

## SECTION 21900 SERVICES TRENCHES AND CABLE CONDUIT CONCRETE BLOCKS

- 21901**  
**General**
- The Contractor shall construct cable conduit in the Project. These cable conduits shall be located as indicated on the Drawings and will accommodate water pipelines, high-voltage and low-voltage cables for crane operation and buildings, cables for yard lights and cables for reefer containers and telephone cables.
- This Chapter also covers manholes and handholes to be constructed as functions of cable conduits.
- Since the Works covered by this Chapter is closely interrelated with subsequent Works, the Contractor shall be in full consideration of subsequent Works as to the method and time of installation of works.
- For this purpose, the Contractor shall be required to submit for the approval of the Engineer a detailed execution programme of his work showing also the time schedule of subsequent Works.
- 21902**  
**Type and Material**
- The materials for service cable trenches shall be subject to the Engineer's approval.
- The cable conduit concrete shall be Grade concrete shown in Table S2 of SECTION 20600.
- The cable conduits to be buried in the concrete for low voltage cables and high-voltage cables shall be asbestos cement conduits (150/100 mm inner diameter).
- The Contractor shall submit for the approval of the Engineer the certificates of quality of these cable conduits prior to their purchase.
- The manholes of these service trenches shall be constructed with brick wall.
- 21903**  
**Excavation**
- Excavation for foundations of cable conduit and manholes covered by this Chapter shall be made to the dimensions specified in DRAWINGS.
- 21904**  
**Construction of Cable Conduit**
- The cable conduit shall be constructed to the shape and dimensions shown on the Drawings in such manner as specified by applicable SECTION 20500, 20600.
- The concrete to be used for cable conduit shall be of Class S2 as shown in Table 20600.3 of SECTION 20600.
- The cable conduit to be buried in the cable conduit concrete shall be spaced accurately and fixed firmly before casting of concrete.
- Where cable conduit concrete of different cross sections join each other, the work of transition areas shall be provided as directed by the Engineer.
- 21905**  
**Manholes and Handholes**
- Manholes and handholes covered by this Chapter shall be constructed to the shape and dimensions indicated on the Drawings.
- For matters not shown on the Drawings, the Contractor shall submit such details for the Engineer's approval.
- 21906**  
**Backfilling**
- The method of backfilling and the type of material for backfilling shall comply with

SECTION 20500.

The backfilling in association with service cable conduit shall be carefully compacted to the satisfaction of the Engineer. If any of the portion of the backfilling is not good, such defect shall be made good at the expense of the Contractor.

**21907**  
**Covers for**  
**Handholes**

Covers for handholes shall be put to the position as indicated on the Drawings, and concrete covers shall be placed as shown on the Drawings.

Covers for handhole shall be made of reinforced concrete or an equivalent to the shape, dimensions and surface marks according to the Drawings.

## SECTION 22200 MISCELLANEOUS

- 22201**  
**General**
- This Section covers construction of kerbs and lighting tower foundations and marking of pavement.
- 22202**  
**Marking of Pavement**
- The pavement shall be marked to indicate the location of each bay, the flow of traffic, sub-track zones of transfer crane, etc.
- These markings shall be clearly and neatly painted in white or other colour as approved by the Engineer. The surface to be marked out shall be clean and dry.
- 22203**  
**Fence Gates**
- Fence and gates for port shall be supplied and installed as shown on the Drawings. The works shall be conducted in accordance with applicable SECTIONS of this Technical Specification.
- 22204**  
**Cat Walks for Reffer Station**
- The cat walks shall fabricated in accordance with the Drawings or by instructed by the Engineer. The main members shall be of the gratings specified in the Clause 318. The cat walks shall be installed and fixed as shown in the Drawings by the manner approved by the Engineer.
- 22205**  
**Water Sewer System**
- The ponds for the Water Sewer System shall be constructed at the location indicated in the Drawings or instructed by the Engineer.
- The ponds shall be composed of Dewatering, Settling Unit Station, Facultative Pond and two Maturation Ponds. In the dewatering station, four sieve-containers shall be included. The material of sieve-containers shall be from galvanizing steel plate SS-400 specified in Clause 304. Galvanization shall be as specified in JIS H8641 or the equivalent standard.
- The facultative pond shall be from reinforced concrete and have piling foundation in order to resist to buoyancy. The detailed design shall be prepared by the Contractor based on the results from the additional geological investigation stipulated in the Clause -147 of Specification.
- The facultative pond and two matutation ponds shall be constructed by stiff clay as shown in the Drawings. The quality of clay shall be subject to the Engineer's Approval. The inner surface of ponds shall be finished by placing geot-fabric filter cloth or equivalent approved by the Engineer.

***Part III***  
***Specifications for Building Works***

# LA UNION PORT DEVELOPMENT PROJECT

## Bidding Documents for Package A : Civil and Building Works

### Volume III-A

<b>Specifications</b> <b>Part III: Building Works</b>
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## SECTION 30100 GENERAL REQUIREMENT

### 30101 Scope of the Works

These Specifications shall cover supply of labor, materials and equipment and the performance of all works necessary for construction of the following buildings and ancillary works for the Project in accordance with the Drawings, Specifications, and as may be further directed by the Engineer.

Building Works to be constructed are:

- a) A Port Administration Building
- b) A Container Freight Station
- c) A Maintenance and Repair Shop
- d) A Container Gate
- e) A Cargo Gate
- f) A Power Supply Station and
- g) A Landscaping Work

### 30102 General

#### 30102.1 Materials and Works

The Contractor shall supply all materials required for completion of the works in accordance with these Specifications.

If the Drawings do not contain particular materials and works which are obviously necessary for the proper completion of the works, all such materials and works shall be included in the unit price stated in the Bill of Quantities for the appropriate items of the building construction works.

Unless otherwise specified, all materials and equipment which will become a part of the permanent works shall be new and of good quality, and shall be subject to inspection, examination and/or test according to the proper industrial standards as specified.

#### 30102.2 Standards

Unless otherwise specifically provided, the quality of material, equipment and workmanship shall comply with JIS, ASTM or other equivalent international standards as specified hereinafter and as approved by the Engineer.

#### 30102.3 Working Drawings and Samples

Working drawings, shop drawings or full size drawings shall be prepared and submitted by the Contractor to the Engineer for his approval as specified herein at no extra cost. The Contractor shall also submit samples or catalogues of construction materials for approval as specified without extra cost. The Engineer shall check such samples or catalogues for the assurance of compliance with the design concept and the Specifications.

#### 30102.4 Scaffolds, Runways etc.

The Contractor shall furnish, erect and maintain during the work as required all scaffoldings, runways, guard rails, and all other temporary constructions as may be necessary for the construction of the works.

#### 30102.5 Cleaning

The Contractor from time to time shall remove all dirt and rubbish caused by the work from the construction site. At completion of the work, the Contractor shall thoroughly

clean the interior and exterior of the buildings.

## SECTION 30200 EARTHWORKS

- 30201  
General** This section covers all earthworks including excavation, filling, backfilling and soil investigation, relevant to Building Works and Utility Services.
- The Contractor is informed that the ground levels shown on the Drawings are for reference purposes only. Since the Works will be in progress in the same area and within the same period as Civil Works on a number of occasions, the Contractor shall program his Works accordingly.
- 30202  
Equipment** The Contractor shall select the most suitable equipment for excavation, filling, hauling, leveling, compaction, etc. A list of this equipment showing types, capacities, numbers, and other information shall be submitted to the Engineer for his approval.
- 30203  
Borrow Pits** The Contractor shall make his own arrangements for borrow pits, when necessary, and shall ascertain by conducting surveys and tests that adequate supplies of suitable materials can be obtained for the Works.
- The Contractor shall propose for the Engineer's approval the locations of his borrow pits.
- 30204  
Safeguarding  
Excavations** The Contractor will be held responsible for the safety of all excavations, for the prevention of injury to workmen, for damage to the adjoining works and property and for the maintenance of all slopes and excavations.
- The Contractor shall provide, fix and remove all necessary open or close timbering, strutting and shoring wherever excavations require temporary support. The Engineer may order such temporary support to be strengthened or altered if he considers it necessary in the interests of the Works as a safeguard against accidents to the workmen, but this shall not relieve the Contractor of any of his responsibilities or liabilities under the Contract.
- 30205  
Excavation** The width and length of the excavation of trenches or foundations pits shall allow enough room for work. When excavation is complete, request approval as to the character and suitability of the foundation material. The foundation shall provide a firm foundation of uniform density throughout its length and width.
- Excavated surfaces which will remain permanently exposed shall be finished off in a neat and workmanlike manner and shall be graded to provide adequate drainage. In the case of excavations in stone or rock filled area or in areas where debris from demolished buildings are found, all loose and fractured rock, stones or debris shall be removed so as to leave a sound face.
- Excavation shall be carried out at all times in a manner which will not disturb adjacent unexcavated ground.
- If the Contractor excavates more material than is called for on the Drawings or instructed by the Engineer, he shall refill the area to the correct level to the approval of the Engineer. Under and around the foundations of structures in particular, such filling material shall be well compacted.
- 30206  
Preparation of  
Ground Surface  
Prior to  
Foundation  
Works** Expected excavation profiles are as shown in the drawings or as instructed by the Engineer where there is no provision in the Drawings. The Engineer may amend the profiles as necessitated by the foundation conditions revealed as excavation proceeds or to suit the actual plant requirements.
- Where structures are to be placed on soil foundations, final trimming shall be by hand to ensure that undisturbed material is uncovered.
- Where piles are to be used, the Contractor shall excavate to the foundation elevation and drive the piles. All loose and displaced material shall be removed and the bottom of the excavation shall be reshape to the foundation elevation. The bed shall be smooth and compact to receive the footing.

