2. EARTHWORK

2.1 General

This Chapter covers earthwork consisting of the following, but not limited to :

(1) Site Clearing, Grubbing and Stripping
(2) Demolishing of Existing Structures
(3) Excavation
(4) Excavation in Drainage Channel
(5) Excavation for Structures
(6) Bench Cut Excavation for Existing Levee
(7) Excavation for Connection Canal
(8) Earthfill
(9) Earthfill for Levee Embankment
(10) Earthfill for Inspection Road Embankment
(11) Dumpfill (Not Applicable)
(12) Backfill
(13) Filling-up of Abandoned Drains with Compacted Materials, if any
(14) Filling-up by Random Materials
(15) Soil Disposal
(16) Sodding
(17) Gravel Metalling
(18) Borrow Areas, if any

The Contractor shall prepare his plans, detailed working drawings and sequence of construction and submit to the Engineer for his review and approval at least thirty (30) days prior to such works being taken up as provided in Sub-clause G3.2 of Vol. III, Part I - General Specifications.

If the Engineer decides the excavated material is suitable for use in embankment and other works, it shall be stockpiled in appropriate areas for later use or hauled to and directly placed in permanent construction, as determined by the Engineer. Stockpiled material shall be smoothed to the lines and grades as directed by the Engineer.

Generally speaking, the unit prices for material excavated from the various construction sties shall include the cost of hauling it to and disposing it at designated spoil bank(s). Suitable material

excavated from the borrow area for use in constructing the levee embankment will be considered basically as embankment material and shall be priced as such.

2.1.1 Character of strata

The Contractor shall satisfy himself of the character of all earth works and ascertain for himself the character of the strata and materials to be excavated or filled.

The Constractor shall also satisfy himself as to the general conditions and circumstances at the site of the works, the obstructions thereon and therein, the form of any channel bed and banks, the flow of water in the drainage channels, the surface of the ground, the possible subsidence of soft ground and poor materials, likelihood of shrinkage and sliding of materials and possibility of floods.

The Contractor shall quote the unit prices in the Bill of Quantities according to his own view of the above, as no allowance will afterwards be made beyond the unit prices tendered in the Bill of Quantities which shall be inclusive of all the above mentioned circumstances.

The Contractor shall also take the risk of having in the excavations, slipping clay, running sand and gravel, subsoil and drainage water, springs, stones, trees, brushwood, timber and debris, obstructions of any kind and material of whatever nature may be encountered : and the unit prices in the Bill of Quantities shall cover these and all other contingencies.

2.1.2 Earthworks to lines, levels and grades

Whole of the earthworks for several parts of the Works shall be carried out to the dimensions and levels as shown on the Drawings, or to such other dimensions and levels as may be ordered by the Engineer. Dimensions, which are based on or related to ground levels, shall be referred to the Engineer before commencing earthworks at any location.

For the purpose of these Specifications, the term ground or channel bed level shall refer to the ground or the channel bed surface before the start of earthwork.

The Contractor shall be completely and solely responsible for setting out the position of the various structures on the ground and establishing an adequate number of bench marks and reference points. The topographical data shown on the Drawings are indicative only and the Contractor shall have to carry out any checking required and make any extra topographical survey which may be necessary. Should the Contractor find any discrepancy between the original surveys

and the new surveys he shall, therefor, inform the Engineer in writing. In such case, the Contractor shall carry out the survey in the presence of the Engineer, and the results obtained at that time shall be used in measurement of the Works.

2.2 Site Clearing, Grubbing and Stripping

2.2.1 Scope of work

When the removal of certain trees and shrubs may be required during the Contractor's operations, the Contractor shall remove such trees and shrubs after seeking prior approval of the Engineer. All trees and shrubs to remain in place shall be protected from damage. Where clearing is required, as in the right-of-way width, and borrow area outside the right-of-way, all combustible materials from clearing operations shall be burned or removed from the work sites or otherwise disposed of as directed by the Engineer.

All materials to be burned shall be piled neatly. Piling for burning shall be done in such a manner and in such locations as to cause the least fire risk. All burning shall be so thorough that the cleared materials are reduced to ashes. The Contractor shall at all times take special precautions to prevent fire from spreading to areas beyond the limits of the cleared areas and shall have available at all times, suitable equipment and supplies for use in preventing and fighting fires in accordance with the provisions of Clause G7.6 of Vol. III, Part I - General Specifications.

Grubbing will consist of the removal of the stumps, jungle growth, brush and rubbish from the work areas to be occupied by permanent structures, roads and canals and from the surface of borrow areas, stockpile sites and elsewhere as directed by the Engineer.

Stripping shall include removal of top soil and perishable or unsuitable material including the existing buildings, foundations, fences, structures and retaining walls, if any, which obstruct the Works. Stripping shall remove all such materials from the ground surface of foundations of the permanent structures, stock piles, borrow areas and sub-grades of the inspection roads, etc., as shown on the Drawings or otherwise directed by the Engineer. The stripping shall be made by a suitable manner employing equipment or tools and as directed by the Engineer. Transportation and disposal of the stripped material to the designated places shall be subject to the direction of the Engineer.

