or which causes staining. Non potable water meeting the contamination limits stipulated below may be used if it produces mortar cubes having 7- and 28-day strengths at least 90 percent of the strength of similar specimens made with potable water. The strength comparison shall be made on mortars, identical except for mixing water, prepared and tested in accordance with ASTM C 109.

Maximum Contamination Limits

Form of Contamination in Water	Maximum Concentration in Percent
Dissolved solids (excluding those listed separately below)	0.20
Sulfates, alkali carbonates or bicarbonates	0.10
Chlorides	0.05
Suspended solids	0.20

935.2 Method of Curing

Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from sun, rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 50 ° F (10 ° C) for the first 3 days and at a temperature above 32 • F (0 • C) for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards.

All materials and equipment needed for adequate curing and protection shall be available at the site prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time.

Curing shall be accomplished by any of the methods listed below, or combination thereof, as approved for a minimum of 7 days. The approved method of curing as approved by the Engineer shall not cause any undesirable blemishes such as surface discoloration and surface roughness. Curing compounds shall not be used on construction joints and surfaces that are to receive waterproofing, paint or membranes.

➤ Ponding

Curing by ponding may be used for horizontal surfaces such as bases, pile caps and slabs. Large areas of horizontal surfaces shall be separated into ponds not exceeding 5 sq.m. The ponds shall first be filled between 12 to 24 hours after pour, unless otherwise authorized by the Engineer, and shall be replenished from time to time so as to maintain the ponding for the specified curing period. The concrete temperature and the temperature of the curing water shall be not greater than 10°C.

➤ Sprinkling

Unless otherwise approved by Engineer, curing by spraying shall commence between 12 and 24 hours after the concrete pour. The concrete shall be maintained damp at all times during the curing period

by periodic light sprays.

➤ **Wet Hessian/Burlap**

Members to be cured by wet Hessian or wet burlap shall be completely wrapped with the material and shall be kept moist at all times during the curing period by regular spraying. Unless otherwise approved by the Engineer, the overlap under normal conditions shall be not less than one-quarter the width of the Hessian or burlap and not less than one-half the width in windy and/or rainy conditions. Before members are wrapped for curing, they shall first be evenly moistened.

Unless approved by the Engineer, burlaps shall be supplied only in rolls and burlap bags shall not be used. Second hand Hessian and burlap, if approved for use, shall be clean without holes and contamination of any kind that can affect the concrete.

➤ **Waterproof sheets**

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 6 mm or other equivalent material having a vapor permeance rating not exceeding 0.5 perms as determined in accordance with ASTM E 96.

Waterproof sheets used for curing shall, unless directed by the Engineer, be spread immediately after the pour. The sheet shall, unless approved by the Engineer, be clear of concrete surface but shall be arranged in such a manner as to prevent the movement of air over the concrete surface. Waterproof sheets shall not be used when the air temperature is 25°C or higher.

➤ **Curing Compounds**

Curing compounds shall be applied in two applications at a coverage rate of not less than 1 ltr/ 7.5 sq.m. Per application or as recommended by the manufacturer.

The first coat shall be applied immediately after the removal of the forms and the acceptance of the concrete finish and after the disappearance of free water on unformed surfaces. If the concrete is dry or becomes dry, it shall be thoroughly wetted with water and curing compound applied just as the surface film of water disappears. The second application shall be applied after the first application has set. During curing operations, any unsprayed surfaces shall be

kept wet with water. The curing membrane will not be allowed on areas against which further concrete is to be placed.

Hand operated spray equipment shall be capable of supplying a constant and uniform pressure in order to provide uniform and adequate distribution of the curing membrane at the rates required. The curing compound shall be thoroughly mixed at all times during usage.

The curing membrane shall be protected against damage for the entire specified curing period. Any coating damaged or otherwise disturbed shall be given an additional coating. Should the curing membrane be continuously subjected to injury, the Engineer may require wet burlap, polyethylene sheeting, or other approved material to be applied at once.

No traffic of any kind will be permitted on the curing membrane until the curing period is completed, unless the Engineer permits the placement of concrete in adjacent sections, in which case the damaged areas shall be immediately repaired as directed.

➤ **Steam Curing**

1. Low pressure steam curing

This shall be in accordance with recommendation of ACI 517.

2. High pressure steam curing

This shall be in accordance with the recommendation of ACI 516.

935.3 Curing time

The minimum curing time shall be the number of days given in the table below, unless the average surface temperature of the concrete during the required number of days falls below 10°C, in which case the period of curing shall be extended until the maturity of the concrete reaches the value given in the Table below.

Conditions under which concrete is maturing	Number of days (where the average surface temperature of the concrete exceeds 10°C during the whole period)			Equivalent maturity (degree hours) calculated as the age of the concrete in ours multiplied by the number of degrees Celsius by which the average surface temperature of the concrete exceeds minus 10°C		
	Other	SRPC	OPCor	Other	SRPC or	OPC
			RHPC		RHPC	
1. Hot weather or drying winds	7	4	3	3500	2000	1500
2. Conditions not covered by 1	4	3	2	2000	1500	1000

NOTE: Other* includes all permitted cements except OPC, RHPC and SRPC.

Key: OPC: Ordinary Portland cement.
RHPC: Rapid-hardening Portland cement. SRPC:
Sulfate resisting Portland cement.

The minimum curing time given in the table above shall be compared with the time required for the cylinders, cured under identical conditions to those which the concrete is subjected, to attain 70% of the characteristic strength. The greater shall be taken as the minimum curing time.

940 READY-MIXED CONCRETE

941 Description

Ready-mixed concrete shall consist of a mixture of cement, water, and aggregates, without air-entraining admixture. The term "ready-mixed" shall include central-mixed or transit-mixed concrete and all will be referred to hereinafter as ready-mixed concrete.

Ready-mixed concrete manufactured in approved plants may be used in the works. Approval of any ready-mixed plant will be granted only when an inspection of the plant indicates that the equipment, the method of storing and handling the materials, the production procedures, the transportation and rate of delivery of concrete from the plant to the point of use, all meet the requirements set forth herein. Permission to use ready-mixed concrete from any previously approved plant may be rescinded at any time upon failure to comply with the requirements of the specifications.

Ready-mixed concrete shall be mixed and delivered to the point of use by means of one of the following operations:

- Mixed completely in a stationary' central-mixing plant and the mixed concrete transported to the point of use in a truck or transit mixer or tank agitator operating at agitator speed, or when approved by the Engineer, in non-agitating equipment "central-mixed concrete".

- Mixed completely at the batching plant or while in transit via transit or truck mixers ("transit-mixed concrete").
- Dry mixed in transit but mixed completely in a truck mixer at the point of use following the addition of mixing water ("truck-mixer concrete").

942 General Requirements

Ready-mixed concrete materials shall comply with all appropriate requirements of **Section 910** of these specifications.

943 Mixing And Delivery

Truck mixers shall be operated within the limits of their normal rated capacity and speed of rotation for mixing as designated by the manufacturer's of the equipment which in turn shall comply with the standards specified in ASTM C 94.

Truck agitators shall be operated within the limits of the normal rated capacity and speed of rotation for agitating (except that the max. speed of rotation for agitating shall be less than the minimum mixing speed) as designated by the manufacturer of the equipment which in turn shall comply with the standards specified in ASTM C94.

When a stationary central construction mixer is used for the complete mixing of the concrete, the mixing time shall not be less than 50 seconds. Mixing time shall be measured from the time all cement and aggregate are in the drum. The batch shall be so charged into the mixer that some water will enter in advance of cement and aggregate, and all water shall be in the drum by the end of the first one-fourth of the specified mixing time.

When a truck mixer is used for complete mixing, each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at mixing speed. All rotation after mixing of 250 revolutions, shall be at agitating speed. All materials, including mixing water, shall be in the mixer drum before the mixing time is started.

Unless the mixing unit is equipped with accurate and dependable device indicating and controlling the number of revolutions at mixing speed, the mixing shall be done at the job site or at the proportioning plant with the mixing unit operated at agitating speed while traveling from the plant to the job site.

When a truck mixer or truck agitator is used in transporting concrete that has been completely mixed in a stationary central construction mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as the agitating speed.

When an operating truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the work site and discharged completely within one hour after the addition of the cement to the aggregates and water. Each batch of concrete delivered at the job site shall be accompanied by a time slip issued at the batching plant, bearing the time charging of the mixer drum with cement and aggregates.

In hot weather, or under conditions contributing to quick stiffening of the concrete, or when the temperatures of the concrete is 30°C or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed thirty minutes except when a retarder is used, in which case it shall be one hour.

When a truck mixer is used for the complete mixing of the concrete, the mixing operation shall begin within 30 minutes after the cement has been added to the aggregate. The concrete when discharged shall be of the consistency and workability required for the job. The rate of discharge of the plastic concrete from the mixer drum shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

Central-mixed concrete which is designed for the purpose may be transported in suitable non-agitation equipment upon the approval of the Engineer.

When non-agitating equipment is used for transportation of concrete, the bodies of the equipment shall be smooth and water-tight with metal containers equipped with gates that will permit control of the discharge of the concrete. When required by the Engineer, approved covers shall be provided for protection against the weather.

The concrete shall be delivered to the work site in a thoroughly mixed and uniform mass and discharged with a satisfactory degree of uniformity. Slump tests of representative samples taken during the discharge shall not differ by more than the tolerances specified in the specifications. Discharge shall be completed within 30 minutes after introduction of the mixing water to the cement and aggregates.

Concrete delivered in outdoor temperatures lower than 5°C, or if the temperature is expected to drop below 5°C during the curing period, shall arrive at the work having a temperature of not less than 10°C nor greater than 32°C.

In supplying ready-mixed concrete, the plant shall have sufficient batching and transporting capacity to ensure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall provide for the proper handling, placing, and finishing of

the concrete. If the rate of delivery does not provide a continuous concrete operation, the Engineer may suspend all or parts of further concrete work until such time as the Contractor provides sufficient additional delivery equipment which, in the opinion of the Engineer, will provide for a continuous concrete operation.

944 Inspection And Testing

Adequate facilities shall be provided for the Engineer to inspect ingredients and processes used in the manufacture and delivery of the concrete. The Contractor shall afford the Engineer without charge, all facilities necessary to secure samples and conduct tests to determine whether the concrete is being furnished in accordance with the specifications.

Sampling and testing of concrete shall be in accordance with the requirements of Section 905.