When any excavated surface is ready for concrete or brickworks, the Contractor shall request the Engineer's inspection and approval, and no foundation shall be covered until this approval has been given. In the case of direct foundations the Engineer may instruct recompaction of the surface if it has become disturbed.

Once the Engineer has approved a foundation, concrete or brickworks shall immediately be placed over it.

**30207  
Filling &  
Backfilling**

**30207.1 Filling Material**

Where indicated on the Drawings, implicated by the levels of structural work or instructed by the Engineer, the Contractor shall fill or backfill and compact with suitable approved material from the excavation or borrow pits.

The Contractor shall not fill or backfill against concrete less than 7 days old or until 90 percent of the design strength is achieved.

**30207.2 Filling Material**

The material for the filling shall be free of excess moisture, roots, sod, large stones or lumps of soil, rubbish or other foreign substances and shall conform to the following:

Material passing 50-mm sieve, 100%.

Soil classification, AASHTO M145.

**30207.3 Backfill Material**

The backfill shall be free draining granular material free of excess moisture, roots, sod, or other deleterious material conforming to the following:

Maximum dimension, 75 mm.

Material passing 75- $\mu$ m sieve, ASTM C 136 and C 117, 15% max.

Liquid limit, ASTM D-4318, 30% max.

**30207.4 Compacting**

The optimum moisture content and maximum density shall be according to AASHTO T-99 method C. Adjust the moisture content of the backfill material to a moisture content suitable for compaction. The backfill shall be placed in horizontal layers that do not exceed 150 millimeters in compacted layers. The layers shall be compacted to at least 95 percent of the maximum density. The in-place determination of the density and moisture content shall be according to AASHTO T-238 and AASHTO T239 or other approved test procedures.

**30208  
Water in  
Excavations**

Unless otherwise specified in the Contract, all excavations shall be carried out at all times in the dry. The Contractor shall be responsible for all measures required for diverting or removing any water which may otherwise enter the excavation from any source whatever. If any foundations are damaged by water, the Contractor shall carry out remedial works as instructed by the Engineer.

**30209  
Disposal of  
Surplus  
Material**

Surplus excavated material, quarry overburden, rock rejected for aggregate, aggregate surplus to the requirements and the like shall not be discarded indiscriminately but shall be removed from the site. Unless otherwise authorized by the Engineer, different types of surplus excavated materials shall be deposited separately in the spoil dumps designated for the purpose outside the project site. The Contractor shall establish the dump site obtaining all necessary permits.

**30210  
Soil Tests**

The Contractor shall carry out Standard Penetration Tests for all building foundation or if required by the Engineer. The Contractor shall minimum carry out one Standard Penetration Test for each corner of every building, except for the Port Administration Building that requires an additional test in the center, and for each 50 running meters of foundation.

For buildings of less area than 50 square meters only one Standard Penetration Test shall be required.

The method of Standard Penetration Test shall be in accordance with ASTM D 1586 or other approved method or standard approved by the Engineer.

The Contractor shall provide all machinery, equipment, workers and technical staff required for the test.

The Standard Penetration Test shall be made until the bearing layer is reached, or to such level as agreed with the Engineer.

The Standard Penetration Test shall be made at every change of strata or for every 1 m of homogeneous strata.

A test report containing the depth of tests, columnar section, type of soil, viscosity, density, inclusions observed and N-values shall be submitted promptly to the Engineer following the test.

From the results of these tests, the Engineer will decide and instruct the Contractor on the required length of piles to be used and the required depth of footing foundation for other structures or whether piling is required or not for foundations of the buildings.

It should be noted in particular that the foundation of a number of the buildings has been designed provisionally on the basis of the present available data on soil condition. Therefore, if awarded the Contract, the Contractor shall check the foundation design of these buildings referring to the actual results of soil survey to be conducted as prescribed in this Specification. If it is deemed necessary, the Contractor shall modify the foundation design accordingly, subject to the approval of the Engineer.

**30211**  
**Foundation**  
**Design of**  
**Buildings**

The Contractor shall review and update the design of the foundation as shown in the Drawings taking into account the additional information collected from the soil test as described in Clause 30210.

The Contractor shall submit within 30 days from the completion of the soil test a foundation review report which shall include proposals for all changes to the design of the foundation.

The Engineer may instruct the Contractor to redesign the foundation of the buildings in accordance with the proposals of the Contractor or may instruct the Contractor to redesign the foundation of one or more buildings for another type of foundation as proposed by the Contractor or as specified in the Contract.

Any adaptation of the structural design of the buildings required as a consequence of the redesign of foundations shall also be carried out by the Contractor.

## SECTION 30300 PILING WORKS

### 30301 General

This section covers furnishing and driving piles for the building works. The Contractor shall submit his program of piling together with the details on manufacturing and driving method he proposes to use, to the Engineer for approval. The expected bearing capacity of pile and/or the length of the piles are shown on the Drawings. All piles required for the building work are Prefabricated Prestressed Concrete Piles.

The piles to be used for building works shall be square shape of 400 mm x 400 mm, 450 mm x 450 mm and 500 mm x 500 mm as shown in the drawings.

### 30302 Materials

#### 30301.1 Concrete

The piles shall be constructed in accordance with the details shown on the Drawings, of prestressed concrete of a compressive strength of 35 N/sq.mm as specified on the provisions of SECTION 30400.

The pile shall be straight that such a line stretched from tip to butt on any face will not be more than 1/1000 of the length of the pile from the face of the pile at any point.

#### 30301.2 Steel

- Prestressing Steel.

The prestressing steel shall consist of seven-wire strands of 12.70mm nominal diameter and Grade 1750 ( 1750 N/sq.mm ) and shall comply with the provisions of SECTION 30400. All prestressing steel shall be free from loose mill scale, loose rust, oil, grease, or other harmful matter at the time of fixing and of placing concrete.

Reinforcing Steel. Ordinary reinforcement steel shall have a specified yield strength of 420 N/sq.mm and shall be in accordance with the provisions set out in SECTION 30400.

All prestressing steel shall be stored in a suitable weather proof shed and protected from dampness. Steel shall not be pitted.

Wires, strands, or bars shall be accurately positioned and maintained in position, both vertically and horizontally, before casting of the concrete, as shown on the Drawings.

### 30303 Formwork

The formwork shall be sufficiently rigid not to deform during the placing and compaction of the concrete and shall be sufficiently tight to prevent loss of water from the concrete.

The casting bed shall be adequately supported to prevent any settlement which might cause cracking of the concrete. If the pile is to be stressed on the casting bed, provision shall be made for the elastic shortening of the concrete under prestress and for the transfer of dead weight after stressing.

All rubbish shall be removed from the interior of the forms before concrete is placed. The faces of the formwork in contact with the concrete shall be cleaned and treated with form oil approved by the Engineer.

Side forms shall be removed as soon as possible after the concrete has set to avoid shrinkage cracks. The pile will not be moved until after the pile has been stressed. All formwork will be removed in such a way as to ensure no damage is done to the concrete.

### 30304 Casting

The piles shall be cast in a horizontal position. Special care shall be taken to place the concrete so as to produce a pile free from any air pockets, honeycomb or other defect

Concrete shall be placed continuously and shall be compacted by vibrating or by other means satisfactory to the Engineer. The forms shall be slightly overfilled, the surplus concrete removed off the top surfaces finished to a uniform, even texture similar to that produced by the forms.

**30305**  
**Tensioning**  
**Procedure**

Tensioning shall be carried out only in the presence of the Engineer unless prior permission has been granted to the Contractor to proceed without the supervision of the Engineer.

All strands to be stressed in a group shall be brought to a uniform tension of approximately 500 kilograms per strand prior to being given their full tension. After this initial stressing the group shall be stressed to a total tension as required on the Drawings by means of hydraulic jacks or other approved appliances equipped with gauges graduated to read directly to one percent of the total load applied, and calibrated to measure accurately the stress induced in the steel. The induced stress shall be measured by elongation of the tendons and checked by gauge pressure. The results obtained shall be within five percent of each other.

Means shall be provided for measuring the elongation to an accuracy of one millimeter in twenty meters of length between the jacking heads. In the event of apparent discrepancies of more than five percent between stresses indicated by gauge pressure and elongation, the entire operation shall be checked carefully and the source of error determined and corrected before proceeding further.

Independent references shall be established adjacent to each anchorage to indicate any yielding or slippage that may occur between the time of initial stressing and final release of the strands.

**30306**  
**Curing**

Curing of the concrete shall be commenced prior to the formation of surface shrinkage cracks and as soon as the concrete has hardened sufficiently to prevent injury.

The pile shall be covered with wet burlap or membrane curing compound as an interim measure to elevated temperature curing.

Precast pretensioned members shall be cured continuously, until the concrete strength, as indicated by compressive tests conforming to ASTM C-39, has reach the Release Strength of 28 N/sq.mm. Curing then may be interrupted for a time interval of not more than two hours for removal of the piles from the casting bed to a curing area. Curing operations shall then be resumed for an additional 48 hours.

**30307**  
**Release**

For precast pretensioned members the strand stress shall be maintained between anchorage's until the concrete has reached a compressive strength equal to the Release Strength specified on the Drawings as determined by compressive tests on cylinders according to ASTM C-39.

After strength requirements are attained, the tension in the strands shall be gradually and simultaneously released and the strands cut off as required in such a way as to prevent shock. It shall be the Contractor's responsibility to transfer the prestress safely and to the Engineer's satisfaction in all respects.