All timber cleared in the area, if marketable, shall remain the property of the Employer. The holes caused by removing the roots shall be backfilled with approved material and compacted in

accordance with the requirements for fill at the level concerned.

Before the commencement of site clearing, grubbing and stripping work, the Contractor shall carry out a survey in the presence of the Engineer or his authorized representative to precisely define the area and to set out the original ground lines within which the Work is to be executed and shall submit his drawings to the Engineer for approval.

2.2.2 Measurement and payment

Measurement, for payment, of site clearing, grubbing and stripping work will be made on the basis of the total designated surface area in square metres as determined by the original ground lines and design lines shown on the Drawings or as directed by the Engineer. The original ground lines shall be established by the Contractor by carrying out survey in the presence of the Engineer's Representative and submitted to the Engineer for his verification and approval prior to the execution of any site clearing, grubbing and stripping work.

Regardless of the quantities actually cleared, grubbed or stripped, measurement for payment shall be made to the prescribed lines, grades and levels and no payment shall be made for such work executed by the Contractor which is beyond the prescribed lines unless the same has been directed by the Engineer in writing.

Payment for site clearing, grubbing and stripping work shall be made at the unit price stated in the relevant items to the area in square metres as prescribed above and so certified by the Engineer in the Bi-Monthly Statement of Account. The unit price shall include all costs of equipment, tools, materials and manpower required to complete the works in all respects and subsequently to demobilize the same as directed by the Engineer.

2.3 Demolishing of Existing Structures

2.3.1 Scope of work

Demolishing works, inclusive of demolishing, chipping, hauling and disposing of the existing works, shall be made to the following structures, but not limited to:

(1) Levee embankment
(2) Parapet wall
(3) Drainage channel revetment

(4) Sluiceways
(5) Extension of existing sluiceways, if any
(6) Drainage connection canal and cross drains
(7) Relocation of irrigation canal, discharge pipe and distribution line, if any.

The Work shall also include the salvaging of designated materials and backfilling of the resulting trenches, holes, areas and depressions.

Before demolishing, the Contractor shall carry out a survey in the presence of the Engineer's Representative to measure the dimensions of the existing structure and submit the survey result to the Engineer for his verification and approval prior to execution of such demolishing.

The demolishing works shall be carried out carefully on the existing masonry parapet wall, revetments and concrete structures by chipping employing suitable hand tools in order to prevent any injuries and damage to the properties and materials neighbouring outside the working site. All costs incurred from such damage due to the Contractor's failure or negligence shall be borne by him. The damages to masonry, parapet wall, revetments and concrete shall be made good as satisfactory and acceptable to the owners at the Contractor's expense. The demolished material shall be disposed-off by the Contractor to the designated dumping yards or as directed by the Engineer.

Basements and cavities left by such removals shall be filled and compacted with acceptable material to the level of surrounding ground.

All designated salvageable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported by the Contractor and stored on specified places in the Project area as directed by the Engineer. All material recovered from demolition shall remain the property of the Employer, if marketable,

2.3.2 Measurement and payment

Measurement including demolishing, chipping, hauling and disposing of the existing structures will be made on the basis of the volume in cubic metres of the material demolished to the lines, grades and levels as shown on the Drawings duly certified by the Engineer.

Payment to the Contractor shall be made at the unit price per cubic metre stated in the Bill of Quantities to the volume as prescribed above and so certified by the Engineer on the Bi-Monthly

Statement of Account.

The unit price stated for the relevant items in the Bill of Quantities shall include all costs incurred from demolishing, chipping, hauling, salvaging and disposing including equipment, tools, materials, manpower, loading, unloading, transport, disposal and subsequent demobilization of the same as directed by the Engineer.

2.4 Excavation

2.4.1 Scope of work

The Contractor shall carry out all excavations other than dredging in whatever material may be encountered in accordance with these Specifications, Drawings or as directed by the Engineer. The Contractor shall provide and operate the equipment for all the necessary excavating, lifting, hauling and transport to deal with every kind of material. The whole of the excavation for the several works is to be carried out to such widths, lengths, depths and profiles as shown on the Drawings, or to such other dimensions as may be ordered by the Engineer in writing.

The Contractor may carry out the excavation by any method he considers most suitable subject to stipulations hereinafter or hereinbefore contained and approval of his proposed method by the Engineer.

All excavations are to be finished to the lines, levels and profiles shown on the Drawings or as directed by the Engineer. Except in so far as specifically provided, over excavation of the works beyond the dimensions shown on the Drawings shall be filled with selected material as ordered by the Engineer.

Where necessary the sides of all excavations shall be properly shored up and supported with struttings and plankings, and the sides shall be close sheeted where necessary to prevent the entry of running sand, mud, etc.

When any excavation has been carried out and trimmed, the Engineer shall be informed accordingly so that he may inspect the completed excavation. No excavation shall be filled-in or covered with concrete until it has been inspected by the Engineer and the Contractor has been authorized to proceed further with the work. Survey points, bench marks, boundary stones and other fixtures, if any, shall not be removed without the written approval of the Engineer. Such fixtures, if removed, shall be restored in their original condition and as directed by the Engineer at

no extra cost to the Employer.