950 PRECAST CONCRETE

951 General

951.1 Scope

This work shall consist of precast reinforced concrete intended to be used for the construction of drain covers, kerbs and concrete blocks for bridge works in accordance with the project specifications and in reasonably close conformity with the lines, sizes, shapes, and typical sections shown on the drawings or established by the Engineer.

This section is primarily a manufacturing specification. The fabricator shall be responsible for all labor, material, and services as required to manufacture the units specified herein. The fabricator shall have a minimum of 5 years successful experience in the fabrication of precast concrete units similar to the units required for this project. The fabricator must have sufficient production capacity to produce, transport, and deliver required units without causing delay in the work. The fabricator must adhere to procedures outlined in PCI MNL- 117 and the PCI Design Manual (2nd Edition) that are applicable to the manufacturing of Precast Concrete pieces of the project.

The successful performance of precast concrete products depends upon controlled manufacture in a central plant and careful field construction work.

The Contractor shall unload, store, protect, and install as covered by this Specification and shall provide and install all anchors and accessories for same. The Contractor shall have sufficient experience in the erection of precast concrete units similar to those units required for this project.

951.2 Applicable Codes

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

- a. ACI 318, "Building Code Requirements for Reinforced Concrete".
 - b. Concrete Reinforcing Steel Institute, "Manual of Standard Practice."
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- c. Prestressed Concrete Institute MNL 117 "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
- d. Prestressed Concrete Institute's "Architectural Precast Concrete Design Manual, 2nd Edition".
- e. American Welding Society, "Structural Welding Code, Reinforcing Code."
- f. ASTM standards as stated herein.

Copies of the above codes shall be made available to the Engineer on site.

951.3 Submissions

Submit the following in accordance with the requirements stipulated in **Section 28** of these specifications.

➤ Product data

1. Mix designs.
 2. Laboratory test reports less than 6 months old from previous projects using the same mix design as submitted above showing compressive strengths meeting the requirements of these specifications. Test reports must include the name of the professional test lab that performed the tests.
 3. Fabricator information as a qualified manufacturer.
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➤ **Shop Drawings**

All shop drawings shall be prepared by a professional showing complete information for fabrication and installation of precast concrete units such as unit dimensions and crosssections; fabrication tolerances; location, size, and type of reinforcement, including special reinforcement; and lifting devices necessary for handling and erection.

In addition, the shop drawings shall indicate the following:

1. Layout, dimensions, and identification of each precast unit corresponding to sequence and procedure of installation.
2. Welded connections by AWS standard symbols. Detail inserts, connections, and joints, including accessories and construction at openings in precast units.
3. Caulked joints, including expansion joints ("soft" type) and grouted joints ("rigid" type).
4. Location and details of anchorage devices to be embedded in other construction.
5. The specified protective finishes for metal items including connectors.

Design modifications may be made only as necessary to meet field conditions and to ensure proper fitting of the work and only as approved by the Engineer. The general design concept shown is to be maintained without increasing or decreasing sizes of members or altering profiles and alignment shown.

The fabricator shall submit the shop drawings to the General Contractor. The General Contractor shall verify all dimensions and coordinate the drawings with field conditions and other trades. The General Contractor shall submit the shop drawings to the Engineer for approval. The fabricator shall not start production until the shop drawings are approved by the Engineer and General Contractor in writing.

➤ **Samples**

Minimum size 6" x 6" x 2" to illustrate the quality, color, and specified surface finish texture.

➤ **Color**

Fabricator must develop a custom colored mix to match a colored sample provided by the Engineer. The color sample to match would either be an earth tone color shade (such as: Indiana limestone color, off-white, buff, brown, brick orange, brick red, light gray, dark gray, dull yellow) or pure white. Painted, stained, or coated precast is not acceptable. Unless otherwise noted, all the precast units on the project will be the same color and of the same mix design.

➤ **Texture**

Texture of the concrete units shall be smooth, dense, fine-grained texture achieved by acid

etching or lightly sandblasting to thoroughly remove all surface cement paste.

Submit samples or catalogue cuts of cast-in gaskets, anchors, and other attachments and accessories as requested by Engineer.

952 Delivery, Storage, and Handling

Delivery of precast concrete units to project site shall be in such quantities and at such times as to ensure continuity of installation.

Storage of the units on site in such a way as to prevent cracking, distortion, warping, staining, or other physical damage and so that fabrication markings are visible.

Lifting of units shall only be made at the designated lifting or supporting points as shown on final fabrication shop drawings.

952.1 *Handling*

Handling devices shall be provided for the purpose of handling and installing the precast sections. Handling devices shall not be visible in the completed works.

953 Construction Materials

Except as otherwise specified in this section, concrete materials and concrete construction shall conform to the requirements in this Series.

Reinforcing steel shall conform to the requirements of Series 800 of the Project Specifications.

➤ **Portland Cement**

Cement shall adhere to ASTM C 150, Type I or Type III with the colour to be white. Gray cement or a blend of white and gray cement may be used as long as the proper colour mix is achieved as determined by the Engineer. Use only one brand, type, and source of supply for each type of cement throughout the entire project.

➤ **Coarse Aggregate**

Color to be white. Darker aggregates may be used as long as the proper color mix is achieved as determined by the Engineer. Coarse aggregates shall adhere to ASTM C 33 and shall be hard, durable, selected, and graded; free of material that causes staining or reacting with cement

➤ **Fine Aggregate**

Color to be white. Darker aggregates may be used as long as the proper color mix is achieved as determined by the Engineer. Fine aggregates shall adhere to ASTM C 33 and shall be hard, durable, selected, and graded; free of material that causes staining or reacting with cement.

➤ **Pigments**

All pigments shall adhere to ASTM C 979 and shall be inorganic, non fading, resistant to lime and other alkalis. Pigments shall not exceed 10% of the cement weight.

➤ **Water**

Water shall conform to the requirements of **Section 913** of the Project Specifications.

➤ **Air-Entraining Admixture**

Air entraining admixtures shall adhere to ASTM C 260.

➤ **Water-Reducing, Retarding, or Accelerating Admixtures**

All water reducing, retarding or accelerating admixtures as selected by the fabricator shall adhere to ASTM C 494 and containing not more than 0.1 percent chloride ions.

954 Construction Requirements

954.1 *Mixing of Concrete*

The aggregates, cement, and water shall be proportioned and mixed in a batch mixer to produce a homogeneous concrete meeting the strength requirements as specified in **Section 921**. In no case, however, shall the proportion of Portland cement be less than 330 kg/m^3 of concrete.

954.2 *Proportioning and Design of Mixes*

1. Prepare design mix for the type of concrete required. Unless otherwise noted, all the precast units on the project will be the same color and of the same mix design.
 2. Design mixes may be prepared by independent testing facility or by qualified precast manufacturing plant personnel, at precast fabricator's option.
 3. Proportion mixes by either laboratory trial batch or field experience methods, using materials
-

to be employed on the project for each type of concrete required, shall comply with ACI 318.

954.3 Mix Properties

Standard-weight concrete shall consist of specified Portland cement, aggregates, pigments, admixtures, and water to produce the following:

1. Compressive Strength of 6000 psi minimum at 28 days as derived from tests performed by a professional testing laboratory using 6" x 12" cylinders per ASTM C39-86;
2. Total Air Content of not less than 4% nor more than 7%.
3. Water Absorption not to exceed 5% by weight when tested per ASTM C 642 by a professional testing laboratory.
4. Color as selected by Engineer per the approved precast concrete sample.

Adjustment to Concrete Mixes may be requested when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by Engineer before using in the work.

Air-entraining admixture is to be used in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion or provide increased workability for low-slump concrete may be used subject to Engineer's acceptance. The admixtures shall be used in the amounts recommended by the admixture manufacturer for climatic conditions prevailing at the time of casting. Quantities of admixtures shall be adjusted with the approval of the Engineer as or when required to maintain quality control.

954.4 Forms

The forms used shall conform to the requirements of **Series 700** of the Project Specifications

954.5 Curing

The precast sections shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strength in 28 days or less. Any one of the following methods of curing or combinations thereof may be used:

➤ Steam Curing

The precast sections may be cured by low pressure, steam-curing system that will maintain a moist atmosphere.

➤ **Water Curing**

The precast sections may be water- cured by any method that will keep the sections moist.

➤ **Membrane Curing**

A sealing membrane conforming to the requirements of AASHTO M 148 may be applied and shall be left intact until the required concrete compressive strength is attained. The concrete temperature at the time of application shall be within 6 • C of the atmospheric temperature. All surfaces shall be kept moist prior to the application of the compounds and shall be damp when the compound is applied.

955 Reinforcing Steel

The reinforcing steel shall conform to the requirements of **Series 800** of the Project Specifications.

In addition, all precast concrete units shall be reinforced with new billet steel reinforcing bars, as necessary for safe handling, setting and structural stress, and the size of the reinforcing shall be specified with a minimum area of steel equal to one quarter of one percent of the cross section area. If the surfaces are to be exposed to the weather, the reinforcement shall be galvanized or epoxy coated when covered with less than 2 inches of material for bars larger than 5/8 inch and 1-1/2 inches for bars 5/8 inch or smaller. The material covering in all cases shall be at least twice the diameter of the bars. Very small non-structural pieces, such as 8" x 8" X 4" quoins, may be made without reinforcing if approved by the Engineer.

Provision for reinforcement supports including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing should be made. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class I) or stainless steel protected (CRSI, Class 2).

The maximum variation in the position of the reinforcement shall be + /- 10mm from the position shown on the Drawings. I n no case, however, shall the cover over the reinforcement be less than 16mm.

The areas of steel reinforcement shall be not less than the design steel areas as shown on the Drawings or as designated by the Engineer.

956 Fabrication

- Fabricate precast concrete units in accordance to the manufacturing and testing procedures, quality control recommendations, and dimensional tolerances as described herein, unless otherwise indicated.
 - Dimensional Tolerances of Finished Units
-

1. Overall height and width measured at face adjacent to mold at time of casting shall be $\pm 1/8$ inch.
2. Angular deviation of plane of side mold shall be $1/32$ inch per 3 inches depth or $1/16$ inch total, whichever is greater.
3. Out of square (difference in length of two diagonal measurements) shall be $1/8$ inch per 6 feet or $1/4$ inch total, whichever is greater.
4. Thickness shall be within $-1/8$ inch and $+1/4$ inch.
5. Tolerances of other dimensions not otherwise indicated shall be the numerically greater between $\pm 1/16$ inch per 10 feet, or $\pm 1/8$ inch.
6. Other tolerances shall be in accordance to PCI MNL-117.