At the ends of piles a recess shall be cut around each tendon to allow cutting off the tendon and filling the recess with grout so that the cover to the end of the tendon is not less than 20 millimeters.

**30308**  
**Preparation for**  
**Driving**

The heads of all piles shall be plane and perpendicular to the longitudinal axis of the pile. Coordinate pile driving so as not to damage other parts of the completed work. The heads of all concrete piles shall be protected by caps of approved design, preferably having cushion at least 100 mm thick next to the pile head and fitting into a casting which in turn supports a timber shock block.

The supports of piles during lifting or moving shall be provided at the quarter points. Provide slings or other equipment when raising or transporting concrete piles to avoid bending the pile or breaking edges.

Full length piles shall be used where practicable. In exceptional circumstances splicing of piles may be permitted. The method of splicing shall be approved by the Engineer.

**30309**

**30309.1 Methods of Driving**

**Driving**

The piles may be driven using a drop hammer, single or double acting steam hammer, or a diesel hammer. The Contractor shall provide a suitable hammer of sufficient weight and/or energy capable of installing each pile to the required penetration and to control the hammer and/or energy to ensure that no pile is damaged during driving. In case the required penetration cannot be obtained by the use of a hammer complying with the above minimum requirements, the Contractor shall provide a heavier hammer, or resort to jetting at his own expense. The minimum hammer energy of the driving equipment submitted for approval, as rated by the manufacturer, shall be at least the energy specified in Table 30300.1 that corresponds to the required ultimate pile capacity.

**Table 30300.1 Minimum pile hammer energy**

Ultimate Pile Capacity (kilonewtons)	Minimum Rated Hammer Energy (kilojoules)
≤ 800	14.0
1330	21.2
1600	28.1

Pile driver leads shall be of approved design and constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in position by workers or stiff braces to ensure support to the pile during driving. Except where piles are driven through water, the leads, shall be of sufficient length so that the use of a follower will not be necessary. Inclined leads shall be used in driving batter piles, and shall provide sufficient lateral support for the pile so that no undue stresses are induced in the pile during driving.

The driving of piling with followers shall be avoided if practicable and shall be done only under written permission of the Engineer. When followers are used, they shall be fabricated from steel of approved type and size, and one pile from each group of 10 shall be a long pile driven without the follower and shall be used as a test pile to determine the average load carrying capacity of the group. Expenses incurred in connection with the testing of the pile shall be provided by the Contractor.

When water jets are used, the number of jets and the volume and pressure of water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all times at least 0.7 N/mm<sup>2</sup> pressure from 20mm jet nozzles. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven by hammer to secure the final penetration.

**30309.2 Accuracy of Driving**

Piles shall be driven with a deviation of not more than 1° from the vertical. After driving, the positions of the pile heads shall not deviate by more than 80 mm from the positions shown on the Drawings. The center of gravity of any row of piles shall be within 50 mm from its theoretical position in any direction.

**30309.3 Defective Piles**

The procedure of driving of piles shall not subject them to excessive and undue abuse producing crushing of the concrete. Manipulation of piles to force them into the proper position, considered by the Engineer to be excessive, will not be permitted. Any pile damaged by reason of internal defects, or by improper driving or driven out of its proper location or driven below the elevation fixed by the Drawings or by the Engineer, shall be corrected at the Contractor's expense by one of the following methods approved by the Engineer:



A second pile or piles shall be driven adjacent to the defective pile.

The pile shall be built up or extended or sufficient portion of the footing extended to properly embed the pile as approved by the Engineer.

All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again to their previous elevations.

#### **30309.4 Cutting off Piles**

Piles shall be cut off at an elevation that they will extend into the footing as indicated on the Drawings. The piles may be cast the full length of the reinforcing bars, provided that the concrete is cut off to expose the reinforcement steel that extends into the footing as shown on the Drawings after the piles have been driven.

### **30310 Driven Pile Capacity**

#### **30310.1 General**

All piles shall be driven to such depths or sets as may be required to obtain the necessary allowable bearing value. The Engineer will decide on the criteria for when this value has been achieved, based on the load tests or driving records. The dynamic formula shall be used to determine the ultimate bearing capacity of the in place pile.

#### **30310.2 Dynamic Load Test**

The dynamic load test shall conform to ASTM D4945. This test requires a dynamic load to be applied by a pile hammer to a driven pile or to a pile being driven, while transducers obtain measurements for predicting the static capacity of the pile. The dynamic load shall be applied to the pile by a pile hammer which is operating at its normal operating level. Waiting periods may be necessary so that soil set-up and relaxation characteristic can be determined.

The Contractor shall notify the Engineer of his intent to drive piles at least three days prior to the installation of the first pile and shall supply a Contractor's pile driving schedule. The Engineer shall determine if a test is to be performed or if some pile driving experience at the proposed site is to be obtained before a decision can be made. The Engineer will establish data for the tests and will also determine the location of all piles to be dynamically load tested.

The hammer selected for driving the test loaded pile shall be used for driving all test piles. If the Contractor subsequently finds it necessary to use a different hammer, the Engineer will determine if an additional dynamic load test is necessary. Any such test shall be completed at no additional cost to the Employer.

After the dynamic testing measurements have been obtained and analyzed and the report in terms of ultimate capacity of piles has been submitted to the Engineer, the Engineer will provide instructions and guidelines for driving the piles.

#### **30310.3 Driving Records**

A record of all piles installed shall be kept by the Contractor and a copy of the record of each day's work shall be given to the Engineer within 24 hours. The record shall contain the following information:

- Date of Driving.
- Date of Casting and Identification Number.
- Location of Pile.
- Length of Pile and Cross Section.
- Ground Level before Driving.

- Estimated Tip Elevation (as shown on the Drawings).
- Actual Tip Elevation after Driving.
- Number of Blows for each 30 cm Penetration from Start of driving.
- Number of Blows for each 10 cm penetration from last 1.0 m of driving.
- Hammer Type, Weight and Rated Energy.
- For Drop Hammer, the Actual Drop Height.
- Details of Interruptions to Driving.
- Details of Re-driving.
- Details of condition of Pile Head.

On completion of piling, the Contractor shall deliver to the Engineer a drawing recording the final depths of all piles relative to project elevations.

#### **30310.4 Driving Formula**

The piles shall be driven to a penetration necessary to obtain the ultimate pile capacity according to the following formula:

$$Ru = (7 \sqrt{E \log (10N)}) - 550$$

Where:

$Ru$  = Ultimate pile capacity in kilonewtons.

$E$  = Manufacturer's rated hammer energy in joules at the ram stroke observed or measured in the field.

$\log(10N)$  = Logarithm to the base 10 of the quantity 10 multiplied by  $N$ .

$N$  = Number of hammer blows per 25 millimeters at final penetration.

Solving for  $N$ :

$$N = 10^x$$

$$x = ((Ru + 550)/(7 \sqrt{E})) - 1$$

Factor of safety = 3.0

The dynamic formula shall be applicable only if all the following apply:

The hammer is in good condition and operating in a satisfactory manner.

The hammer ram falls freely.

A follower is not used.

The head of the pile is not crushed.

## SECTION 30400 CONCRETE WORKS

### 30401 General

#### 30401.1 Standards

The materials and workmanship used in the manufacture of concrete shall be in accordance with ASTM C-143, ASTM C-39, JIS A 1101, JIS A 1108, JIS A 1132 JIS A 1105, ASTM C-150 ASTM C-31, ASTM C-1077, ASTM -94 C and ASTM C-33 or approved equivalent international standards as appropriate for concrete works, and as modified by this Specification.

#### 30401.2 Materials to be Used

The Contractor shall advise the Engineer, within 30 days of the award of contract, of the source of all materials to be used in concrete for the works. In the event that the Contractor later proposes to obtain materials from a different source he shall notify the Engineer at least 30 days before such materials are to be used.

#### 30401.3 Shop Drawings

The Contractor shall submit shop drawings at least six weeks prior to the start of any construction for the Engineer's approval.

### 30402 Aggregates

#### 30402.1 General

Aggregates shall consist of naturally occurring materials fully complying with JIS A 5005, ASTM C-33 except as modified hereafter, and shall be obtained only from sources approved by the Engineer.

#### 30402.2 Test

As required by the Engineer aggregates shall also be tested and classified to ASTM C-294 and ASTM C-295 and the results of such testing submitted to the Engineer.

#### 30402.3 Gradings

After trial concrete mixes have been satisfactorily completed the Contractor shall check the gradings of the aggregate regularly and for this purpose shall take samples from the stockpiles under the supervision of the Engineer. Gradings shall be checked at least once for every 50 tons of each type of aggregate delivered.

#### 30402.4 Changes of Quality of Grading

Should the Engineer consider that the quality or grading of the aggregates supplied is different from that of the aggregates used in approved trial mixes, he may direct the Contractor to take 50 kg samples in his presence and consign them to an approved laboratory for full testing at the Contractor's expense.

#### 30402.5 Approvals of the Engineer

No aggregate shall be incorporated within the works without the approval of the Engineer.

#### 30402.6 All in Aggregate

All-in aggregates shall not be permitted in the Works.

#### 30402.7 Cleaning of Aggregates

Aggregates shall be entirely free of vegetable, organic or other such deleterious matter.