During the progress of the work, the Engineer may find it necessary or desirable to vary the slopes, grades or the dimensions of the excavations from those specified herein and the Contractor shall not be entitled to any additional allowance above the unit prices tendered in the Bill of Quantities for excavation by reason of such changes. Any other open-cut excavation, performed at the option of the Contractor such as to secure access to the required work, for disposal of material excavated, or for any other purpose, shall be kept within the limits approved by the Engineer and shall be at the expense of the Contractor with no costs being charged to the Employer.

Following works shall not be measured and paid separately and the cost hereof shall be deemed to be included in the unit prices of various excavation items in the Bill of Quantities :

(1) Excavation either in the dry or in water and any dewatering which may be necessary.

(2) Excavation through any material to any depth unless stated otherwise in the Bill of Quantities.

(3) Trimming and, where necessary, benching the excavation to the correct profiles, lines and levels and compacting to receive concrete or other construction materials.

(4) Selecting excavated material proven to be unsuitable or suitable for use as embankment material and setting aside suitable excavated materials.

(5) Transporting excavated materials to spoil dumps or stock piles except as designated in the respective excavation work items in the Bill of Quantities including any special measures taken for such transportation due to existing access conditions.

(6) Removal of wooden groynes, if any, that might interfere with excavation profiles and subsequent re-driving of the same as directed by the Engineer.

(7) Any additional topographical survey required for completion of the Works including establishing secondary survey points.

2.4.2 Excavation beyond true line

If from any cause whatsoever excavations other than for concrete work are carried out beyond their true line and level other than at the direction of the Engineer, the Contractor shall at his own cost

make good to the required line and level with the approved material and in such a manner as the Engineer may direct.

If from any cause whatsoever excavation for concrete works are carried out beyond their true line and level other than at the direction of the Engineer, the Contractor shall at his own cost fill in to the required line and level with concrete similar in grade to that intended to be used in the true concrete work unless otherwise directed.

2.4.3 Unsuitable materials

Fill materials excavated from the drainage channels and drainage ditches which, in the opinion of the Engineer, cannot be compacted to the specific density as provided for in Sub-clause 2.9.2. hereinafter after breaking up, wetting or drying, shall be classified as "unsuitable materials". Unsuitable materials shall not be included in the embankment and shall be disposed of as specified in Sub-clause 2.15.1 hereof.

2.4.4 Transportation of excavated materials

The transportation of excavated materials to fill site or disposal of excess or unsuitable materials shall be carried out in accordance with the approved schedule of earthwork operation by the Engineer. The Contractor shall transport materials by the most appropriate route between excavation and dumping or the route directed by the Engineer. No separate payment shall be made for transportation of earth material up to and byond the distance specified in the excavation, of which the cost shall be included in the unit prices of appropriate excavation items.

2.4.5 Measurement and payment

Measurement, for payment, of each kind of material of excavation will be made on the basis of the volume in cubic metres as a solid mass prior to excavation as determined from the original ground lines and design lines as shown on the Drawings or as directed by the Engineer. The original ground lines shall be surveyed in the presence of the Engineer or his authorized representative and submitted to the Engineer for verification and approval prior to the start of excavation.

Regardless of the quantities actually excavated, measurement for payment shall be made to the prescribed lines, levels and grades and no payment shall be made for excavation or removal of materials by the Contractor which is beyond the prescribed lines unless such excavation or removal has been directed by the Engineer in writing.

Payment for the various items of excavation shall be made at the unit price to the sum calculated for the volume in cubic metre as prescribed above and so certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices stated in the relevant items in the Bill of Quantities shall include all costs incurred from all equipment, tools, materials and manpower required to complete the works in all respects and subsequent demolisation of the same.

All costs incurred by the Contractor from the correction or restoration of the works during the course of excavation of such works shall be borne by the Contractor and no claim for extra costs shall be considered by the Employer.

2.5 Excavation in Drainage Channel

2.5.1 Scope of work

The work covered under this Clause shall mean the excavation in a drainage channel, which is not be executed by means of a dredger.

It is scheduled that the soil excavated in the original ground of the drainage channel is used for levee embankment as practically as possible. The Contractor shall survey the borrow area in the channel, if designated, and submit his excavation programme along with drawings showing the location and extent of borrow areas, excavation lines, grades, levels and other dimensions and requirements for approval of the Engineer.

The area in which the excavation is carried out shall be site-cleared and surface-stripped in accordance with Clause 2.2 hereinbefore. After the surface soil is stripped, the soil material to be used for the levee embankment shall be excavated to the lines and grades as shown on the Drawings or as directed by the Engineer. Excavation shall be carried out in strict conformity to the requirements provided for in Clause 2.4 hereinbefore.

Excavation in the drainage channel shall generally be carried on from the downstream reaches to the upstream reaches to avoid flooding due to the occurrence of unexpected high water, and also carried on from the center of channel to the levee side to ensure the easy access for obtaining the fill material for levee embankment.