- Position Tolerances

For cast-in items measured from datum line locations as shown on reviewed shop drawings:

1. Anchors and inserts shall be within $3/8$ inch of centerline location shown on shop drawings.
2. Blockouts and reinforcements shall be within $1/4$ inch of position shown on shop drawings, where such positions have structural implications or affect concrete cover. Otherwise the blockouts and reinforcements shall be within plus or minus % inch.

Fabricate units straight, smooth, and true to size and shape, with exposed edges and corners formed or stoned to a minimum radius unless otherwise indicated. Precast trim units that are cracked, broken, spalled, stained, or exceeding the specified manufacturing tolerances will not be acceptable.

- Testing

All test specimens are to be prepared by an ACI certified Grade 1 Field Testing Technician. All tests shall be conducted by a certified testing laboratory with testing paid for by the Fabricator. Results to be kept on file for at least two years and submitted upon Engineer's request. No testing is required on projects where the total volume of concrete is under 25 CF.

A one set of 6" x 12" cylinder tests shall be conducted for every 500 cubic feet of concrete placed. At least one set of cylinder tests must be conducted for projects that require more than 25 cubic feet of concrete but less than 500 cubic feet.

One absorption test shall be made for every 500 cubic feet of concrete placed. At least one absorption test must be made for projects that require more than 25 cubic feet of concrete but less than 500 cubic feet.

- Curing

Cure units in a warm, moist, totally enclosed curing room for a minimum of 20 hours. Cast-In Items

The Fabricator to provide reglets, slots, holes, inserts, and other accessories in units to receive dowels, reglets, waterstops, flashings, anchors and other similar work as indicated.

- Anchorages

Steel Plates shall be of structural quality, hot-rolled carbon steel in compliance to ASTM A 283, Grade C.

Steel Shapes shall adhere to ASTM A 36.

Stainless Steel Shapes shall adhere to AISI Type 302/304.

Anchor Bolts shall adhere to ASTM A 307, low-carbon steel bolts, regular hexagon nuts and carbon steel washers.

Electrodes for Welding shall comply to AWS Code.

The finish of Steel Units exposed to weather shall be hot-dip galvanized after fabrication in accordance to ASTM A 153. Units not exposed to weather shall be painted with one coat of rust-inhibitive primer; threaded inserts cast into precast units, hot-dip galvanized, electrogalvanized, or cadmium plated.

The installation Contractor is to provide loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other miscellaneous loose steel shapes not provided by other trades, necessary for securing precast units to supporting and/or adjacent members.

- Surface Finish

All surface cement paste shall be removed by means of acid etching or lightly sandblasting to provide a smooth, dense, fine-grained texture with no streaks or blotches. Texture and quality of finish to be generally equal to the approved sample when viewed in direct daylight at a 10 foot distance.

- Color

The color of the units shall be generally equal to the approved sample when viewed in direct daylight at a 10 foot distance. Color variation between pieces shall be minimal.

957 Performance Requirements

Applicable standards for inspection and quality control shall be PCI MNL - 117 "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products" and PCI's "Architectural Precast Concrete Design Manual, 2nd Edition".

The Precast Concrete units shall show no obvious repairs or imperfections other than minimal color variations when viewed with the unaided eye at a 20 foot distance in good typical daylight illumination.

Any unacceptable precast units that cannot be repaired to the Engineer's satisfaction in accordance with the aforementioned criteria are deemed unacceptable and are to be replaced by the Contractor.

Precast sections shall be subject to rejection on account of failure to conform to any of the Specification requirements. Individual sections may be rejected because of any of the following:

- Fractures or cracks (except hairline cracks);
- Defects that indicate imperfect proportioning, mixing and molding;
- Honeycombed or open texture; and
- Damaged ends, where such damage would prevent making a satisfactory joint.

960 MISCELLANEOUS

961 Tolerances

The tolerances given below shall be the maximum permissible deviations from the specified dimensions, levels, alignment, positions etc., as shown on the drawings of the structures or structural elements, and supersede any other figures given before.

➤ Verticality

i) Using ordinary formwork:
1 in 400 Max 25 mm

ii) Using sliding formwork:
1 in 200 Max 50 mm

➤ **Surface regularity**

i) Using ordinary formwork3 mm

ii) Using sliding formwork6 mm

➤ **Culvert superstructure**

Position 10 mm

Alignment: Superstructure as a whole :1 minute

➤ **Dimensions**

Leading dimensions in plan+/- 25 mm

➤ **Thickness of slabs, width and depth of beams**

plus tolerance 15 mm

minus tolerance: 3% of the specified dimensions within the range 5 mm to 15 mm

➤ Surface regularity (all elements other than upper surface deck).....3 mm

Surface regularity shall be tested by straight edge.

➤ **Reinforcing steel**

Except for the requirements given hereunder, no tolerances are given for the placing and fixing of reinforcing steel.

Steel shall, however, be neatly and accurately fixed in a manner that is consistent with proper workmanship and the structural integrity of the member. Specifically the following requirements shall apply:

a. Tension steel

The actual position of tension steel shall not deviate from the true position by an amount that would reduce the effective lever arm by more than 2% of the overall depth of the member or 10 mm, whichever is the greater.

b. Concrete cover

The concrete cover on reinforcement steel shall nowhere be less than the specified cover.

c. Spacing between bars

The spacing between closely spaced parallel bars, especially in beams and columns, shall, unless otherwise detailed, not be less than maximum size of aggregate used in the concrete.

d. Bending of reinforcement

The requirements of BS 4466 regarding dimensional tolerances for the cutting and bending of steel shall apply with the provision that the other requirements stated in this section must be met even if the tolerances in BS 4466 are not exceeded.

➤ **Miscellaneous**

a. Chamfers

Fillet used for chamfers shall be made of hardwood, plastic or metal to a tolerance of 1 mm in cross sectional dimensions and the actual chamfer on the concrete shall not vary by more than 3 mm for the specified dimensions.

b. Kerbs, copings, sidewalks, parapets, etc.

The elements shall be constructed to the specified dimensions within a tolerance of +5mm on any dimension.

The alignment shall not deviate from the true alignment by more than 10 mm in any place nor shall the alignment deviate by more than 5 mm from the true alignment over any length of 5 m.

990 METHOD OF MEASUREMENT & PAYMENT

Measurement and Payment for Concrete Works shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to this section shall be made under the item heading "Concrete Works" in the Bills of Approximate Quantities.

Concrete works shall be measured by the cubic metre complete in place of the several classes of concrete involved.

Measurements shall be based on the dimensions as shown on the Drawings or as otherwise directed and authorized by the Engineer. No measurement will be made of unauthorized areas or for extra thickness.

The contract pay unit for the concrete is cubic meters which rate is in full compensation for preparation of design mixes, any necessary submissions to be made, furnishing of suitable material (i.e., water, cement, aggregates), admixtures (when required), mixing of material, transporting, forming, placement, vibrating, curing, finishing, joint fillers, sealants, water stops, testing and for all labour, equipment, tools and all other items necessary for the proper completion of the work

Bill Item Description Pay Unit

I.1	Blinding Concrete - Class 'C'	m ³
I.2	Mass Concrete - Class 'B'	m ³
I.2	Structural Concrete - Class 'A'	m ³

SERIES 1200

STRUCTURES

SERIES 1200 – STRUCTURES

1201 GENERAL

1202 Scope

The work covers the construction of bridges, box culverts with its corresponding headwalls and wing walls and foundations for power poles inclusive of structural excavation, formwork, reinforcing steel, concrete placement and backfilling with suitable fill material, all to the stipulated grades and levels as specified in the drawings.

1203 Scheduling of Structures Works

The Contractor shall schedule the construction of the road structures to complement the roadway embankment work so as to prevent any damage to already constructed road works. Should the earth work progress exceeds the progress of the drainage work to the point where the completed roadway layers may be affected by the poor water drainage, the Contractor is required to open adequate waterways through the roadway at the locations where drainage structures are to be installed. Any damage to the roadway caused by water passing through these openings shall be repaired at the Contractor's expense.

The Contractor shall so schedule the work that no excavation will be left in an exposed condition for a period greater than 30 days unless otherwise approved by the Engineer. If the Contractor fails to meet this requirement, the Engineer will order the Contractor to suspend further such excavation until the Contractor's construction progress enables him to meet the requirement.

1204 Working Drawings

Notwithstanding any contradiction with the relevant section within **Series 0** of these project specifications, the Contractor is required to submit to the approval of the Engineer the following:

- Two copies of the soil investigation report for each indicating the foundation stabilization, including the degree of instability of the existing material, necessary depth of excavation, and suitability of the proposed backfill material;
 - Four copies of the detailed shop drawings for each element in the form of dimensional plans, sections and reinforcement plans and sections; and
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➤ Reinforcement Bar Bending Schedules.

No work on any structure will be permitted to proceed prior to the full submission and approval of the above stated working drawings.

1210 STRUCTURAL EXCAVATION

1211 Description

This work shall consist of the excavation of materials required for the construction of bridges, box culverts, power pole foundations and other structures in accordance with these specifications and in reasonably close conformity with the lines, grades and typical cross sections shown on the plans or established by the Engineer. This work also covers all necessary clearing and grubbing; all necessary bailing; drainage; pumping; sheeting and the construction of cofferdams or cribs, if found necessary, and their subsequent removal; the disposal of all material obtained from such excavation if deemed unsuitable for backfill.

1212 Construction Requirements

This work shall include the removal of all materials of whatever nature encountered in the necessary excavation for the construction of the of all structures and the satisfactory spoiling of all unsuitable materials in approved disposal areas. The removal of any structures encountered shall adhere to relevant section within **Series 200** of these specifications.

The Contractor shall notify the Engineer in advance of the beginning of any excavation for structures constituting a pay item in the Bills of Approximate Quantities so that the Engineer may observe the cross-sectional elevations and measurements taken of the excavated area in view of the existing ground. All materials removed in excess of those stipulated in the method of measurement or were backfilled prior to approval by the Engineer will not be paid for.

The excavation shall be carried to the elevations shown on the working drawings approved by the Engineer. No other source other than the approved working drawings (i.e., Borings and soil tests made during design, and actual investigation of the completed foundation excavation) shall constitute the basis for construction or measurement. No subsequent works to excavation will be permitted until the Engineer or his representative has fully approved the excavation work performed.