#### 30402.8 Aggregate Gradings

Aggregate gradings shall conform to those used in the approved trial mix for the appropriate class of mix within the following tolerances:

Sieve Size	Nominal Size of Graded Coarse Aggregate Tolerance (%) by Weight of Amount Passing		
	40 mm - 5 mm	20mm - 5mm	14 mm - 5mm
50	0	na	na
37.5	± 2	± 0	na
20.0	± 10	± 2	± 0
14.0	na	na	± 2
10.0	± 8	± 8	± 10
5.0	± 2	± 3	± 3

Sieve Size	Fine Aggregate Tolerance %
10	± 0
5	± 5
2.36	± 10
1.18	± 10
600 µm	± 10
300 µm	± 10
150 µm	± 3

#### 30402.9 Changes in Source of Supply or Grading

Sample loads of aggregates of approximately 300 kg for each aggregate type shall be submitted to the Engineer for his preliminary approval for each and every change in source of supply or grading. From each load the Contractor shall take two representative samples, each of 50 kg and subject them to grading analysis and all those tests required by this specification and such other tests as the Engineer may direct. The sample loads shall be retained for use in the concrete trial mixes to be carried out by the Contractor.

#### 30402.10 Handling and Storage of Aggregates

The fine and coarse aggregate shall be handled and stored separately in such a manner that segregation of the various sized particles shall not occur. The dumping of aggregates down sloping stockpiles will not be permitted. The stockpiles shall be formed on a free-draining platform of impervious concrete or similar approved hard-standing and shall be kept free from foreign substances. Care shall be taken to avoid the crushing of aggregates by stockpiling equipment.

#### 30402.11 Protection of Aggregates

Aggregates shall be covered to protect them from windblown dust; they shall also be shaded from the sun to keep them cool when ambient shade temperatures exceed 25°C.

### 30403 Water

#### 30403.1 General

The Contractor shall arrange for an adequate supply of water for all purposes where required upon the Works. Water used in or in connection with the Works shall conform to ASTM C-94. The Contractor shall provide details of his proposed sources to the Engineer for approval.

#### 30403.2 Source of Water

Where water is to be obtained from a source other than a public utility supply, or as required by the Engineer, the Contractor shall have testing carried out by an approved independent testing laboratory in accordance with ASTM C-94 and the results sent to

the Engineer for approval.

### **30403.3 Samples**

Subsequently, samples shall be taken and tested at least once every month, or more frequently, if the quality of the water is subject to variations of the climate.

### **30403.4 Sea Water**

Sea water shall neither be used in concrete mixes nor for the curing of concrete.

### **30403.5 Test**

The quality of mixing water shall also be checked not less frequently than once per week by the testing of three concrete cylinders, made with distilled water, alongside three additional cylinders to normal test requirements. The times for concrete to attain initial set should not differ by more than 30 minutes and the strength at 3 days shall not be less than 90% of that obtained with distilled water.

## **30404 Cement**

### **30404.1 Specification**

Cements for incorporation into the Works of Structural Concrete shall be Portland Cements comply to JIS R 5210, or equivalent and Portland Cement Type I to ASTM-C150 or equivalent.

The Contractor shall not change or modify any arrangement for the sources of supply, transport, storage and certification without the approval of the Engineer.

### **30404.2 Sources**

The Contractor shall not change or modify any arrangement for the sources of supply, transport, storage and certification without the approval of the Engineer.

### **30404.3 Storage of Cement**

Except as may be approved by the Engineer for grades or qualities of cement not available in the Country or State in which the works are to be constructed, cement shall be obtained direct from the manufacturer and delivered direct to the site whether in bulk by approved purpose-built vehicles or in sealed bags. It shall be stored in silos or approved containers or in bags, and shall be protected against any ingress of moisture, dust or other contamination. Bags shall be stored in stacks not more than 1.5 m high in well ventilated waterproof buildings having a raised dry floor. Cement shall be delivered in quantities sufficient to ensure that there is no suspension or interruption of concreting at any time and shall be used in the order of delivery. No lumpy or partially hydrated cement shall be used. Different types of bagged cement or from different manufacturers shall be stored separate and distinct. When cement is delivered in bulk it shall immediately be placed in the silos or approved containers.

### **30404.4 Storage in Silos**

Bulk cements of different types, or from different manufacturers, shall be stored in separate silos and distinctly marked. Precautions shall be taken during unloading, handling, storage and use of cement to prevent the emission of dust and to provide adequate protection from the weather. When mean daily ambient temperatures exceed 25°C all sheds, silos and purpose built delivery vehicles shall be painted white.

### **30404.5 Storage Keeper**

The Contractor shall employ competent store keepers who shall have charge of the cement stores and keep suitable records of the delivery and use of all cement. Copies of these records shall be furnished to the Engineer as requested, showing in such detail as he may require, the quantity of cement used during the day in each part of the Works.

### **30404.6 Manufacturer's Certificates**

The Contractor shall promptly provide the Engineer with manufacturer's certificates

for each consignment or as otherwise agreed certifying that the cement complies with the requirements of the relevant Standard. These certificates shall record the results of the standard tests on samples, taken and tested from each consignment. In addition, routine test certificates are to be supplied by the manufacturer showing the average results of sample tests made on batches of cement produced at his works.

#### **30404.7 Test**

The Engineer may also make any further tests which he may consider necessary to satisfy himself that any cement on site complies with the specification and has not suffered any deterioration in any manner during transit or storage. Any cement which has not been used within two months from the date of manufacture shall be tested for compliance with the relevant Standard. No cement shall be used in the Works until it has been passed as satisfactory by the Engineer.

#### **30404.8**

Cement shall be used in order of delivery.

#### **30404.9**

Cement held for more than 90 days since manufacture shall be tested, prior to use, for "loss on ignition", in accordance with ASTM C-114.

#### **30404.10**

Cement of different brands or manufacturers shall not be used in the same part of the Works.

#### **30404.11**

Imported cements shall be tested as may be required by the Engineer prior to their incorporation in the Works notwithstanding that the cement may have been tested prior to delivery to the site.

#### **30404.12**

The Engineer may reject any cement not meeting this specification. Cement rejected by the Engineer shall be immediately removed from the Site.

#### **30404.13**

Cements shall not be placed in the mix at temperatures in excess of the ambient temperature.

### **30405**

#### **Admixtures and Additives**

#### **30405.1**

Admixture and additives shall only be used in specified circumstances, on specified occasions and then only with the approval of the Engineer in each case. Admixtures and additives used at the direction of the Engineer shall conform with and be used in accordance with this specification and as may be determined by the Engineer.

#### **30405.2**

Admixture and additives shall only be used in specified circumstances, on specified occasions and then only with the approval of the Engineer in each case. Admixtures and additives used at the direction of the Engineer shall conform with and be used in accordance with this specification and as may be determined by the Engineer.

#### **30405.3**

The Contractor shall apply in writing to the Engineer requesting approval to use admixtures or additives not later than two months before he proposes to incorporate the same into a concrete mix and then only:

- a) To improve the workability of concrete mixes when mean ambient daily

temperatures exceed 25°C.

**30405.4**

Such application shall include full documentation and test information as may be required or recommended by JIS A 6204 or other internationally recognized standards as may be applicable to the admixture or additive. The Contractor shall also provide a full method statement for his proposals.

**30405.5**

The Engineer reserves the right to reject any such application without reason being given and the Contractor shall not in consequence be entitled to any claim on any grounds whatsoever.

**30405.6**

Admixtures and additives approved in specific terms by the Engineer shall conform and be used in accordance with the manufacturer's instructions or such relevant internationally recognized standard or as may be specified or approved by the Engineer.

**30405.7**

Admixtures or additives containing chlorides will not be approved for incorporation in concrete.

**30406  
 Steel  
 Reinforcement  
 to Concrete**

**30406.1**

Steel reinforcement used in structural concrete shall conform to the requirements of JIS G 3101, ASTM A615.

**30406.2**

The Contractor shall prepare bending schedules stating shapes, diameters, lengths and quantity of steel reinforcement. The bending schedules shall be submitted in duplicate to the Engineer for approval and no reinforcement shall be bent until such approval has been received. In general the bending schedules shall be submitted to the Engineer six weeks before production is to commence and in general the Engineer will reply within four weeks of the schedules being submitted. Upon request these periods may be reduced, within reason, for particular schedules required urgently. Permission to use the bending schedules by the Engineer shall not in any way relieve the Contractor of the responsibility of providing the steel reinforcement shown on the Drawings.

**30406.3**

Bar reinforcement shall comply with the following unless specifically noted otherwise on the Drawings:

Bar Size mm Diameter	Material	Characteristic Strength	Ref. Code
Less than 10	A <sub>I</sub>	280 N/mm <sup>2</sup>	ACI 318M-99
10 mm or more	A <sub>II</sub>	420 N/mm <sup>2</sup>	ACI 318M-99

**30406.4**

The prestressing steel for precast prestress concrete shall consist of seven-wire strands of 12.70 mm nominal diameter and nominal area of 92.90 mm<sup>2</sup>, Grade 1750 (1750 N/mm<sup>2</sup>).

**30406.5**

Test certificates shall be provided for each consignment of steel which shall include

the results of the cast analysis of the bar supplied, the carbon equivalent value, and the tensile bend and rebend tests. The tensile test results shall include the cross-sectional area.

**30406.6**

All reinforcement shall be bundled by size with separation of casts and each bundle shall be identified by durable tags bearing the manufacturer's name or mark, the reinforcement size or designation, the cast mark and the appropriate certificate reference. All reinforcement shipped by sea shall be stored below deck whether in containers or not.

**30406.7**

After delivery to the Site, the Engineer may require the Contractor to carry out confirmatory tests on further samples at an approved nominated laboratory. Any steel which, as a result of such confirmatory tests, does not comply with the Specification will be rejected and shall be removed from Site without delay.