During the execution of excavation in the drainage channel, the Contractor shall fill up depressions located on the route of hauling the excavated materials. Where earth material from excavation

must necessarily be transported to the fill sites or stock piles with different haul distances, the cost of excavation shall include the transportation of fill material up to the distance designated in the relevant excavation items in the Bill of Quantities. No transport for distance greater than the above distance shall be separately measured and paid.

The excavated soil extracted from the drainage channel shall not be disposed of to the drainage channel, even if dredging is being executed downstream of the excavation. All excavated materials shall be placed in the designated stockpiles or disposal area alongside the levee separately depending on the suitability for its reuse as embankment material.

Special caution shall be given throughout the execution period for prompt removal of the construction equipment to safe places when there is an unexpected high water stage.

2.5.2 Tolerances

The excavated surface shall be finished to the lines and grades as shown on the Drawings or to other lines and grades as may be ordered by the Engineer. The dimensions of the cross-section on the completion of excavation in the drainage channel shall conform to the following tolerances :

Works	Tolerance from Designated Point
Excavated surface (except structure sites) and filling surface in depressions	-10 cm to + 10 cm in depth measured perpendicular to the surface
Excavated bed width of channel	zero to + 50 cm

2.5.3 Measurement and payment

Measurement and payment for the relevant items of works in the Bill of Quantities will be made in accordance with Sub-clause 2.4.5 hereinbefore. The unit prices stated in the Bill of Quantities shall include all costs incurred from equipment, tools, materials, fuels, electric power and manpower employed for the excavation, hauling and disposing to the stockpiles and/or fill sites.

All cost incurred from filling up depressions in the drainage channel located on the route of hauling the excavated materials shall be borne by the Contractor. No claims for such extra costs

shall be considered by the Employer.

2.6 Excavation for Structures

2.6.1 Scope of work

Excavation for structures shall include excavation of all soil, sand, gravel and boulder if any, stockpiling of soil fit for reuse and dumping of soil unfit for reuse to the designated places.

Excavation for structures shall be carried out in a safe manner and to the lines and levels shown on the Drawings or to such lines and levels as approved by the Engineer.

The base and side slopes of excavation against which concrete is to be placed shall be finished accurately to the dimensions shown on the Drawings or prescribed by the Engineer, and the surfaces so prepared shall be moistened with water and tamped or rolled with suitable tools or equipment for the purpose of securing firm foundations. If at any point the natural foundation material is disturbed during the excavation process or otherwise, it shall be compacted in place, or it shall be removed and replaced with suitable earth materials or concrete as directed by the Engineer at the expense of the Contractor.

When the foundation material is soft or otherwise unsuitable in the opinion of the Engineer, the Contractor shall remove the unsuitable materials to the dimensions as directed by the Engineer and fill in to the required lines and levels with approved material in a manner acceptable to the Engineer.

Trench excavation for concrete pipe, cross drains, drain pits and side drain ditches for the permanent roads shall be performed by the use of hand tools and/or approved mechanical equipment, in such a manner as to prevent shattering of the sides and bottom of the excavation.

2.6.2 Measurement and payment

Measurement and payment for the relevant items of work in the Bill of Quantities shall be made in accordance with Sub-clause 2.4.5 hereinbefore.

2.7 Bench Cut Excavation for Existing Levee, if any

2.7.1 Scope of work

Bench cut for the existing levee shall be made along the slope of the existing levee in order to ensure proper bond between the existing levee and the new levee to be constructed over it.

Bench cut excavation shall be made to the lines and grades as shown on the Drawings and as directed by the Engineer in such a manner as not to cause any cracks on the excavated surface of the existing levee. If cracks or other damages are caused, they shall be restored to the full satisfaction of the Engineer and all costs incurred from such restoration shall be borne by the Contractor.

After bench cut excavation, no bush, roots, sods or any other perishable or unsuitable materials shall be placed or left remaining on the bench cut excavated surfaces.

2.7.2 Measurement and payment

Measurement for bench cut for the existing levee will be made to the area in square metres in accordance with the lines, grades, dimensions and other requirements shown on the Drawings and/or area as prescribed above and so certified by the Engineer in the Bi-Monthly Statement of Account.

The unit prices stated in the relevant items in the Bill of Quantities shall include all costs of materials, equipment, tools and manpower required for excavation, loading, transporting, disposing of excavated materials as directed and all other items necessary for completion of the works.

2.8 Excavation for Connection Canal, if required

2.8.1 Scope of work

Excavation in the connection canal, if required, shall generally be carried out in accordance with Clause 2.4 hereof, and the work is to be executed in such a manner as to ensure that the side slopes, as shown on the Drawings, are not in any way endangered by under-cutting.

Soil excavated from the connection canal shall be placed temporarily alongside excavation sites at

designated places depending on the suitability of its reuse as fill material.

The transportation of fill material and disposal of unsuitable materials extracted from the connection canal shall be made in accordance with the respective provisions stipulated in Sub-clauses 2.4.4 and 2.15.1 hereof.