In the event that the excavation has been done below the footing elevation approved by the Engineer and *I* or beyond the lateral limits for footings shown on the working drawings (i.e., width and length) or as directed by the Engineer, the over-width and over-depth excavation shall be backfilled with the same class of concrete designated for the footing and shall be poured monolithically with the footing at the Contractor's own expense.

When unstable material or other unsuitable material is encountered below the designated structural foundation elevation, the Contractor, at the instruction of the Engineer, shall excavate such unstable material and replace it with suitable and stable backfill material or Class "C" Concrete as shown on the plans or directed by the Engineer.

Foundation pits shall be excavated according to the outlines of the footings as shown on the drawings and shall be of sufficient size to permit the placing of the full width and lengths or the footings shown with full horizontal beds. Rounded or undercut corners and edges of footings will not be permitted.

1212.1 Reinforced Concrete Box Culvert Cast in Place

Channels shall be cut into previously constructed and compacted embankment from the top of the sub-grade at the embankment height, or twice the nominal span of the culvert whichever is less. The channel width shall be no greater than the external span of the culvert plus 300 mm on each side when the Contractor elects to use external forms, or the external span of the culvert plus 80 mm each side when he elects not to use external forms.

If the Contractor elects to use forms and the channel is excavated wider than specified, the entire backfill of the channel to the top of the culvert shall consist of bedding concrete pursuant to the relevant section in Series 300. The concrete backfill shall be at the Contractor's own expense.

If the Contractor has elected not to use forms and the channel is excavated wider than specified, he shall either use forms or increase the thickness of the side walls of the culvert to fill the channel width. Over depth excavation of the channel shall be compensated for by increasing the thickness of the concrete base of the culvert or as otherwise directed by the Engineer. The additional concrete required shall be at the Contractor's expense.

1220 FORMWORK, REINFORCEMENT AND CONCRETE

Formwork, reinforcement and concrete works shall conform to the requirements of **Series 700, 800 and 900** of these specifications respectively.

1230 JOINTS

1231 General

Expansion joints and contraction joints shall be of the material and form as shown on the drawings. This section covers the supply and installation of all permanent joints that permit relative movement between contiguous structural members.

The use of any type of expansion joint shall be subject to the approval of the Engineer. The Contractor is advised to obtain approval from the Engineer on the type of expansion joints prior to its use on the Works.

1232 Materials

1232.1 Joint sealing compound

Poured joint sealing compound shall consist of hot or cold poured material as recommended by the manufacturer.

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

➤ AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2628	(1981) Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
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ASTM D 2835	(1989) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements.
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➤ FEDERAL SPECIFICATIONS (FS)

FS SS-S-140 1	(Rev C; Notice 1) Sealant, Joint, Non-Jet-Fuel-Resistant, HotApplied, for Portland Cement and Asphalt Concrete Pavements
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Copies of the applicable codes shall be made available on site for the use of the Engineer.

Joint sealant material shall conform to the following material and respective applicable codes:

- a. Preformed Polychloroprene Elastomeric Joint Seals adhering to ASTM 0 2628.
 1. Thermoplastic hot-poured sealants shall comply with the requirements of U.S. Federal specifications SS-S-1401B, BS 2499 or AASHTO M 173.
The sealants shall be of the rubberized bituminous type containing a minimum of 20% natural or synthetic rubber.
-

2. Thermoplastic cold-applied sealants shall comply with the requirements of U.S. Federal specification SS-S-156.

The sealants shall be of the rubberized bituminous type containing a minimum of 20% natural or synthetic rubber.

3. Thermosetting chemically curing sealants shall comply with the requirements of U.S. Federal Specifications SS-S195B, American National Standards Institute Specification ANSI A 116.1 (formerly ASA A 116.1 and USA SI A 116.19) or BS 4254.

The final IR H D (international rubber hardness degree) of the sealant shall be 20+/- 5.

Other sealants may be used if approved by the Engineer after submission of full specifications and information by the Contractor."

- b. Preformed elastomeric compression seals shall comply with the requirements of AASHTO M220

- c. Accessories

1. Lubricant for installation of Preformed Compression Seals shall conform to ASTM 02835.
2. Primer

When a primer is to be used in conjunction with the sealant it shall be of the prescribed proprietary material.

3. Adhesives

Adhesives used in conjunction with preformed seals shall be of an approved type compatible with the material seal.

4. Bond Breakers

Polyethylene tape, coated papers, metal foils on similar material may be used where bond breakers are required.

5. Back-up material

Back-up material shall consist of a compressible material of correct width and shape in order to ensure that after installation it is approximately 50% compression and the sealant can be formed to the specified depth.

Back-up materials shall be compatible with the sealant used. Material containing bitumen or volatile shall not be used with thermosetting chemically curing sealants.

The material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

1232.2 *Preformed joint filler*

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTMD 1752 (1984) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

Copies of the applicable codes shall be made available on site for the use of the Engineer.

Preformed joint filler shall be of the thickness described in the Contract within a tolerance of ± 1.5 mm. It shall be 25 mm less in depth than the thickness of the slab, within a tolerance of ± 3 mm and in suitable lengths each not less than 1.2 m. Holes to accommodate dowel bars shall be accurately bored or punched out to be a sliding fit on the dowel bars.

The material comprising joint filler shall be of approved quality such that it can be satisfactorily installed in position at the joint.

Expansion-joint filler shall be pre-molded material conforming to -ASTM O 1752. Unless otherwise indicated, filler material shall be 10 mm (3/8-inch) thick and of a width applicable for the joint formed. Joint filler shall consist of sheets or strips of the following materials

complying with the requirements of the relevant specifications listed:

- a. Bitumen-Impregnated fibre board and bitumen-impregnated cork board in accordance to U.S. Federal Specifications HH-F-341F or AASHTO M213.
- b. Resin-impregnated cork board complying with U.S. Federal Specifications HH-F-341
- c. Flexible foams of expanded polyethylene or polyurethane, PVC or polypropylene adhering to AASHTO M 153.
- d. Rigid foams of expanded polyethylene, polyurethane or polystyrene adhering to BS 4840 or BS 3837.
- e. Custom built Expansion Joints

With respect to dimensions, attention is drawn to the overall dimensions of the expansion joints and to limiting concrete dimensions of that portion of the structure that is to accommodate the joints. No alteration to the concrete that will be visible in the final structure and no major re-arrangement of the pre-stressing anchorages shall be permitted in order to accommodate joints of excessive size. All joints to be installed along a skew shall be accurately dimensioned to ensure compliance with the design and manufacture below. Unless otherwise specified, proprietary expansion joints shall include the complete expansion joint assembly traversing the roadway, curbs, footpaths and median and shall include the coping and parapet cover plates as well as the drainage system to drain the expansion joint.

With respect to the design and manufacture of preformed joint fillers, the expansion joint shall be designed to withstand the movements, displacement and rotations specified on the drawings in conjunction with the loads prescribed in the code of practice adopted for the design of the structure without over stressing any part in terms of "working load" requirements or exceeding the requirements for serviceability limit state. Any strengthening of the supporting member required to resist forces imparted by the structure shall be for the Contractor's account. The specified movements, displacements and rotations shall be accepted without impairment of the efficacy or riding quality of the joint. The joint shall be vibration free, resistant to mechanical wear and other forms of abrasion and shall resist corrosion. It shall have good riding characteristics, be skid resistant and silent, be of watertight construction or have provision for the disposal of water, debris or grit collecting in the joint, and be of such construction so as to facilitate easy inspection, maintenance and repair. Prior to the manufacture of the joints, the Contractor shall submit to the Engineer for his acceptance detailed drawings of each expansion joint.

The expansion joints delivered to the site shall be suitably marked to clearly show the sequence and position of installation.

Other joint-filler materials may be used upon the approval of the Engineer of the information submitted by the Contractor."

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened

containers. Sealants whose shelf life has expired shall be removed from the site.

1233 Construction Requirements

1233.1 Preparation of joints

Joints shall be installed at locations indicated and as authorized. Filled joints shall be accurately formed to the dimensions shown and with the filler material specified on the drawings.

No expansion joint or part thereof shall be installed prior to the establishment of final surfacing level based on a complete level survey of bridge deck(s). The survey shall be carried out before the construction of kerbs, channels or bituminous surfacing.

Sawing of joints shall be undertaken at such time so as to avoid edge spalling or ravelling. After removal of the temporary filler material or breaking out the excess concrete, the inside faces of the joint shall be wire-brushed or grit- blasted to remove all laitance and contaminants. Thereafter the joint shall be cleaned out and blown out with compressed air to remove all traces of dust. Solvents shall not be used to remove contaminants from concrete and porous surfaces. Care shall be exercised to ensure the primers of adhesives are applied only to surfaces that are absolutely dry.

1233.2 Expansion Joints

Pre-molded expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend to the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 3 mm (1/8-inch) radius, except where a resilient floor surface will be applied.

The filler shall be secured in position so that it is not displaced during concreting or thereafter if the filler is to remain permanently in the joint.

\$Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a recess 20 mm (3/4-inch) deep to be filled with sealant. The wood strip shall be removed after the concrete has set. In lieu of the wood strip, a removable expansion filler cap designed and fabricated for this purpose may be used. Wherever polystyrene or similar material susceptible to damage is used to form joints, it shall be lined with a hard surface on the side to be concreted. The hard surface shall be sufficiently resilient to ensure that the joint and surfaces can be formed free from defects.

The expansion joint shall form an even surface with the road surface on either side and the deviation across and shall comply with the requirements for surface regularity measured by ordinary straight-

edge.

On completion of the installation of specialist expansion joints), the Contractor shall submit to the Engineer a certificate from the manufacturer or supplier of the joint(s), certifying acceptance of the installation. Notwithstanding the issuing of such a certificate, the manufacturer or supplier shall not accept any responsibility for the installation of joint(s) and shall not relieve the Contractor of his responsibilities under the Contract.

1233.3 Concrete nosings

Concrete nosings forming the edge of expansion joints shall be constructed as follows:

After the concrete in the structural member has hardened sufficiently, the protruding ends of the reinforcing steel shall be bent onto the concrete surface of the formed recess.

Before the asphalt surfacing is laid, the recess shall be filled with well-compacted crusher run sand or weak mortar. The Contractor shall ensure that the concrete surfaces and reinforcing steel are not contaminated with bituminous agents. Thereafter the asphalt surfacing shall be laid continuously over the joint.