**30406.8**

Bends, cranks and other working of reinforcement bars shall be performed by competent artisans in accordance with ASTM A-615 and ASTM A 615M-95b. Reinforcement bars shall be bent cold in an approved bending machine.

**30406.9**

Bending hot at cherry red heat i.e. not exceeding 850°C may be allowed except for bars which depend on cold working for their strength. Bars bent hot shall not be cooled by quenching.

**30406.10**

Unless otherwise approved by the Engineer all laps and splices shall be located as indicated on the Drawings.

**30406.11**

Steel reinforcement in structural concrete shall be welded only with the approval of the Engineer.

**30406.12**

Concrete 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 complying in all respects with the requirements of this Specification. They shall be securely wired in position to the second layer of reinforcement in from the concrete surface using 1.6 mm diameter soft annealed iron tying wire which shall not be embedded in the spacer block more than 15 mm. The spacer blocks shall be thoroughly soaked in fresh water immediately prior to pouring concrete.

**30406.13**

The number, size, form and position of all steel reinforcing bars, ties, links, stirrups, and other reinforcement shall be in exact accordance with the drawings and they shall be kept in the correct position and with the required cover, without displacement during the process of pouring and compacting the concrete in place, in a manner approved by the Engineer. The Contractor shall provide all necessary distance pieces and spacer bars to maintain the reinforcement in the correct position. The type of distance pieces shall be subject to the approval of the Engineer. Temporary supports within the concrete to keep reinforcement in place will not be allowed. Any ties, links, or stirrups connecting the bars shall be taut so that the bars are properly braced, and the inside of hooks and bends shall be in contact with the bars around which they are



intended to fit.

**30406.14**

All reinforcement shall be stored under a waterproof shelter and supported above the surface of the ground and any water lying on the ground, and shall be protected from damage and corrosion.

**30406.15**

Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Mechanical cleaning equipment for the removal of millscale or rust etc. of an approved design shall be provided by the Contractor on Site for this purpose.

**30406.16**

Partially set concrete which may adhere to exposed reinforcement during concreting operations shall also be removed.

**30406.17**

Concrete cover to ferrous metal being used as or for the placement of reinforcement shall be not less than 30 mm nor more than 35 mm or as noted or within  $\pm 2.5$  mm of the dimensions noted or shown on the Drawings.

**30406.18**

Where sections of the work are carried out in lifts, the reinforcement projecting above the lift being cast shall be adequately supported so as to prevent movement of the bars during the casting and setting of the concrete.

**30406.19**

Reinforcement temporarily left projecting from the concrete at construction or other joints shall not be bent out of position except with the approval of the Engineer.

**30407**

**Formwork**

**30407.1**

All formwork, shuttering, supporting falsework, struts and staging shall be of suitable quality, either metal, timber or other approved material and of such strength with ample scantlings as to ensure that the shuttering remains rigid and without distortion throughout the placing, ramming, compacting and setting of the concrete. The design of the formwork shall be such as to enable it to be struck and removed without damage to the concrete. No shutter fixings or supports, other than certain approved internal ties, will be allowed to be incorporated in the finished concrete. The Contractor shall submit his designs, in duplicate, for consideration not less than 14 days before the proposed commencement of each part of the work and work shall not start until the Engineer's approval has been received. Details of all proposed formwork and lining appropriate to the class of finish shall be submitted for approval by the Engineer before any materials are brought onto the Site. Where required by the Engineer, samples of formwork shall be constructed and concrete placed so that the proposed methods and finish can be demonstrated.

**30407.2**

All joints in shuttering or moulds shall be in either horizontal or vertical planes, and shall be of such a design as to ensure that there is no loss of fine materials or cement during the placing or consolidation of the concrete.

**30407.3**

All shuttering or moulds used for forming the face of exposed concrete, where specified to be "wrought", shall be of especially smooth planed or lined construction. Where "wrought" shuttering is not specified, sawn timber shuttering may be used which shall be designated as finish class F1. All wrought shuttering shall be provided

with 25 mm by 25 mm splays on internal and external angles unless otherwise directed by the Engineer. Wrought shuttering is to be aligned to a tolerance of  $\pm 3$  mm except where a closer tolerance is required.

Wrought shuttering shall be to three classes as shown in Table 30400.1 and described as follows:

a) Class F1

Class F1 finish is for surfaces against which back-fill or further concrete will be placed. Formwork shall consist of sawn boards, sheet metal or any other material which will prevent the loss of grout when the concrete is vibrated.

b) Class F2

The irregularities in the finish shall be no greater than those obtained from the use of wrought square edged boards arranged in a uniform pattern. The finish is intended to be left as struck but imperfections such as fins and surface discoloration shall, if required, be made good by methods approved by the Engineer.

c) Class F3

The formwork shall be lined with a material approved by the Engineer to provide a smooth finish to uniform texture and appearance. This 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 and obtained from only one source throughout any one structure. The Contractor shall make good any imperfections in the finish as required by the Engineer.

**TABLE 30400.1 – Surface Finish to Concrete**

Class	Location
F1	Buried footings and foundations,
F2	Walls and other faces to be plastered,
F3	All exposed structural concrete in buildings, interior of all pits and drainage structures.

**30407.4**

Permanently exposed concrete surfaces shall be protected from rust marks and stains of all kinds.

**30407.5**

Unless otherwise described in the Contract all formwork joints for exposed surfaces of concrete to Class F2 and F3 finish shall form a regular pattern with horizontal and vertical lines continuous throughout each structure and all construction joints shall coincide with these horizontal or vertical lines.

**30407.6**

The inside surfaces of forms shall, except for permanent formwork, or unless otherwise agreed by the Engineer be coated with a release agent approved by the Engineer. Release agents shall be applied strictly in accordance with 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.

**30407.7**

All internal metal ties where permitted or parts thereof shall be extracted without damage to the concrete and any resulting holes shall be filled with a permanently impermeable filler to the satisfaction of the Engineer. No permanently embedded metal part shall be less than the specified cover to the reinforcement from the finished surface.

**30407.8**

The shuttering shall be cleaned out prior to concreting and thoroughly freed from sawdust, shavings, rust, dirt, mud or other debris, and special removable sections of shuttering shall be provided to facilitate this, all to the approval of the Engineer. After concreting, the exposed surfaces of the shuttering shall be cleaned of all adhering concrete before depositing fresh concrete.

**30407.9**

Void formers shall be sufficiently robust to resist damage during concreting operations. They shall be adequately supported and anchored in such a way as to prevent flotation or displacement during concreting. Where void formers are of hollow construction, drain holes shall be provided of a size and in positions to be agreed by the Engineer.

**30407.10**

All fixing blocks, brackets, built in bolts, holes, chases, inserts, and the like shall be accurately set and firmly fixed in position prior to the placing of concrete. No cutting away of concrete for any of these items shall be carried out.

**30407.11**

Bolts and other inserts to be cast into the concrete shall be securely fixed to the formwork in such a way that they are not displaced nor shall there be any loss of grout through holes in formwork during concreting. Continuous inserts of the channel or dovetail slot type and all fittings to which bolts or other fixings will later be attached shall be sealed and rendered grout-tight prior to commencement of concreting.

**30407.12**

Immediately upon striking the formwork all filler materials and obstructions shall be removed from all inserts, etc., over their entire length. Construction joints shall not be formed within 100 mm of any insert or channel. External ferrous fixings shall be fixed such that the specified cover is maintained between such fixings and any reinforcement.

**30407.13**

All formwork shall be inspected and approved by the Engineer before concrete is placed and the Contractor shall allow adequate time in his concreting programming for such inspection and for carrying out any remedial action or correction required by the Engineer.

**30407.14**

Except as may be approved by the Engineer, shuttering below or between tides shall be so fitted and caulked that the ingress of water is prevented. The shuttering is to be so restrained and the rate of placing of concrete so arranged as to prevent uplift and consequent deflection of the shutters due to buoyancy.

**30407.15**

The Engineer shall be informed in advance when the Contractor intends to strike any formwork.

**30407.16**

The removal of formwork and shuttering for structural concrete shall be effected in such a manner as will ensure that no shock, vibration or damage to the concrete occurs. No formwork shall be removed before the concrete has attained sufficient strength, so that the concrete shall at no time be subjected to loading, including that from its own weight, which will induce a compressive stress in it exceeding one third of its compressive strength at the time of loading or of the specified 28 day strength. For the purpose of this Clause, the assessment of the strength of the concrete and the stresses produced by the loads shall be subject to the agreement of the Engineer. For special structural concrete, formwork shall only be removed after such time and/or strength has been determined and specified by the Engineer.

**30407.17**

The minimum periods which shall elapse between the placing and compacting of structural concrete and the removal of the shuttering for various types of faces are given in the following table but this will not relieve the Contractor from his obligation to delay removal of the shuttering until the concrete has attained sufficient strength, and the Contractor will be held responsible for and shall make good at his own expense all injury and damage arising from premature removal of the shuttering. A small portion of the shuttering shall be removed to ascertain that the concrete has set sufficiently hard before the whole area of the shuttering is removed.

**TABLE 30400.2 Formworks Stripping Times**

Type of Formwork	Percent of Specified 28-Day Strength	Minimum Stripping Time
Vertical faces of foundation plinths and precast items	50	1 day
Vertical faces of columns, beams and walls	50	5 days
Undersides of suspended slabs, beams, etc.	70	10 days
Slabs		14 days
Beams		
Props to suspended slabs, beams, etc	70	15 days

**30407.18**

The periods indicated above assume that the structure is carrying normal dead loads only. The Contractor shall ensure that no loads of such an intensity that will cause damage are applied to newly constructed work. Any damage caused by such overloading shall be made good by the Contractor at his own expense to the satisfaction of the Engineer.