2.8.2 Measurement and payment

Measurement and payment for the relevant items of work in the Bill of Quantities shall be made in accordance with Sub-clause 2.4.5 hereinbefore. All costs incurred by the Contractor in complying with the requirements of the Sub-clause 2.8.1 shall be included in the respective unit prices stated in the relevant items in the Bill of Quantities. No claims for such extra costs shall be considered by the Employer.

2.9 Earthfill

2.9.1 Scope of work

Earthfill shall include procurement, loading and transportation of materials, unloading of materials, moisture control, placing, spreading, compaction and all other necessary works for construction of the embankments for levee and inspection roads and fillings in other parts of the works with suitable materials obtained from channel excavation and/or designated borrow areas.

Earthfill shall be preferably constructed during the dry season or during the periods of relatively low precipitation.

All embankments shall be constructed to the lines and levels shown on the Drawings or established by the Engineer. The materials for earthfill shall not contain any stump, brush, weed, root, turf, clod and other organic material that may decay. Clod of clay or other materials shall be broken apart and no accumulation at the foot of the side slopes of embankment will be permitted. The Contractor shall make due allowance for consolidation and settlement whether compaction is specified or not, such that the levels, widths and the dimensions of the finished surfaces at the end of the Defects Liability Period shall not be less than the levels and dimensions shown on the Drawings. This may be achieved by the Contractor by increasing the height of the levee by five (5) percent of the height prescribed on the Drawings. This arbitrary percentage increase in the levee height is only for the Contractor's guidance and the Employer shall in no way be responsible for any deductions or conclusions drawn from the same by the Contractor. The required increase in

height of the levee shall be governed by the prevailing site conditions and construction method and equipment deployed by the Contractor and the cost of all such allowances shall be deemed to be included in the unit prices of the earthfill.

2.9.2 Placing and compaction of material

Prior to the commencement of earthfilling, the Contractor shall carry out under the direct supervision and to the satisfaction of the Engineer a series of field tests to determine the optimum conditions of compaction and the minimum number of passes of each type of equipment required to compact to the specified dry density hereinafter for each type of fill material. The cost of carrying out such tests shall be deemed to be included in the respective unit prices for earthfills in the Bill of Quantities.

No fill material shall be placed when, in the opinion of the Engineer, satisfactory work cannot be done on account of heavy rain or other adverse conditions.

Material shall be spread in layers not exceeding thirty (30) cm in thickness before compaction, which shall be subject to the Engineer's determination upon the results of trial embankment tests.

The material obtaining and placing operations shall be such that the materials when compacted shall be blended sufficiently to secure the required dry density and sufficient impermeability and stability of the compacted fill. Moisture content of the embankment materials prior to and during compaction shall be maintained uniformly throughout each layer of the materials. If the surface of any layer of embankment is too dry or smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or scarified in an approved manner to provide a satisfactory bonding surface.

Fill material for levee embankment shall be compacted by means of approved compacting equipment to a density specified in Sub-clause 2.10.5 hereinafter.

The earthfill for other parts of the Works shall be carried out with the approved materials and compacting equipment, and the fill material shall be compacted to a density as directed by the Engineer.

In so far as practicable as determined by the Engineer, moistening of the material shall be performed at the site of stockpiles or borrow areas. Moistening shall be supplemented by sprinkling at the time of compaction, if necessary, and approved by the Engineer. If the moisture

content is beyond the suitable range, the operation shall not proceed except with the specific approval of the Engineer, until the material has been wetted or allowed to dry out within the required range of the moisture content. No adjustment in price shall be made on account of any delays occasioned thereby.

When the material has been conditioned as hereinabove specified and the surface has been scarified in an approved manner to bond subsequent layer, the new layer shall be compacted by the approved compacting equipment as the nature of the soil dictates to achieve at least the prescribed degree of compaction.

At the end of each day, or whenever operations are suspended by any reason, the surface shall be left smooth and slightly crowned to shed water.

2.9.3 Preparation of surface under embankment

No materials shall be placed on any portion of embankment foundations until such foundation has been cleared, stripped, suitably prepared and has been approved by the Engineer for placing fill. Test areas, trenches and cavities made by the removal of unsound foundation materials or for the inspection of sub-surface foundation shall be filled with selected materials.

Foundation material which does not have such density in an undisturbed condition as prescribed for the fill material shall be moistened and compacted by means of compaction equipment or shall be removed and refilled or shall be treated in a manner as directed by the Engineer.

The foundation surface under all embankments shall be scarified in an approved manner to provide a satisfactory bonding surface. This scarified foundation surface upon which compacted fill will be placed shall be moisture-conditioned immediately prior to placing of fill upon the surface to the same conditions as specified for compacted fill. If the placing of fill has been suspended, the surface of the fill shall be prepared as crowned shape before fill placing operations are resumed.

2.9.4 Fill adjacent to structures

Fill material adjacent to the structures shall be placed in such a manner as will ensure that they can be compacted without damage to the structures. Compaction adjacent to all structures shall be carried out by hand or by suitable hand operated equipment.