The asphalt surfacing corresponding to the width of the nosing shall be cut with a diamond saw blade and all material shall be removed from the nosing recess. The concrete surfaces of the recess shall then be roughened to expose the aggregate and to leave a sound irregular surface. The reinforcing steel shall thereafter be bent, fixed and placed as detailed on the drawings.

Immediately before the concrete nosings are cast, the prepared concrete surfaces shall be treated with an approved epoxy resin adhesive. Opposite concrete nosings, separated by a 10 mm thick joint filler strip, shall be cast simultaneously and the curing period shall be 10 days.

After the concrete in the nosing has cured for at least 3 days, the gap between the nosing shall be enlarged to the required dimensions by cutting both sides with parallel diamond saw blades. The depth of the saw cut shall be such that a ledge is formed along the lower edge of the cut on which the sealer unit can be supported. The exposed corners of the nosings shall be ground to have a 10 mm chamfer.

After the joint has been sealed, wearing surface of the nosing shall be treated with a bituminous primer to the satisfaction of the Engineer.

Traffic shall not be permitted to pass over the joint before the concrete in the nosing has aged at least 10 days.

The concrete used in the construction of the nosings shall be Class 40/14 and shall have a slump of not less than 50 mm and not exceeding 75 mm.

1233.4 Epoxy mortar nosings

Epoxy mortar nosings shall not be used unless detailed on the drawings. Where epoxy mortar nosings are permitted, a special specification will be provided by the Engineer for its construction.

1233.5 Sealing of joints

Sealed joints shall be made watertight over full length of the joints, unless otherwise permitted by the Engineer.

The primer or adhesive shall be applied strictly in accordance with the manufacturer's instructions. Unless otherwise specified the primer shall be applied within the temperature range of 10°C to 40°C and the sealant shall be applied after the curing period of the primer and within the period that the primer remains active.

Sealants shall be applied strictly in accordance with the manufacturer's instructions by a person skilled in the use of the particular type of sealant. Trapping of air and formation of voids in the sealant shall be avoided. The sealant shall be finished to a neat appearance flush within edges of the concrete or to the specified depth.

Thermoplastic hot-poured sealant shall not be poured into the joints when the temperature of the joint is below 10°C. The safe heating temperature shall not exceed the specified pouring temperature by more than 10°C.

Two-part thermosetting chemically curing sealant shall not be applied after expiry of the specified pot-life period, which commences once the base and activator of the sealant have been combined.

In case of Preformed compression seals, the seals shall be inserted and secured with a lubricant adhesive covering both sides of the seal over the full area in contact with the inside faces of the joint. The lubricant adhesive shall be applied immediately ahead of inserting seal.

The seal shall be installed in a compressed state with the appropriate equipment so that under the most adverse conditions the seal will remain compression. The seal shall at all times be between 5 mm and 1 D mm below the level of the pavement.

Joints in seals shall be bonded or fused and shall be only at positions agreed to by the Engineer.

Restrictions on joint width and temperature at the time of installation of the sealant or seal will be shown on the drawings. In the absence of these and unless otherwise specified, installation shall be carried out only within the temperature range of 5°C to 30°C.

1240 WATER STOPS

1241 Materials

Water stops shall be made of material which is resistant to chlorides, sulphate, or other deleterious substances which may be present in the environment of the works. No water stop material shall be brought on to site or used on the Works until the Contractor has made a full submission of the details of the materials he proposes to use including samples for the Engineer's approval. All samples shall be adequate length for testing.

Water stops shall be of natural rubber, or flexible PVC and of the type specified or shown on the drawings.

- a. Natural rubber water stops shall comply with the requirements of AASHTO M 198 Type A.
- b. Flexible PVC rubber water stops shall comply with the requirements of AASHTO M198 Type B.

Rubber water stops may be of synthetic rubber and shall have an elongation at breaking stress of at least 500 percent at 25°C and shall allow joint movement of at least 50 mm. Polyvinyl-chloride (PVC) water stops shall be extruded from an unfilled plasticised PVC polymer or copolymer which does not contain any reclaimed or scrap PVC. PVC water stops shall have an elongation at breaking stress of at least 225 percent at 25°C and shall allow joint movement of at least 10 mm.

Low modules water stops shall be of rubber PVC as described above but shall have an elongation of at least 200 percent at 25°C under a tensile stress of 6 MPa and shall allow joint movement of at least 50 mm.

Water stops shall be supplied in lengths as long as possible considered with ease of handling and construction requirements.

Rubber or plastic materials joints other than joints shall be supplied ready made by the manufacturer. Butt joints shall be made on site in accordance with the manufacturer's instructions and with equipment supplied for purpose by the manufacturer.

Water stop material delivered and placed in storage shall be stored carefully off the ground to avoid damage and contamination with oil, grease, or other pollutants. Rubber and plastic water stops shall be stored in cool well ventilated places away from direct sunlight.

1242 Construction Requirements

Rubber and plastic water stops which are embedded in one side of a joint more than one month before the scheduled date of placing concrete, shall be protected from the sun on the other side.

Water stops shall be firmly fixed in the form work so that they cannot be displaced during placing of concrete and shall be completely free of all dirt, grease, oil, etc, before placing concrete. Where eyelets are provided these shall be fully wired to the reinforcement and be

the only means whereby the water stop is fixed. In no circumstances shall a water stop be punctured with nails etc. as a means of fixing.

Unless a waterstop is equipped with an effective watertight interlocking system for the joining of sections, all joints in waterstops shall be bonded or fused to have a tensile strength of at least 50% of that of the unjointed material. At intersections and abrupt changes of direction, waterstops shall be joined with prefabricated junction pieces.

Concrete shall be placed carefully around water stops so as to avoid distortion or displacement and shall be fully compacted. Where water stops lie in a horizontal or nearly horizontal plane the Contractor shall ensure that no voids are left on the underside of the water stop.

Form work around water stops shall be carefully removed to avoid damage. if water stops suffer any damage which cannot be properly repaired in situ the Engineer may require a section of concrete to be removed and the water stop to be replaced.

1250 WATERPROOFING AND DAMPPROOFING

1251 Scope

This work shall consist of providing dampproofing and waterproofing systems on concrete surfaces at the locations indicated on the Plans or as directed by the Engineer, all in accordance with these Specifications.

All backfilled concrete surfaces shall be damp proofed through the application of approved bituminous materials.

1252 Material Components

Waterproofing shall consist of the application of a preformed membrane; a rubberized liquid asphalt membrane, or a cold applied liquid membrane, all as set forth below.

1252.1 Dampproofing

This type of dampproofing consists of a prime coat and two mopped applications of an approved bituminous material.

1252.2 Preformed Waterproofing Membrane

This type of waterproofing system consists of applying a preformed bituminous membrane of approved manufacture to concrete surfaces in strict compliance with the manufacturer's recommendations.

1252.3 Rubberized Liquid Asphalt Membrane

This type of waterproofing system consists of applying a hot, liquid asphalt membrane of approved manufacture to concrete surfaces in strict compliance with the manufacturer's recommendations.

1252.4 Cold Applied Liquid Membrane

This type of waterproofing system consists of applying an acrylic resin based elastomeric membrane of approved manufacture to concrete surfaces in strict compliance with the manufacturer's recommendations.

1253 Construction Methodology

1253.1 Surface Preparation

New concrete shall have cured a minimum of 7 days in accordance with ACI-308. New or existing surfaces shall be free of oil, grease, curing compounds, algae, moss, laitance, friable matter, bituminous products and previous waterproofing membranes. If required, degreasing shall be performed with detergent washing in accordance with ASTM D4258. Concrete surfaces shall be abrasively cleaned in accordance with ASTM D4258 and all spalls repaired with concrete patch materials per the Engineer's and Manufacturer's recommendations. Voids and blowholes on vertical surfaces shall be repaired in the same manner.

Areas of minor surface deterioration or depression of 1.27 cm (0.5") and greater in depth shall be brought to grade with an approved patching mortar. Cracks and joints shall be treated in accordance with the manufacturer's recommendations as approved or directed by the Engineer.

The applicator shall be responsible for the protection of equipment and adjacent areas from over-spray or other contamination that may be caused by application of the dampproofing or waterproofing.

1253.2 Dampproofing

No dampproofing shall be applied in wet weather, nor when the temperature is below 35°F without special authorization from the Engineer. Should the surface of the concrete become temporarily damp,

it shall be covered with a 5 cm (2") layer of hot sand, which shall be allowed to remain in place long enough to produce a warm and dry condition. The sand shall be swept back, uncovering sufficient area for commencing work. The operation may be repeated as the work progresses.

Immediately after the surface is prepared and in order to insure a proper bond between the dampproofing material and the concrete, a prime coat shall be applied. The primer shall be sprayed or brushed on the surface at a rate of approximately .452 liter / m² so as to cover it completely and uniformly. The quality of the primer and the method of application shall be approved by the Engineer.

Concrete or other surfaces which are to be protected by dampproofing shall be mopped or brushed with two coats of an approved bituminous material for absorptive treatment. The bituminous material shall be heated to a temperature between 300°F and 350°F. The material will be stirred frequently to avoid localized overheating. The heating kettle shall be equipped with thermometers. The bituminous material shall be applied with suitable mops or brushes. Each coat shall be mopped over the surface, completely covering same with a continuous heavy film. When any breaks or thin spots show in the dampproofed surface after drying, they shall be retouched to secure an even impervious coating.

The interval between successive applications shall not be less than 18 hours.

The completed dampproofing shall be protected by the Contractor from damage by subsequent construction operations.

1253.3 Preformed Waterproofing Membrane

Concrete surfaces that are to receive this type of waterproofing shall have a wood float or trowelled finish.

The Contractor shall furnish the services of a competent field representative of the approved manufacturer to be present at the work site prior to any use of materials. The representative shall instruct the Contractor and the Engineer on installation and inspection procedures and to inspect the condition of the prepared surfaces. The representative will remain on the job site until the completion of the work.

A prime coat is to be applied only to areas that will be covered with membrane within the following 24 hours. Any areas not covered within 24 hours must be re-primed. The primer material and rate of coverage shall meet the specifications of the manufacturer. The primer shall be allowed to dry one hour or until tack free before placing the membrane. The membrane shall not be applied at temperatures below 40°F.

All corners such as at curbs shall be double covered by using an initial strip of 30.5 cm (12") minimum

width, placed along the axis of the corner. Inside corners should be finished with a fillet, and outside corners should be rounded. Areas around drains or other protrusions should be double covered with the membrane for a minimum of 6-inches in each direction, then liberally coated with an approved mastic.