**30407.19**

The finished surface of all concrete work shall be sound, solid and free from honeycombing, protuberances and blemishes and shall, if defective in any way, be brought to the attention of the Engineer and made good in a manner directed by him immediately his instruction is given. No plastering, touching up or making good defective concrete will be allowed without prior agreement of the Engineer.

**30407.20**

Shuttering shall be provided for all slopes exceeding 15° to the horizontal to enable the concrete to be properly compacted. Where concrete has to be poured against a hard face in lieu of shuttering, the thickness of concrete shall be increased by not less than 100 mm on that face to provide additional cover. Before any concrete is poured against a hard face all leakage or percolation of water which, in the opinion of the Engineer could cause damage to wet concrete shall be effectively sealed. In addition, fissures or openings in the hard face which would cause loss of concrete whilst it is wet shall also be effectively sealed. Structural concrete shall not be poured against vertical or inclined rubble fill or earth surfaces in lieu of shuttering.

**30407.21**

After completion of the structure all forms and falsework shall be completely removed but no forms or falsework shall be removed without the consent of the Engineer.

**30408**

**Left-in-place  
Formwork**

**30408.1**

Where it is intended to leave formwork in place after the concrete it supports has been cast that formwork shall, unless otherwise directed by the Engineer, be of glass reinforced cement. The shape shall be such that no re-entrant angles are presented to concrete being poured and no hindrance shall be offered by the formwork to compaction of the concrete.

**30408.2**

The sectional properties of the formwork shall be such that the full deadweight represented by the wet concrete can be carried without the permanent deflection of the formwork exceeding one ninetieth of its free span. Where such deflection exceeds 10 mm the formwork shall be provided with a camber sufficient to offset the expected deflection.

**30308.3**

The materials used in manufacture of such formwork shall not be aggressive either to concrete or to reinforcement and shall not present a health hazard when cut or worked

**30409**

**Unformed  
Concrete  
Surface**

**30409.1**

For finishing of top surfaces on formless concrete, the following types of finishes will be required.

- Type U .1 Screeded Finish

Type U. 1 is a screeded finish for surfaces of foundations, beds and slabs to be covered by backfill and subsequent stages of construction. It is also the first stage for finishes U.2 and U.3.

The finishing operation shall consist of levelling and screeding the concrete to produce a uniform, plain or surface, surplus concrete being struck off by a straight edge immediately after compaction. Screed lines shall run in the direction of falls to assist drainage.

- Type U.2 Wood Trowel Finish

Type U.2 is a trowelled finish for surfaces of beds and slabs where a hard smooth steel-trowelled surface is not required. Trowelling shall be done only after the concrete has hardened sufficiently, and may be by hand. Care shall be taken that the concrete is worked no more than is necessary to produce a uniform surface free from screed marks.

- Type U.3 Trowel Finish

Type U.3 is a hard smooth steel-trowelled finish for surfaces of tops of walls, copings and other members exposed to weathering, seatings for bearing plates and the like, where the metal is in direct contact with the concrete. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface.

The surface shall be trowelled under firm pressure and left free from trowel marks.

**30409.2**

The permissible tolerances in unformed surfaces for the various classes of finish specified above shall not generally exceed the following limits.

Type U.1 Screeded finish +15 mm, -10 mm

Type U.2 Wood float finish + 6 mm, - 3 mm

Type U.3 Steel trowel finish + 3 mm, - 3 mm

**30410.  
Concrete Mix  
Design**

**30410.1**

The design of concrete mixes shall be the responsibility of the Contractor in accordance with this Specification.

**30410.2**

The term concrete shall include all concrete except dry-lean concrete wherever it is incorporated in the Works.

**30410.3**

Concrete shall be designed to be dense, impermeable and durable.

**30410.4**

The various grades of concrete required for the works are indicated on the Drawings and are defined in Table 30400.3. All grades of concrete shall consist of Ordinary Portland Cement or Sulphate Resisting Cement, as specified in 30404.1, where designated mixed with suitable proportions of fine and coarse aggregates with an approved overall grading. The concrete shall be the most suitable combination of lean mix and low water/cement ratio, consistent with the method of compaction, strength and other requirements of this specification.

**TABLE 30400.3 Concrete Grades**

Concrete Class	Nominal Max. Aggregate Size (mm)	Characteristic Strength (N/mm <sup>2</sup> )		Standard Slump P (cm)	Minimum Cement Content (Kg/m <sup>3</sup> )	Maximum Free Water/Cement Ratio
		28 days	7 days			
<b>S1: Below First Floor Level.</b> Pile Caps, Foundations Beams, Foundations for Pits and Equipments.	25	21	13	15 ± 2.5	360	0.49
<b>S2: Upper First Floor Level.</b> Beams, Columns, Slabs, Walls, Sidewalks.	25	28	19	15 ± 2.5	360	0.49
<b>S3: Drainage, Utility.</b> Manholes & Pits	25	18	10	5 ± 1.5	300	0.55
<b>S4: Precast Prestress Concrete.</b> Piles and slab.	25	35	24	15 ± 2.5	360	0.49
<b>S5: Lean Concrete.</b>	25	18	NS	18 ± 2.5	270	0.65

**30410.5**

The minimum cement content of all concrete mixes to be used in the various parts of the works shall be as shown in Table 30400.3.

**30410.6**

The maximum cement content shall be 500 kg/cum except when ambient temperatures exceed 25°C when it shall not exceed 450 kg/cu m.

**30410.7**

Workability shall be the minimum consistent with achieving dense well compacted concrete free from segregation, bleeding, honey-combing and surface imperfections. The Contractor shall be responsible for deciding the workability of the fresh concrete, subject to the approval of the Engineer, and shall submit either compaction factor test results together with slump test results obtained from the trial mixes. These workability tests shall be in accordance with ASTM C-143. The Engineer will approve the workability of trial mixes on the basis of the compaction factor test results. The corresponding slump test results may subsequently be used during production of concrete as a control test only. If there should be doubt as to the

workability of concrete measured by the slump test the workability shall be confirmed by compaction factor tests . Notwithstanding that the Contractor shall be responsible for deciding the workability, the mix proportions after being accepted shall not be altered without the agreement of the Engineer.

#### **30410.8**

Concrete shall be referred to by class group for various combinations of the characteristic compressive strength, maximum aggregate size and minimum cement content. The classes of concrete required for the Works are shown in Table 30400.3 and on the Drawings.

#### **30410.9**

A concrete specified by class group is required to fulfill all criteria appropriate to that classification.

#### **30410.10**

No concrete shall be placed in the Works until the trial mix results have been approved by the Engineer.

#### **30410.11**

When the mix has been approved, no variations beyond those permitted by this specification shall be made in the proportions, the original source of cement and aggregates, or in the type, size or grading of the latter without the consent of the Engineer who may require further tests to be made.

#### **30410.12**

The Engineer may also require practical tests to be made on site by filling trial moulds to confirm the suitability of the mix for the Works. In these tests the type of plant used for the mixing and the steel reinforcement shall be similar in all respects to those intended for use in the Works.

#### **30410.13**

When the Contractor intends to purchase factory-made precast concrete units, the Engineer may dispense with trial mixes and laboratory tests provided that evidence is given which satisfies him that the factory regularly produces concrete which complies with the Specification. The evidence shall include details of mix proportions, water/cement ratio, workability and strengths obtained at 7 and 28 days.

#### **30410.14**

The Contractor shall submit calculations showing the maximum temperature rise which mass concrete pours of 25 cubic metres volume, or greater, and any reinforced concrete member with a least dimension exceeding 1 m between faces, for the mix designs he proposes.

### **30411**

#### **Batching and Mixing Concrete**

##### **30411.1**

At least four weeks prior to carrying out any concrete works to the Engineer for approval Contractor shall submit details of the batching and mixing equipment he proposes to use including the manufacturer's name, type of plant and estimated output. The plant shall be sufficient to meet requirements without overloading.

##### **30411.2**

The quantities of the ingredients shall be accurately gauged by weight before being mixed dry together. The aggregates shall be weighed separately for each size and the cement shall be weighed in a different container from that used for the aggregates. The weighing machines shall be of an approved type (to ASTM CP-94) and manufacture and shall be fitted with scales which shall indicate the weight of each ingredient of the batch to an accuracy of  $\pm 2$  per cent. The range of the weighing



machine shall not exceed twice the normal working load. Water shall be gauged either by volume or by weight to an accuracy of  $\pm 2$  per cent.

**30411.3**

The weighing machines shall be maintained in a clean condition. They shall be checked under the supervision of the Engineer over the scale ranges, by placing known weights certified by an acceptable testing agency in the weighing compartments before commencement, and thereafter at least once for every 1,000 tones of material weighed or not less than once per week.

**30411.4**

The water content of the aggregates shall be determined before mixing is commenced on every day that concrete is to be produced. Samples for determining the water content shall be taken from those stocks of aggregates which will be used during the day. When no precipitation occurs, the water content of the aggregates shall be checked once more during the day, after such time as the Engineer shall agree. During precipitation the water content shall be checked every two hours unless otherwise directed. The weighed quantity of aggregates shall be such that the correct weight of dry aggregates is taken into the batch mix and the amount of water added to the mix shall take into account the water content of the aggregates. All testing for water content, the frequency of testing and calculations of batch proportions shall be subject to the Engineer's approval.

**30411.5**

All concrete shall be mixed in power driven machines of approved type and capacity. The capacity of the mixing plant shall be such that the planned peak production rate and continuity of output are maintained under normal working conditions. The mixing plant shall comply with ASTM CP-94.