Unless otherwise specified, no fill material shall be placed and no compaction shall be permitted adjacent to concrete for fourteen (14) days after the placing of the concrete.

Compaction of backfilling material placed above buried concrete, however, shall not be permitted to be carried out with vibrating except with the prior approval of the Engineer.

2.9.5 Trial embankment

(1) General

The Contractor shall demonstrate to the Engineer the performance of equipment for controlling moisture, placing, spreading and compacting of the material by constructing a trial embankment.

(2) Scope of trial embankment

Trial embankment shall be carried out on the specified materials such as Types A, B and C stated under Sub-clause 2.10.1 for evaluating :

- The levee construction methods proposed by the Contractor,
- The effects of layer thickness,
- The effects of roller passing and compacting, and
- Other items deemed necessary by the Engineer.

(3) Schedule

The Contractor shall submit a schedule of trial embankment including laboratory tests to the Engineer for his approval at least two (2) months before the commencement of levee work.

In the schedule, the trial embankment including laboratory tests shall be scheduled to be finished at least five (5) days before the commencement of works.

(4) Required quantities of materials

The quantities of materials to be provided for trial embankment shall be as follows; or as directed by the Engineer :

- Type A : Two thousand (2,000) m^3
- Type B : Two thousand (2,000) m^3
- Type C : As directed by the Engineer

(5) Equipment

All equipment necessary for trial embankment shall be furnished by the Contractor. Unless otherwise approved by the Engineer, the compacting equipment shall be tamping roller type of ten (10) to twenty (20) ton class.

(6) Moisture control

Prior to the start of placing and spreading works, moisture content of trial embankment materials shall be adjusted to four (4) to five (5) percent dry side of natural moisture content or as directed by the Engineer.

(7) Field and laboratory tests

Field tests shall be carried out near the embankment site in the Project area. The conditions of tests are as follows unless otherwise directed by the Engineer.

- Spreading thickness : 20 cm and 30 cm for each material
- Passage of roller : 2, 4, 6 and 8 times
- Field density tests : 24 points
- Laboratory tests (Physical and compaction) : 2 cases each for each material

2.9.6 Moisture content adjustment

The moisture content of earthfill materials, prior to and during compaction, shall be distributed uniformly throughout each layer of material. As far as practicable, the material shall be brought to the proper moisture content in the excavation areas to ensure adequate compaction effect. Supplementary watering or drying may be carried out on the embankment, and such wetted or dried soil shall be thoroughly mixed to attain uniform moisture content distribution before compaction.

When each layer of material has been conditioned to have a moisture content in the required range, it shall be compacted by use of an approved compacting equipment as may be necessary to attain the specified compaction .

2.9.7 Soil tests

Tests on earth materials for use as embankment as well as on the compacted levee shall be performed by the Contractor at his expense by use of his laboratory and laboratory equipment, or by use of the existing laboratory approved by the Engineer, to determine and control the soil characteristics, suitability, moisture content, dry density/ moisture content relation, etc. All test results in the form of a report shall be prepared by the Contractor and approved by the Engineer. The tests performed by the Contractor prior to commencement of the earthwork, and every time when the soil characteristic changes, shall include the following :

(a) Compaction test
(b) Particle size distribution test
(c) Specific gravity test
(d) Moisture content test
(e) Dry density test
(f) Plastic limit test
(g) Triaxial shear test

The results shall be submitted to the Engineer for his approval.

The field moisture content and field dry density tests of the compacted earthfill will be made for each layer and every two thousand (2,000) m^3. The Contractor shall prepare the soil test programme according to the earthfill placement and operation schedule and shall submit it to the Engineer for approval.

Should test results prove that changes in the embankment material are necessary in order to obtain the prescribed compacted fill, these changes or obtaining of suitable material shall be at the Contractor's expense.

2.9.8 Finishing

Finishing of crest surface and slopes of the embankment shall meet the formation height and gradient as shown on the Drawings or as determined by the Engineer and tolerances allowable for

finishing shall be specified as follows :

- Variation in formation height measured at any point on the crest shall not be lower than the formation height (design levee crest).

- Gradient of both the embankment slopes shall not be steeper than the specified gradient and unevenness of the embankment slope shall not exceed ten (10) cm inwards and ten (10) cm outwards.

2.9.9 Measurement and payment

Measurement for earthfill will be made on the basis of the volume in cubic metres of each material placed and compacted within the lines, grades and dimensions of the design section as shown on the Drawings or as directed by the Engineer.

Unless otherwise approved by the Engineer in writing, no payment shall be made to the Contractor for material placed outside the limits of levee shown on the Drawings. The volume of extra embankment shall not be taken into account for measurement and payment.

All costs incurred from the embankment shall include obtaining, loading and transportation of fill material from borrow areas or stockpiles, preparation of surface under the embankment, unloading of the fill material at site and placing, moisture control, compaction and finishing including all equipment, tools, materials, manpower necessary for completion of the works and subsequent withdrawal of the same.