The membrane should be laid from the low point to the high point with the membrane overlapped a minimum of 10.16 cm (4"). Misaligned or inadequately lapped seams must be repaired.

The wearing surface should be placed as soon as possible after application of the membrane. A careful inspection must be made before covering the membrane, and any tears or holes must be repaired with necessary patches.

1253.4 Rubberized Liquid Asphalt Membrane

The Contractor shall furnish the services of a competent field representative of the approved manufacturer to be present at the work site prior to any use of materials. The representative shall instruct the Contractor and the Engineer on installation and inspection procedures and to inspect the condition of the prepared surfaces. The representative will remain on the job site until the completion of the work.

At the option of the Engineer, the Contractor shall apply the liquid membrane on a sample area not less than one (1) m² in size. When approved, the sample area shall serve as a standard of acceptance for all membrane work.

All mixing and application of the liquid membrane system shall be done in strict accordance with the printed instructions of the approved manufacturer and as directed by the Engineer. The Contractor shall submit to the Engineer, when requested, evidence indicating that the proposed membrane applicator subcontractor is fully qualified to perform the work, and any proposed subcontractor found not qualified shall, at the written request of the Engineer, be removed forthwith by the Contractor.

The surface conditioner shall be applied evenly, using a low pressure sprayer, to all surfaces at a rate not exceeding 0.1 Liter / m² or not less than .06 Liter / m², depending on the concrete surface. The conditioner shall be allowed to dry before application of the membrane.

Cakes of membrane shall be melted in an approved double shell melter under continuous agitation until the material can be drawn free-flowing and lump-free at a temperature not exceeding 425°F.

Membrane shall be applied evenly at the rate of one pound per square foot to provide a continuous coating not less than 1/8-inch thick and averaging 3/16-inch thick.

The areas to be waterproofed shall be inspected during application of the liquid membrane system by the Engineer to insure that the membrane thickness to the requirements. Any deficiencies shall be

repaired at the expense of the Contractor.

Immediately following application of the membrane, and before it cools and before vehicular or foot traffic is allowed on the membrane, the entire waterproofed bridge deck shall be covered with rolled asphalt sheets.

Protective sheets shall be laid parallel to the center line of the bridge roadway unless otherwise approved by the Engineer. The protective sheets should not be allowed to overlap at either the longitudinal or transverse joints. The joint should be a tight butt type. The maximum allowable space between sheets is .635 cm (1/4"). The entire application of protective sheets shall be free of wrinkles, bubbles, fishmouths or other defects.

Following placement of the protective sheet, a bead of hot membrane shall be placed along the joint where the sheet terminates at the face of the curb. The bead shall be continuous to prevent water from entering between the protective sheet and membrane.

During the waterproofing work, field samples of the membrane material may be taken for evaluation by the Engineer. Tests shall include penetration, flow, low temperature flexibility and adhesion and elasticity, all as specified herein.

1253.5 Cold Applied Liquid Membrane

The requirements for the manufacturer's representative are the same as set forth above. The Contractor shall furnish the services of a competent field representative of the approved manufacturer to be present at the work site prior to any use of materials. The representative shall instruct the Contractor and the Engineer on installation and inspection procedures and to inspect the condition of the prepared surfaces. The representative will remain on the job site until the completion of the work.

Random tests for adequate tensile bond strength shall be conducted on the substrate by the applicator on site using an Elcometer Adhesion Tester Model 106 or similar at a minimum frequency of three tests per 500 m². Smaller areas shall receive a minimum of three tests. Should the tensile bond strengths be lower than 100 psi on concrete (or failure within the concrete) or 290 psi on steel, the Engineer may request further surface preparation.

Application can proceed while air and substrate temperature are between 32°F and 104°F providing the substrate is above the dew point. Outside these temperatures the manufacturer shall be consulted. All components of the system shall be measured and mixed strictly in accordance with the manufacturer's recommendations. Mixing shall be done with either an air driven high speed paddle or an explosion proof mixer. Prior to the application of any materials, the surface must be clean and free from loose debris, moisture, oil, grease or other contaminants.

A single coat of spray, roller or brush applied primer is required for all steel and concrete surfaces. This primer shall cure tack free before application of the waterproofing membrane.

The waterproofing membrane shall be spray applied with suitable equipment, approved by the manufacturer, in two colour differentiated coats, each with a wet film thickness of 60 mils per coat providing a finished minimum thickness of 80 mils on any peak. Checks for wet film thickness shall be carried out typically every 10m². The membrane shall cure between coats and before application of the tack coat.

A tack coat, supplied by the same manufacturer, shall be applied directly to the waterproofing membrane prior to surfacing.

When necessary, repairs shall be performed as follows:

1. Patching

If an area is left untreated or the membrane becomes damaged, a patch repair shall be carried out to restore the integrity of the system. The damaged area shall be cut back to sound material and wiped with solvent (e.g., acetone) up to a width of at least 10 cm (4") on the periphery, removing tack coat and any contaminants. The substrate shall be primed, if necessary, followed by the application of membrane. A continuous layer shall be obtained over the substrate with a 10 cm (4") overlap onto the existing membrane.

2. Overlapping

Where the membrane is to be joined to existing cured material and at day joints, the new application

shall overlap the existing one by at least 10 cm (4"). No preparation shall be necessary unless the existing materials are contaminated with tack coat or dirt in which case the repair/overlap area shall first be wiped with solvent (e.g., acetone).

During all stages of application, the membrane shall be protected by the Contractor from damage by construction operations.

The Engineer and the applicator shall jointly review the deck area(s) in which the completed system has been installed, prior to surfacing. Any irregularities or other items which do not meet the requirements of the Engineer shall be addressed at this time.

1260 BACKFILLING FOR ROAD STRUCTURES

1261 Construction Requirements

All structures shall be backfilled with approved well - graded granular materials that will produce a dense and well-compacted backfill fulfilling the standard compaction tests. Materials such as sod, debris, and soil containing organic matter shall not be used. Rocks may be used in the backfill only with the express permission of the Engineer and only when voids between the rocks are filled with fines and properly compacted.

Under no circumstances shall water with high concentration of Sodium Chlorides (i.e., salt) be used.

No backfill shall be placed against any structure without permission of the Engineer. In general, no un-braced structure or cast-in-place culvert shall be subjected to the pressures of backfilling or to live loads until 3 days after the expiration of the period designated for the removal of forms. At the direction of the Engineer, this period may be extended if subnormal curing conditions exist. Backfill, placed around culverts, pipes, abutments, piers, and power pole foundations shall be deposited on both sides to approximately the same elevation at the same time. Special care shall be taken to prevent any wedging action against the structure. The slopes bounding the excavation shall be stepped when necessary, to prevent such wedge action.

Jetting of fills' or other hydraulic methods, involving or likely to involve liquid or semi-liquid pressure shall be prohibited.

The material shall be placed in layers and compacted by means of suitable equipment, or by tamping with mechanical tampers or hand tampers. Each layer shall be compacted to 95 MOD or as specified by the drawings. Each successive layer shall contain only that amount of material which will ensure proper compaction, but in no case shall any layer be greater than 150 mm (loose measurement) in

depth. The moisture content of the soil to be used for backfill shall be uniform.

Water shall be drained from the areas to be backfilled whenever practicable. In cases where, in the opinion of the Engineer, it is not practicable to drain the areas to be backfilled. The backfill material may be deposited in the water in thin layers and compaction will not be required until the backfilling has progressed to the point where all water has been absorbed by the backfill material.

In no case shall surplus material be dumped in the channel of the stream but shall be disposed of in the approach embankments or as directed.

1262 Construction Limits

The Contractor shall complete the backfill around bridge abutments and foundations, box culverts to the level of the original ground line for the full width of the excavation area. If the top of the culvert extends above the original ground line, the Contractor shall continue the compacted backfill to the top of the culvert and for a width of 3 m on each side of the culvert to the full width of the roadway embankment. If the roadway embankment is in place at the time of backfilling, the Contractor shall backfill around the culvert, as outlined above, to the top of the culvert.

1290 METHOD OF MEASUREMENT AND PAYMENT

1291 General

No separate measurement nor payment shall be made for the adherence to the contents of this section

1292 Structural Excavation

Measurement and Payment for Structural Excavation shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to Structural Excavation shall be made under the item heading "Structural Excavation" in the Bills of Approximate Quantities.

Payment of unclassified structural excavation will be limited to excavation for footings or foundations of structures (i.e., bridges, box culverts, retaining walls, power poles and as otherwise shown on the drawings or specified herein) regardless of the type of material through which the excavation is made.

Unclassified structural excavation shall be measured by the cubic meter of material removed, computed by the average end area. Measurement shall be made by the Contractor in the presence of the Engineer, in a manner approved by the Engineer.

The pay volume of structural excavation shall be that measured with a prism with limiting planes of (a) the bottom of the foundation as shown on the drawings or otherwise specified by the Engineer (b) the vertical planes shown on the drawings or otherwise specified by the Engineer and (c) the upper limits as follows:

Fill Areas

The original ground surface as recorded on approved cross sections.

Cut Areas (roadway cut-sections, channel changes, and stream channel cleanouts)

The top of cut grade such as top of fill or flow line of channel as shown in the drawings or otherwise directed by the Engineer. The volume of excavation in cut areas shall be measured and will be paid for as provided in the relevant section in **Series 200** of these specifications.

Box Culverts

Excavation for box culverts shall be that actually removed between the upper limit as described above and the bottom of the foundation except that no measurement shall be made of nor payments made for material removed outside of a volume bounded by vertical planes 300 mm outside the footings.

Excavation for toe walls shall be limited to the actual depth of the toe walls and vertical planes 300 mm outside the outer face of the toe walls and contiguous with the inner blind face of the toe wall.

Miscellaneous Structures

Excavation for retaining walls, wingwalls, power pole foundations and other miscellaneous structure, shall be measured according to the methods described for box culverts.

Special Conditions

When the Contractor encounters special or unusual conditions for which he requires special structural excavation limit, the Engineer is to be notified in due time of such event. In such cases, the Engineer may direct special structural excavation limits where-ever he deems them necessary. Only the additional excavation appropriately approved by the Engineer due to encountering such special

conditions shall be relevant for payment.