The mixing time, speed and operation shall be those used by the mixer manufacturer to assess its performance and the Contractor shall submit manufacturer's data sheets to the Engineer for approval of the equipment. The type of plant shall be such that the concrete in the mixers may be observed and the consistency checked visually during the process of mixing.

**30411.6**

Where concrete is batched and mixed in ambient temperatures exceeding 25°C batching and mixing plant shall be painted with a gloss finish white paint and kept clean on the outside as well as the inside. Batching and mixing plant shall be protected from the sun and from the wind to prevent loss of cement.

**30411.7**

Mixing times shall be only as long as is necessary to produce a uniform concrete mix. Water shall be added only when all the dry materials have been thoroughly mixed.

**30411.8**

Ready-mixed concrete, batched off the Site, may be used only with the agreement of the Engineer and shall comply with all requirements of the Contract. The concrete shall be carried in purpose-made agitators, operating continuously. The Contractor shall ensure that the concrete has not stiffened in the interval between batching and arrival on site. Batching times shall be recorded on the delivery notes. When truck-mixed concrete is used, water shall be added under supervision, either at the Site or at the central batching plant, as agreed by the Engineer but in no circumstances shall water be added in transit. The time of water introduction shall be recorded on the delivery note. The ready-mixed concrete supplier shall provide the Engineer with inspection and testing facilities equal to those required by this contract for concrete

batched on Site.

**30411.9**

The entire contents of the mixer shall be discharged from the drum before materials of a succeeding batch are loaded for mixing. No mixer having a rated capacity of less than one-bag batch shall be used nor shall a mixer be charged in excess of its rated capacity.

**30411.10**

Mixers which have been out of use for more than 30 minutes or if the type or grade of mix is to be changed, shall be thoroughly cleaned before any fresh concrete is mixed. Unless otherwise agreed by the Engineer, the first batch through the mixer shall be a grout mix sufficient to coat blades, pan and discharge chute of the mixer. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another. Concrete which has developed its initial set or has partially hardened shall not be re-mixed.

**30411.11**

No hand-mixing of concrete shall be permitted for structural or blinding concrete. If the Engineer permits the hand-mixing of concrete for temporary or non-structural work the designed or approved cement content of each batch shall be increased by one tenth. The size of each batch shall not exceed 0.1 cu m. Mixing shall be carried out on a properly constructed timber platform with closed joints so to as avoid the loss of any grout or on a stone or concrete floor of adequate size to permit thorough mixing. The dry materials of the batch shall be thoroughly mixed by turning them over at least twice. Water shall then be added through a rose head after which the whole mixture shall be turned over until it has been mixed.

**30411.12**

The workability of the concrete shall be measured at least once every two hours or as directed by the Engineer.

**30411.13**

Concrete will not be accepted for inclusion in the Works unless its workability is within the following limits of that measured and approved for the relevant trial mix.

Slump	$\pm 25$ mm or $\pm$ one third of the required value, whichever is the greater;
Compaction	$\pm 0.03$ , where the required value is 0.90 or more; $\pm 0.04$ , where the required value is less than 0.90 but more than 0.80; $\pm 0.05$ , where the required value is 0.80 or less

The "required value" is the value for the approved design mix and all tests shall be in accordance with ASTM 1077.

**30411.14**

The workability of the first batch of concrete for every grade produced on any day shall be measured by the compaction factor test. Comparative slump tests shall also be taken.

**30411.15**

All plant shall be properly maintained to the satisfaction of the Engineer

**30411.16**

At all times batching and mixing shall be carried out by an experienced operator.

**30411.17**

Cement mortar shall, unless otherwise specified or ordered, consist of one part of cement to three parts of fine sand by volume, mixed and thoroughly incorporated together with just enough water to render it workable.

**30411.18**

Cement grout for general purposes shall consist of cement and water mixed in the proportion of one part by volume of cement and one and a half parts by volume of water. The grout shall be used within one hour of mixing.

**30412**  
**Transport and**  
**Placing**  
**Concrete**

**30412.1**

The concrete shall be discharged from the mixer and transported to the Works as quickly as practicable by means that shall be approved by the Engineer and which shall prevent adulteration, segregation or loss of ingredients, and ensure that the concrete is of the required workability at the point and time of placing.

**30412.2**

All concrete surfaces, formwork and reinforcement against which concrete is to be placed shall be properly prepared before mixing is commenced. Concrete droppings or grout shall be removed, reinforcement or metal items to be embedded or surrounded by concrete shall be free from any loose rust, mill scale or mould oil and other deleterious matter, and all surfaces against which concrete is to be placed shall be thoroughly cleaned. Formwork shall be free from standing water. The Contractor shall allow for and use mechanical or other means of removal of all foreign matter from these surfaces and provide all necessary temporary openings in the formwork for such removal. Concrete shall not be placed against concrete of a different designation until the concrete previously placed has properly hardened unless otherwise agreed by the Engineer.

**30412.3**

Concrete shall not be placed in any part of the Works until the Engineer's approval has been received. A system of inspection sheets shall be implemented for authorization by the Engineer and his nominated staff.

**30412.4**

If concreting is not started within 24 hours of approval being given, approval shall again be obtained from the Engineer. Concreting shall then proceed continuously over the areas between construction joints.

**30412.5**

The temperature of the concrete when deposited, shall not exceed 32°C. It shall be compacted in its final position within 30 minutes of discharge from the mixer.

**30412.6**

Unless otherwise agreed by the Engineer concrete shall not be dropped into place from a height exceeding 1.5 meters. When trunking or chutes are used they shall be kept clean and used in such a way as to avoid segregation.

**30412.7**

Concrete shall be placed in horizontal layers to a compacted depth not exceeding 450 mm where internal vibrators are used, or 300 mm in all other cases. Procedures for placing and compacting concrete in the Works shall be to the approval of the Engineer and shall be decided by the Contractor prior to commencement of concreting. Where concrete is to be placed in multiple layers, each layer shall be continuous and unless otherwise directed by the Engineer shall be placed and compacted while the concrete in the immediately underlying layer is still workable. When the concrete is placed in more than one layer, compaction of a layer shall extend into the underlying layer to

ensure there is no segregation between successive layers but care shall be taken to avoid any disturbance of partially set layers which have been previously placed. Over-vibration shall be avoided.

**30412.8**

If during concreting a previously placed layer or edge of concrete has set before a subsequent layer has been placed, concreting shall be stopped and the placed concrete cut back to a sound face at the Contractor's cost.

**30412.9**

Placement of concrete by pumping will be permitted only if authorized by the Engineer in writing after approval of a modified mix design and preliminary trials as specified.

**30412.10**

All concrete shall be compacted to produce a dense homogeneous mass. Unless otherwise agreed by the Engineer, it shall be compacted with the assistance of vibrators capable of transmitting frequencies of not less than 6000 cycles per minute and capable of imparting an acceleration of 69 to the concrete immediately in contact with them. Sufficient vibrators in serviceable condition shall be on Site so that spare equipment is always readily available in the event of breakdowns. Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. Internal vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity thoroughly to compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Where immersion type vibrators are used, contact with reinforcement and all inserts shall be avoided, so far as is practicable. Vibration shall not be used to make concrete flow in the forms over distance so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms. Concrete shall be compacted in its final position as soon as it is placed in the forms but no later than 30 minutes after being placed.

**30412.11**

Slabs may be compacted and screeded by a mechanically vibrated tamping beam of a type approved by the Engineer.

**30412.12**

Where concrete is conveyed and placed by mechanically pumped pressure, the equipment shall be suitable in kind and adequate in capacity for the work and shall be so arranged that no vibrations result which might damage freshly placed concrete. The operation of the pump shall be such that a continuous stream of concrete shall be ejected where it is to be used in such a manner that there will be no contamination of the concrete or separation of the ingredients. After completion of each concreting operation, the entire equipment shall be thoroughly cleaned.

**30412.13**

Water or cement grout used for wetting pump or placer delivery pipes shall not, under any circumstances, be discharged into formwork or other concrete containers. Water, cement grout, concrete residue or debris discharged from delivery pipes during unblocking or washing down operations shall not be directed into the freshly placed concrete.

**30412.14**

All plant used for placing and compacting concrete shall be kept clean and free from

coats of hardened concrete, grout or other obstructions.

**30412.15**

The Contractor shall provide adequate lighting, to the satisfaction of the Engineer, at such places where approval has been given for transporting or placing of concrete at night or where daylight is excluded or may be restricted during the concreting operations.

**30412.16**

During the placing of concrete, a competent steel fixer and carpenter shall be in constant attendance, so as to make any necessary adjustment or correction of the reinforcement and formwork.

**30412.17**

The Contractor shall take all reasonable precautions to prevent sea water or sea spray from affecting concreting operations. In areas likely to be so affected, the formwork shall be adequately protected and all parts which are found to be affected shall be thoroughly washed down with clean fresh water. Under no circumstances shall concrete be contaminated by salt water during placing.

**30412.18**

If concreting is suspended due to plant breakdown or for any cause, a stop-end shall be formed square to the work without delay. Should the period of suspension not exceed thirty minutes, concreting may be recommenced provided that the surface is first cleaned. The fresh concrete shall be tamped so as to be contiguous with the concrete previously placed, to the satisfaction of the Engineer. Should the period of suspension exceed thirty minutes no further concreting shall be carried out until the previously placed concrete has hardened and its surface has been prepared as a construction joint. Where the concrete is visible, such as in exposed faces of a retaining wall etc., it shall be cut back to a horizontal construction joint to the extent and in a manner approved by the Engineer before concreting is recommenced.