Payment for the works shall be made at the unit prices per cubic metre stated in the respective work Items in the Bill of Quantities to the sum calculated by the volume in cubic metre as prescribed above and duly certified by the Engineer on the Bi-Monthly Statement of Account.

The trial embankment including field and laboratory tests shall be made under the supervision of the Engineer and the cost incurred for the same shall be included in respective unit prices stated in the Bill of Quantities.

All costs incurred by the Contractor in complying with the requirements of this Clause including, scarifying of foundation surface before placement of earthfill, changes in the embankment construction method due to variations of fill material, etc. shall be deemed to be included in the respective unit prices stated in the relevant items in the Bill of Quantities and no claim for such

extra costs shall be considered by the Employer.

2.10 Earthfill for Levee Embankment

2.10.1 Scope of work

The Specifications of this Clause cover the construction of levee embankment to be newly constructed as well as heightening of the existing levee. The Contractor shall construct these levee embankments to the lines, grades and dimensions as shown on the Drawings, as directed by the Engineer and in accordance with these Specifications.

Based upon the material characteristics, levee material has been classified into Types A, B and C for this Project as shown in the table below :

Classification of Embankment Material

Type	Description of Levee Material
A	Material obtained in the drainage channel
B	Locally available material covered with Type C material
C	Material obtained from designated borrow areas

Two types of levee embankment are proposed, viz, homogeneous type comprising of only Type A material and zoning type comprising of both Type B and Type C materials.

2.10.2 Setting-out

The Contractor shall entirely be responsible for accurate setting-out of the works including staking of alignment of levee and reference pegs based on the information supplied on the Drawings and the instructions given by the Engineer in accordance with Chapter G5, Vol. III, Part I - General Specifications. The costs to conform to the requirements of this Clause shall be included in the unit price of the earthfill of levee embankment stated in the Bill of Quantities.

2.10.3 Site clearing and stripping of topsoil

The areas to be occupied by levee embankments including the slopes of existing levee to be heightened shall be cleared and stripped in accordance with Clause 2.2 hereof. All vegetation, tree stumps, organic materials and other obstructions shall be removed from the right-of-way area. Fences, buildings and structures designated for removal shall be disposed of or re-erected as directed by the Engineer. All cleared materials shall be disposed off in accordance with Clause 2.15 hereof.

2.10.4 Preparation of surface under levee embankment

Foundation on which levee embankments are to be placed shall be prepared generally in accordance with Sub-clause 2.9.3 hereof, and no materials shall be placed on any portion at the foundations until such foundation has been approved by the Engineer for placing fill. Test areas, trenches and cavities made for removal of unsound foundation materials or for inspection of sub-surface foundation materials shall be filled with selected material and properly compacted.

The slopes of the existing levee to be heightened, on which the fill materials are placed, shall be bench-cut with the dimension of thirty (30) cm in vertical and of more than sixty (60) cm in horizontal lengths, to prevent sliding of new filled materials.

2.10.5 Placing and compaction of materials

Material to be used for levee embankment shall generally conform to the requirements of Sub-clauses 2.9.1 and 2.9.5 hereof.

Material for levee embankment shall be obtained from adjacent drainage channel excavation materials or from the designated borrow areas or as approved by the Engineer. Fill materials obtained from the above shall be placed and compacted in accordance with the following specifications :

(1) Fill material shall be placed in layers not exceeding thirty (30) cm in thickness before compaction as specified under Sub-clause 2.9.2 hereinbefore. Each layer shall be spread out approximately fifty (50) cm beyond the design lines shown on the Drawings so that the portion of embankment near the side slopes is properly and sufficiently compacted. The levee portion thus provided beyond the design lines shall be subsequently removed and trimmed to the lines and grades as shown on the Drawings or as directed by the Engineer.

All costs incurred from said works shall be deemed to be included in the unit price for earthfill stated in the Bill of Quantities and no extra payment for the same shall be made to the Contractor.

(2) Compaction shall be carried out by means of approved compacting equipment such as tamping roller of ten (10) to twenty (20) ton class so as to obtain a dry density of not less than ninety (90) percent of the maximum dry density for types A and B materials, and ninety three (93) percent for type C material, measured at the wet side of the optimum moisture content.

(3) The number of passes required for the compacting equipment shall be determined based upon the test results of trial embankment stipulated under Sub-clause 2.9.5 hereinbefore.

Except in so far as approved by the Engineer, however, the subsequent filling made on the embankment constructed shall not be permitted until adequate foundation conditions are achieved.

During the execution of the work, the Contractor shall take care of the embankment completed at each stage. The Contractor shall not be relieved for this work from any obligation and responsibility under the Contract up to the issuance of the Certificate of Satisfaction. The cost of earthfill for levee embankment of this Clause shall include the allowance for such care of the works.

2.10.6 Finish to embankments

The Contractor may elect to construct the embankment over-size and finally trim back to the designed section but no specific payment shall be made for this operation and cost thereof shall be included in the unit price for earthfill of levee embankment.

The finished surfaces of the top crown and side slopes of the levee embankment shall present an even and neat appearance. Sod facing shall be placed thereon in accordance with Clause 2.16 provided hereunder.