The contract pay unit for Structural Excavation is cubic meter which rate is in full compensation for all excavation, trimming, cleaning, foundation adjustment, backfilling, compaction, water and the disposal of surplus materials and the furnishing of all equipment, tools, labor, and all other items necessary for the proper completion of the work.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
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L.1	Unclassified Structural Excavation	m3
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1293 Joints and Waterstops

No separate measurement or payment shall be made for works performed under this section or any part thereof as its cost is deemed to be included as part of the concrete works within the Bills of Approximate Quantities.

1294 Waterproofing

Measurement and Payment for Waterproofing shall be as below unless specified otherwise in the **Appendix to Specifications.**

All measurement and payments related to Waterproofing shall be made under the item heading "Waterproofing" in the Bills of Approximate Quantities.

"Preformed Waterproofing Membrane," "Rubberized Liquid Asphalt Membrane," and "Cold Applied Liquid Membrane," all will be measured by the number of square meter of each system actually placed in accordance with the Plans and/or as directed by the Engineer.

No separate measurement shall be performed for "Damp proofing".

The contract pay unit for Waterproofing is square meter which rate is in full compensation for procurement of material, placement, sundry items, maintenance, labour, equipment and tools required for the completion of the works as specified.

1295 Backfilling

No part of this section shall be measured or paid separately as it is deemed to be included under the Structural Excavation pay item.

SERIES 1400 – EROSION CONTROL AND SLOPE PROTECTION

1401 GENERAL

1402 Scope of Works

The works shall consist of the furnishing of material and construction of protective covering in stone pitching, cast in situ concrete pitching or precast concrete blocks on exposed surfaces such as earth slopes, drains. The work also covers heavier protection in the form of riprap and the construction of masonry walls, all as shown on the Drawings or as ordered by the Engineer for the erosion control and slope protection of the Works.

1403 Preparation of Slopes

The surfaces upon which slope protection works are to be placed shall be excavated, shaped, trimmed and shall be thoroughly compacted to the required grades and lines.

A footing trench, were specified, shall be excavated along the toe of the slopes, all as shown on the drawings or as directed by the Engineer. All footing trenches and prepared areas shall be approved prior to placement of any protection works. Subgrade or base shall be firm or compacted as directed.

1410 RIP - RAP PROTECTION

1411 Scope

This work shall consist of furnishing and placing loose or mortared rip-rap protection at the locations shown on the Drawings, or as ordered by the Engineer, in accordance with the Specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the Drawings or established by the Engineer.

1412 Materials

Stone for rip-rap shall be hard field or quarry not susceptible to disintegration or excessive weathering on exposure to the atmosphere or water. The stones furnished shall be sound, durable, free from soft material such as sand, clay, shale or organic material and shall not contain an excessive amount of elongated stone.

Samples of the stone material proposed for use in the Works shall be submitted to the Engineer for

approval prior to its use in the Work. Each stone shall weigh between 20 and 70 kg and at least 60% shall weigh more than 45 kg. Submission of samples shall adhere to the contents of the relevant section within Series 0 of these specifications.

The minimum apparent specific gravity shall be 2.5 and the maximum absorption shall be 6% when tested in accordance with AASHTO T85-85. The stone shall have an abrasion loss not greater than 45% when tested in accordance with AASHTO T96.

The grading of rip rap stone shall be as follows. -

Rock Mass KG	Percentage Larger Than Classes				
	1/2T	1/4 T	Light	Facing	Cobble
900	0-5	-	-	-	-
450	50 -100	0-5	-	-	-
220	-	50 - 100	0-5	-	-
90	90 - 100	-	50 -100	0-5	-
34	-	90 - 100	90 - 100	50 - 100	0-5
11	-	-	-	90 -100	95 - 100
min Penetration of concrete (mm)	450	350	250	200	150

Stone for loose rip rap shall be quarried, fractured, or otherwise predominantly angular. The laterite bedrock of competent quality would be acceptable and the rock shall be cut to roughly cubic shape to above dimensions manually, mechanically or by blasting. Stone for mortared rip-rap may be rounded (boulders) or angular. The size and shape of the stones shall be such as to allow for proper placement.

Mortar for mortared stone rip-rap shall consist of 1:3 cement: sand mortar by volume. Water shall be added and the material thoroughly mixed to yield a mix of suitable consistency to ensure proper mortaring of rip-rap. Sand and cement shall conform with the relevant requirements of **Series 900** of these specifications.

1413 Construction Requirements

1413.1 Loose Riprap

Stones shall be placed so as to minimize the voids. Larger stones shall be placed in the footing trench and on the lower levels of the slope.

Packed rip-rap shall be constructed from stones individually placed to break joints and be firmly bedded on the prepared surfaces. The spaces between larger stones shall be filled with spalls and smaller stones shall be securely rammed in place. On inclined surfaces, the rock shall be laid in long horizontal lengths starting from the bottom and not in strips up the slope.

Dumped rip-rap shall be constructed by dumping the stone on the prepared surfaces, spreading it by means of bulldozers or other suitable earth moving equipment and trimming it to the required lines and levels. The material shall be placed in a manner that will prevent segregation of the small and larger stone, and the final layer shall be tight with a minimum of voids.

After completion and approval of the riprap placement, the surface voids of the riprap in the footing trench and on the lower portions of the slope shall be filled with excavated material and dressed to the satisfaction of the Engineer.

1413.2 Mortared Riprap

Stones shall be placed so as to minimize voids. Larger stones shall be placed on the lower levels of the slope.

Methods for placement of rip-rap shall be similar to those indicated in Sub-Section 1413.1.

The surfaces of the stones shall be thoroughly cleaned of all adhering dirt and clay before placing any mortar.

The spaces between the stones shall be filled with concrete mortar which shall be vibrated, spaded, and rodded into place until the voids are completely filled to a minimum depth of 500 mm from the face of the rip-rap. Excess material and spillage shall be cleaned from the front face of the riprap before hardening.

The exposed mortar shall, immediately after completion of each section of rip-rap, be cured using clear curing compound in accordance with the relevant requirements of **Series 900**. Alternatively, if approved, the mortared riprap shall be protected from the sun and kept moist for at least 4 days after completion of mortar placement.

1420 STONE PITCHING

1421 Material

Stone for pitching shall be sound, tough and durable, with no stones less than 200 mm in minimum dimension, except that smaller pieces or spalls may be used for filling spaces between the larger stones. Rocks or stones shall be of such a shape that a stable protection structure of the required thickness is formed.

Rounded boulders or cobbles are not used. However and only upon obtaining the Engineer's approval, rounded boulders or cobbles shall be used on slopes less than 2: 1. Should the need arise to use the rounded boulders or cobbles in slopes steeper than 2: 1, then only grouted stone pitching can be used.

Samples of the stones to be used on any particular pitching job shall be submitted for approval of the Engineer. The submission shall adhere to the content of the relevant section within **Series 0** of these specifications. All stones to be used on site on the pitching job shall be inspected by the Engineer or his representative prior to installation.

If the need arise for mortared stone pitching, the mortar shall adhere to the requirements as stipulated in **Section 1412**.

1422 Placement

The stone pitching shall be bedded on 100 mm laterite aggregate layer acting as filter packing.

The stones shall be laid interlocking as close as possible with the finished surface presenting an even, tight and neat appearance with no stones varying by more than 25 mm from specified surface grades or lines. The thickness of the pitching measured at right angles to the surface shall not be less than 200 mm.

The method of placement shall be as follows:

Commencing at the bottom of the trench, the stone shall be laid and firmly embedded into the slope and against adjoining stones. The stones shall not be laid with their longitudinal axes at right angles to the slope and with surfaces in contact so as to break joints. The stones shall be rammed well into the bank or surface to be protected and the spaces between the larger stones shall be filled with fragments of approved pitching stone securely rammed into place. Placing of rock by dumping shall not be allowed.

1430 GEOSYNTHETIC MATS FOR SLOPE PROTECTION

1431 Scope

The contents of this section are to be considered as guideline specifications for application of geosynthetic mats to finished slopes for protection against erosion. Detailed specifications on the material to be used and method of construction should be presented by the particular manufacturer to the approval of the Engineer.

The works shall include the supplying of special geosynthetic mats, rolling out on the profiled slope of completed embankments, pegging down, seeding and filling with friable topsoil material at locations indicated by the Engineer.

Once a layer of vegetation has formed, the geosynthetic mat provides root systems with a permanent reinforcement. The result is an integrated, effective erosion-control system.

1432 Material

1432.1 Geosynthetic material

Geosynthetic material should be designed to trap soil particles and seeds encouraging plant growth to assist in developing a strong vegetation as a permanent natural protection against erosion.

The materials should be in accordance with relevant ASTM and AASHTO Standards.

Geosynthetic material should be factory-filled with a mineral filter of stone chippings bound by bitumen. This prefabricated mineral filter should be flexible and permeable to water and roots.

The thicknesses of the mat will be 10 - 20 mm and in widths varying from 1 to 5.75m.

1432.2 Topsoil

Topsoil to be furnished by the Contractor, shall consist of loose, friable, sandy loam free of admixture of subsoil, refuse, stumps, roots, rocks, brush, weeds or other material which would be detrimental to the proper development of vegetative growth. The minimum and maximum pH value shall be 5 and 8 respectively.

Topsoil shall contain a minimum of 3 % percent and maximum of 20 percent organic matter.

Topsoil shall have a grading analysis as follows:

Sieve Designation	Percentage by weight passing square mesh sieve
2.5 cm	100
6mm	97-100
2.00mm	80-100

Topsoil shall not contain stones 5 cm and over in diameter. Prior to stripping, topsoil shall have demonstrated by the occurrence upon it of healthy crops, grass or other plant growth that it is good quality and reasonably free draining.

1432.3 Seeding

Before seeding the Contractor shall furnish written evidence to the Engineer that seed has been tested for purity and germination. Seed specified without a purity or germination requirement, at time of sowing shall be from the previous or current year's harvest and shall be labeled to include name, date (month and year) collected and the name and address of the seed supplier.

A sample of all materials is to be submitted for the approval of the Engineer and adherence to the specifications. The submission shall adhere to the content of the relevant section within Series 0 of these specifications.

1433 Construction Requirements

1433.1 Excavation

The slope will be shaped to a smooth profile, free from vegetation, roots, stones, etc., filling any voids. The slopes must be stable and properly compacted, in particular in back filled areas. Anchor trenches are to be excavated at the *toe* and shoulder of the embankment not less than 300 mm deep. If the soil is of poor quality, the surface layer should be improved by including some topsoil.

1433.2 Seeding

The area above normal water level will be seeded with 30 gr/m² of suitable seed.