**30412.19**

A complete record shall be kept by the Contractor of the date, time and placing of all grades of concrete in each portion of the work and this shall be available for inspection by the Engineer at any time. The Contractor shall supply suitable maximum/minimum thermometers and record the ambient shade temperature adjacent to the concrete mixer and to all parts of the Works where the concrete is being placed. A record of the daily maximum and minimum temperatures during concreting shall be kept on Site and a copy shall be given to the Engineer each week during which concrete is placed.

**30412.20**

Unformed concrete surfaces shall be screeded floated or trowelled to produce the finishes shown on the Drawings and specified herein. Before the initial set takes place the surfaces shall be rescreeded, floated or travelled where necessary to close up cracks and prevent excessive bleeding.

**30413  
Construction  
Joints**

**30413.1**

The position and detail of any construction joints not described in the Contract shall be subject to the approval of the Engineer and shall be so arranged as to minimize the possibility of the occurrence of shrinkage cracks.

**30413.2**

The upper surface of lifts of concrete walls and columns shall be horizontal unless otherwise described in the Contract and if the formwork extends above the joint on the exposed face it shall be cleaned of adhering concrete before the next lift is placed.

**30413.3**

Horizontal construction joints shall be washed with a fine spray of water from a high pressure hose within two hours of the completion of placing to expose the aggregate. Care shall be taken to ensure that no disturbance or loosening of the aggregate, or cracks or other defects in the concrete are caused.

**30413.4**

Should the treatment of a construction joint by the methods described above not be satisfactory then the whole joint surface except for a strip 38 mm wide adjacent to exposed faces shall be scabbled to a depth of 13 mm.

**30413.5**

Immediately after the placing of concrete, all accumulations of mortar splashed on the reinforcing steel and the surface of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel bond at and near the surface of the concrete, while cleaning the reinforcing steel.

**30413.6**

The Contractor shall prepare and submit bay layout drawings and concreting schedules for the Engineer's approval in adequate time prior to preparation for concreting to enable any changes the Engineer may consider necessary to be made.

**30413.7**

Immediately before placing fresh concrete against faces of previously placed and hardened concrete, the surface of construction joints shall be thoroughly cleaned and wetted.

**30413.8**

Keyways shall be formed in all horizontal and vertical construction joints except where ordered to be omitted by the Engineer. Keyways shall be accurately formed to approved dimensions with formwork which will not be displaced during concreting.

**30414**

**Curing Concrete**

**30414.1**

All concrete shall be properly water-cured to the satisfaction of the Engineer. The concrete shall be protected from harmful effects of, for example, sunshine, wind, rain-fall, water and shock. All water for curing concrete shall be of mixing quality. Curing compounds will not be permitted except with the Engineer's approval and then only after the specified water curing has been satisfactorily carried out.

**30414.2**

For the top exposed surfaces of concrete substantially free from starter bars or other obstructions, every part of the exposed surface shall be covered with polythene or similar impermeable sheeting immediately after finishing. The sheeting shall be in direct contact with the concrete or as directed by the Engineer where some initial separation is necessary to obtain a particular surface finish. The sheets should overlap adjacent sheets at the edges, and they should be fixed down at the ends and edges, to prevent air circulating over the concrete.

**30414.3**

As soon as the concrete has stiffened sufficiently, and in any case after not more than 24 hours, the sheeting shall be removed and the surface, covered with wet hessian. The sheeting shall be replaced immediately to reduce evaporation from the hessian. Additional water should frequently be introduced under the polythene sheeting to keep

the hessian thoroughly and permanently wet. For top surfaces curing shall continue for not less than 28 days or such other time as the Engineer may direct.

**30414.4**

Horizontal surface (e.g. slabs or floors) shall be shaded from the sun by means of hessian or shade-netting on frames for 14 days after construction.

**30414.5**

On removal of the formwork to vertical surfaces the concrete shall be closely wrapped with wet hessian and enclosed with polythene sheeting. Battening shall be used to keep both hessian and polythene lightly in contact with the walls. The hessian shall be kept wet by frequent additions of water, and it shall be retained in position for not less than 28 days unless otherwise directed by the Engineer.

**30414.6**

On removal of the hessian and sheeting, the concrete shall be sprayed with an approved curing compound as soon as the surface dry.

**30414.7**

Walls facing the sun shall be shaded using hessian or shade-netting for 14 days after placing of concrete.

**30414.8**

Water spraying may be sparingly used with the approval of the Engineer for curing inaccessible areas, but great care shall be taken to prevent the cooling action of a water spray from causing sudden thermal contraction on warm concrete surfaces.

**30414.9**

Thermal insulation to large concrete pours shall be provided at the request of the Engineer.

**30414.10**

If the Engineer approves the use of a curing compound it shall be applied in the manner and at the rate recommended by the manufacturer. Where spraying equipment is used, it shall be maintained in a thoroughly clean condition and shall not be used for any material other than the approved curing compound. The curing compound shall be applied to the surface of the concrete as soon as water curing has been finished but any free water allowed to dry out before the compound is applied. Care shall be taken not to damage the surface during the application. If the period of drying out exceeds one hour, water curing shall continue until conditions enable the surface to be dried within 1 hour and the curing compound applied.

**30414.11**

Where a wetted absorbent covering is used, the Contractor shall ensure that the covering is kept continually damp and that in no circumstances shall alternate wetting and drying occur. The Engineer may prohibit the use of wetted absorbent covering where the surface being protected is likely to be cooled excessively by drying winds and in such cases, the Contractor shall submit alternative proposals to the Engineer for approval.

**30414.12**

The Contractor shall take steps to prevent any damage to newly cast surfaces. Suitable barriers and warning notices shall be erected to prevent access over concrete which has been recently placed, and no plant, equipment and the like shall be placed thereon

until the surface is hard enough to bear such loads without damage. Edges, corners and other areas shall be adequately protected against accidental damage.

**30414.13**

The Contractor shall submit details of the proposals for curing and protecting each section of the work for the approval of the Engineer before placing any concrete or any precast units are cast.

**30414.14**

Accelerated curing will not be permitted except where approved by the Engineer.

**30415  
Concrete  
Sampling,  
Testing and  
Control**

**30415.1**

Test cylinders size shall be taken from the concrete mixes and tested as specified to check that the concrete complies with the Specification. These tests shall be in accordance with JIS A 1108 and ASTM C-39 and ASTM C-192.

**30415.2**

The acceptability of the concrete shall be judged on the 28-day test results in accordance with JIS A 1108, ASTM C-39 and on the density and appearance of the concrete. Test results from 7-day old cylinders, or cylinders cured and tested in an approved accelerated testing program, may be used only as a guide or indication of the acceptability or otherwise of the concrete.

**30415.3**

The rate of sampling shall for the different uses of concrete be as follows:

Reinforced Concrete Rate 2

Mass Concrete Rate 3

**30415.4**

A set of six cylinders shall be made from each sample, two for testing at 7 days and four at 28 days. At least one set of cylinders shall be taken from concrete of each particular grade each day the concrete of that grade is used. The actual rate may be modified by the Engineer.

**30415.5**

The action to be taken should the concrete not be acceptable will depend on the circumstances and shall be in accordance with ASTM C-39. Should any 7-day or earlier test indicate that the concrete may fail to comply with the Specification, the Engineer shall be informed immediately. Props, falsework and other supports shall not be removed without the approval of the Engineer who may order further tests to be carried out at his discretion.

**30415.6**

Where the control tests specified above show that mix proportions should be modified, the Contractor shall give details of the proposed modifications to the Engineer for his approval together with details of the results of trials upon the new mix before the new mix is used in the Works. Failure to modify the mix proportions adequately to maintain the specified requirements of the concrete and early enough to permit trial mixes to be tested may result in an instruction by the Engineer to the Contractor requiring him either to use prescribed proportions until such time as agreement on a mix design is reached or to cease concreting operations. Any additional cost arising from modifications of mix proportions necessary to satisfy the requirements of the Specification or the temporary use of prescribed proportions, or as a consequence of any order to cease concreting operations or for any other reason shall be borne by the Contractor. The contractor shall be permitted no extension of time for delays resulting



from an order made under this clause.

**30415.7**

If additional tests are ordered by the Engineer over and above those specified herein, he shall direct the Contractor to carry them out.

**30416  
Precast  
Concrete**

**30416.1**

Precast concrete shall be lifted or supported only at points described in the Contract and shall be handled and placed without impact.

**30416.2**

Precast concrete units shall be fabricated with concrete of the specified class placed into a grout-tight mould. If so required the mould shall be laid on a vibrating table and vibration applied while the concrete is placed. In all other cases the concrete shall be compacted as required by other relevant clauses of this Specification.

**30416.3**

The contractor shall be responsible to provide a precast prestress slab plate as shown in the drawings, adequate to the superimposed loads also shown in the drawings. The Contractor shall submit shop drawings and installation methods for the Engineer's approval.

**30416.4**

The Contractor will be permitted to obtain precast concrete units from outside suppliers provided that they comply with the Specification and that the Contractor obtains the Engineer's approval for each supplier. Such supplier shall provide all those facilities for inspection by the Engineer required by this Contract for similar work on Site.

**30416.5**

The Contractor shall give the Engineer full details of his proposed methods of handling precast concrete piles, slabs and units. The Engineer will examine these details and will either approve the methods or order modifications designed to ensure that no excessive stresses are set up in the piles, slabs or units. Concrete shall at no time be subjected to loading, including its own weight, which will induce a compressive stress in it exceeding one third of its compressive strength at the time of loading or of the specified twenty-eight day strength.