1433.3 Laying

The matting will be placed in either trench, pinned at 1 meter centers and unrolled. Work will be carried out either from the shoulder down or from the toe up. No longitudinal installation will be permitted. The roll is to be kept on or near the ground during installation to avoid unintentional, total unrolling.

1433.4 Cutting to length

A spade or disc cutter will be used to cut to the lengths required. People should not work or stand at the downhill side of the roll for safety reasons.

1433.5 Back filling to trenches

The mat will be pinned at 1 meter centers into the other trench. The anchor trenches will be back filled and compacted.

Concentrations of surface water run off should be prevented from flowing over the newly laid slope either by a small bund along the shoulder or diversion through gutters or pipes laid on the slope.

1433.6 Securing of overlaps

Overlaps of 300 mm should be allowed for adjacent sections laid 'in-the-dry', 500 mm if laid 'in-the-wet'. All overlaps should be formed upstream over downstream and pinned at 1 meter centers. In areas of turbulence of high velocities, it is recommended to pin at 500 mm centers. Particular attention should be paid to pinning at water level and in the tidal zone.

1433.7 Intermediate pinning

In severe conditions the placing of intermediate pins at a rate of 1 pin/m² is recommended; under normal conditions intermediate pinning at a rate of 1 pin/3 or 4 M² is sufficient. Important: Intermediate pinning of the matting into any low spots should be carried out to ensure total contact between the geosynthetic mat and the soil below. However, it is best to back fill or reprofile all such low spots or voids.

1433.8 Securing the edges

Free edges should be adequately secured; the connection to hard revetments or structures requires special attention.

1433.9 Blinding

If laid during the summer months, the geosynthetic mat should be blinded with a thin layer of sand or friable topsoil to prevent any heat absorption from damaging the seed (not more than a few mm cover).

1434 Submissions

The Contractor must submit to the approval of the Engineer, the following documentation:

1. The manufacturers literature and recommendations for use of the particular material;
2. A list of previous projects in which the manufacturer supplied the material for; and
3. Complete inventory of physical properties, standard drawings & specifications of all elements which the Contractor proposes to use and has included in the pricing.

The submission shall adhere to the content of the relevant section within **Series 0** of these specifications.

1440 GABION PROTECTION

1441 Description

This work shall consist of the furnishing of materials and construction of gabions, in locations as indicated on the Drawings or as directed by the Engineer.

1442 Materials

Gabions shall consist of approved type galvanized steel wire mesh baskets (or other approved types such as heavy duty plastic mesh) filled with selected rock.

Galvanized steel wire mesh shall conform to ASTM A 390 Class 3, or equivalent and with the requirements shown on the Drawings. The wire mesh shall be twisted to form hexagonal openings of uniform size. The maximum nominal opening size shall be 100 mm. Mesh shall be constructed so as to resist pulling apart at any of the twists or connections forming the mesh when a single wire strand in a section is cut.

Baskets shall be furnished in one or more sizes which can be assembled to provide the minimum dimensions, stability, and structural integrity of the installation specified. Sizes of gabion baskets will normally be 2 m long 1 m wide by 0.5 m to 1 high. Non-standard sizes shall be provided to suit the particular installation, as shown on the Drawings.

Baskets shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled on Site into rectangular baskets of the specified sizes. Gabion baskets shall be of single unit construction. Long gabions assembled with diaphragms between adjacent baskets, for use as foundation mattresses, etc., may not require lids.

Base, lid, ends and sides shall be either woven into a single unit or one edge of these members connected to the section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

All perimeter edges of the mesh forming the basket shall be securely clip bound or selvedge so that the joints formed by tying the selvedges have at least the same strength as the body of the mesh.

Perimeter (edge), tie, and connection wire shall conform to ASTM A 641, Class 3, Medium Temper, and the minimum diameters shown on the Drawings.

Materials for filling the gabion baskets shall consist of rocks (rounded boulders or angular) which shall be clean, strong, durable and highly resistant to weathering, and conforming to the following requirements:

- a. Dimensions shall ranges from 200 mm to approximately 125 mm diameters.
Not more that 5% shall be smaller than 100 mm;
- b. The apparent specific gravity shall be greater than 2.30 *Ton/m3*;
- c. The maximum absorption shall be 6%;
- d. Abrasion loss not greater than 35%
- e.

Samples of the material to be used, stones, wire, etc. shall be submitted for the approval of the Engineer. The submission shall adhere to the conditions stipulated in the relevant section within **Series 0** of these specifications.

1443 Construction Requirements

Each gabion basket shall be assembled by binding together all vertical edges with wire ties on approximately 150 mm spacing or by use of a continuous piece of connecting wire stitched around the vertical edges with a coil every 100 mm.

Empty gabion units shall be installed to line and grade as shown on the Drawings. Wire ties or connecting wire shall be used to join the units together in the same manner as described for assembling. Internal tie wire shall be uniformly spaced and securely fastened in each cell of the structure. A standard fence stretcher, chain fall or iron rod may be used to stretch the wire baskets and hold alignment.

The gabion baskets shall be filled with rocks as specified, placed by hand or machine to assure alignment and avoid bulges with minimum voids. Alternate placing of rock and connection wires shall be performed until the gabion is filled. After filling, the lid shall be bent over until it meets the sides and edges, and shall be secured to the sides, ends and diaphragms with wire ties or connecting wire in the manner described for assembling.

1450 MASONRY WALLS

1451 General

Masonry walls may be plain with dry joints or be constructed with stones in cement mortar, as indicated on the Drawings, specified or ordered. The minimum mass of stone shall be 10kg. The minimum dimension of stone shall be 75 mm.

1452 Plain Masonry Walls

A foundation trench shall be excavated down to rock or to material of adequate bearing capacity, and the minimum depth shall be 300 mm below ground level. Large selected stones shall be used in the foundation layer. Flat and stratified stones shall be laid with the flat surface in the horizontal plane. Stones shall be individually placed to break joints and to provide a minimum of voids, and shall be firmly bedded against adjoining stones. The spaces between the larger stones shall be filled with spalls securely rammed into place. The larger stones shall not bear on the spalls used to fill the voids. The top ends of the wall shall be neatly finished with selected coping stones. The resulting appearance of the wall shall present an even and tight surface.

1453 Cement-mortared Masonry Walls

The walling shall be constructed as specified in **Section 1452** with the exception that the stones shall be wetted and set in a 3: 1 sand: cement mortar. Exposed stones on the wall faces shall be cleaned of mortar by washing or wire brushing. The mortar shall be flush pointed to the approval of the Engineer who may require a capping and end treatment in the same mortar.

Weep holes shall be provided as ordered and shall be cleaned of mortar and any other clogging material that may have entered during construction.

The walling shall be protected from the elements and be kept moist for a minimum period of four days after completion.

1490 METHOD OF MEASUREMENT AND PAYMENT

1491 Rip – Rap

Measurement and Payment for rip-rap works shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to this section shall be made under the item heading "Rip-Rap" in the Bills of Approximate Quantities.

Loose or mortared rip-rap protection shall be measured by the meter square of completed and accepted work. Measurements shall be based on the dimensions shown on the Drawings or as otherwise authorized by the Engineer. No measurement shall be made of unauthorized areas or for extra thickness.

The contract pay unit for Rip-Rap is square meter which rate is in full compensation for preparation of surfaces, furnishing, transporting, handling, placing the rip-rap, labour, equipment, tools, supplies, and all incidentals necessary for the completion of the works as specified.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
N.1.1	Mortared Rip-Rap Protection	m ²
N.1.2	Loose Rip-Rap Protection	m ²

1492 Stone Pitching

Measurement and Payment for stone pitching works shall be as below unless specified otherwise in the **Appendix to Specifications**.

All measurement and payments related to this section shall be made under the item heading "Stone Pitching" in the Bills of Approximate Quantities.

Stone pitching shall be measured by the meter square of completed and accepted work. Measurements shall be based on the dimensions shown on the Drawings or as otherwise authorized by the Engineer. No measurement shall be made of unauthorized areas or for extra thickness. No separate measurement shall be made for the bedding material.

The contract pay unit for Stone Pitching is square meter which rate is in full compensation for quarrying, transporting, selecting, obtaining stones from existing embankment, storing as necessary, placing, trimmings the stones and bedding on the specified material, all labour, equipment, tools and all other items necessary for the proper completion of the work.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
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N.2

Stone pitching

m²

1493 Geosynthetic Mats

Measurement and Payment for Geosynthetic mats shall be as below unless specified otherwise in the **Appendix to Specifications.**

All measurement and payments related to this section shall be made under the item heading "Geosynthetic Mats" in the Bills of Approximate Quantities.

The method of measurement of the work incorporated under this section shall be per square meter of geosynthetic mats placed and accepted by the Engineer.

The contract pay unit for Geosynthetic mats is square meter which rate is in full compensation for the supply and installation of geosynthetic mats including all necessary pegs, seeds and friable top-soil material all in accordance with specifications, drawings and instructions of the Engineer.

Bill Item

Description

Pay Unit

N.3

Geosynthetic Mats

m²

1494 Gabion Protection

Measurement and Payment for Gabion construction shall be as below unless specified otherwise in the **Appendix to Specifications.**

All measurement and payments related to this section shall be made under the item heading "Gabions" in the Bills of Approximate Quantities.

The Gabions shall be measured by the cubic metre furnished, installed, and completed in places and locations in accordance with the Drawings and as specified herein as directed by the Engineer. Excavation and surface preparation for Gabions shall not be measured separately for payment but will be considered as subsidiary work.

The contract pay unit for Gabion Construction is cubic meter which rate is in full compensation for excavation, furnishing and placing Gabion baskets, filling materials, and for all labor, equipment, forms, tools and all other inter alia necessary for the proper completion of the work.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
N.4	Gabions (sizes)	m ³

1495 Masonry Walls

Measurement and Payment for Masonry Walls shall be as below unless specified otherwise in the **Appendix to Specifications.**

All measurement and payments related to this section shall be made under the item heading "Masonry Walls" in the Bills of Approximate Quantities.

The unit of measurement for masonry walls shall be the cubic meter of actual walling constructed and accepted.

The contract pay unit for Masonry Walls is cubic meter which rate is in full compensation for excavation of foundation, furnishing all materials, trimming of areas, placing of stones, cement mortared where necessary, and for all other work necessary to complete the walls as specified.

<u>Bill Item</u>	<u>Description</u>	<u>Pay Unit</u>
N.5	Masonry Walls	m ³