2.10.7 Tolerances in embankment dimensions

Unless otherwise specified, no point on the surface of the completed levee embankment shall be more than the under-mentioned distance from the designated surface. Should the levee embankment be formed beyond the specified allowances at the time of the Certification of

Completion provided for in Clauses 48 (1) and 48 (2) of Vol. II - General and Special Conditions of Contract, the Contractor shall establish the specified or such other section as the Engineer may direct without additional payment.

The Contractor shall make due allowance for consolidation and settlement of embankment, such that the levels, widths and dimensions of the finished surface at the end of the Defects Liabilitity Period shall not be less than the levels, widths and dimensions shown on the Drawings. The cost of all such allowances shall be included in the unit price of levee embankment.

All tolerances shall be within the limits specified in the table given below :

Tolerances for Levee Embankment

Description (Designated Point)	Tolerance from
Surface levels (Centre of levee)	- 5 cm
Top width of embankment	- 10 cm
Deformation perpendicular to slope	- 10 cm

2.10.8 Measurement and payment

Measurement and payment for both types of levee embankment will be made on the basis of volume in cubic metres of each material placed and compacted within the lines, grades and dimensions of the design section as shown on the Drawings or as directed by the Engineer. Such measurements shall further, be based upon the ground surface obtained after stripping and the design section shown on the Drawings and the method approved by the Engineer.

Payments for Items of levee embankment for the two types of levee shall be made at the respective unit prices per cubic metre stated in the Bill of Quantities. These unit prices shall include the cost incurred from all plants and equipment, tools, fuel and electric power, materials and manpower required for completion of levee embankment work including preparation of surface under embankment, spreading and compaction of embankment material, finish to the embankment, allowance for consolidation and settlement of levee embankment, etc. Payment for the levee embankment shall be made to the actual volume of fill materials in cubic metre as determined and certified by the Engineer in the Bi-Monthly Statement of Account.

No separate payment shall be made for preparation of surface under embankment, and stockpiles, spreading and compaction of the fill material, finish to the embankment and allowance for consolidation and settlement of levee material up to the Certificate of Satisfaction and no such claim shall be considered by the Employer.

2.11 Earthfill for Road Embankment

2.11.1 Scope of work

The Specifications of this Clause cover the construction of the road embankment including approach ramps. The work comprises obtaining, loading and transporting material from borrows areas or stockpiles, unloading fill material at site, the supply of all manpower, materials and Construction Plant and Equipment, and the performance of all earthworks for the road embankment in accordance with the Drawings or direction of the Engineer.

The Contractor shall be entirely responsible for setting-out the alignment of the road embankment. After setting-out the alignment, the site clearing and stripping shall be made in accordance with the requirements provided for in Clause 2.2 hereinbefore. The earthfill shall conform to the requirements of Clause 2.9 hereinbefore.

The works of the road embankment shall be performed in parallel with the progress of bridge and levee embankment to be constructed alongside them.

2.11.2 Measurement and payment

Measurement and payment for the relevant items of work stated in the Bill of Quantities will be made in accordance with Sub-clause 2.9.9 hereinbefore.

All costs incurred by the Contractor in complying with the requirements of Sub-clause 2.11.1 hereof shall be included in the respective unit prices stated in the Bill of Quantities. No claims for such extra costs shall be considered by the Employer.

2.12 Backfill

2.12.1 Scope of work

Backfill shall be carried out on the front and the side of outlying structure and elsewhere as shown

on the Drawings or as directed by the Engineer, with approved materials complying with the Specifications for earthfill provided for in Clause 2.9 hereinbefore. For the backfill to be provided around the sluiceways, the elevation of original ground lines which form part of the levee, materials and all other related works shall conform to the applicable requirements of Clause 2.10 hereinbefore. The backfill shall be compacted after placing fill material in continuous horizontal layers not more than thirty (30) cm in height. Unless otherwise specified, placing and compaction of any backfilling materials shall conform to the applicable requirements of Sub-clause 2.9.2 hereinbefore.

Prior to the commencement of placing backfill material adjacent to structures, the place shall be cleaned of all remaining forms for concrete and other temporary works. Compaction shall be made in such a manner as will ensure that filling material can satisfactorily be compacted without damage to the structures by means of the approved equipment. The backfilling material shall be watered or allowed to dry in order to maintain or achieve the prescribed moisture content for compaction. The cost of such watering or drying out shall be covered by the unit prices for backfill stated in the Bill of Quantities.

Unless otherwise provided for in the Specifications or directed by the Engineer, backfill materials shall be placed and compacted at least fourteen (14) days after the placing of concrete.

2.12.2 Free draining backfill

Free draining backfill shall be placed to the lines and dimensions as shown on the Drawings or as directed by the Engineer.

The materials to be used for free draining backfill shall be selected pervious material which is well graded with a maximum rock size of fifteen (15) cm and shall not contain more than five (5) percent, by mass, of material passing a 0.074 mm mesh sieve as stipulated in JIS Z-8801or approved equivalent. Fragments larger than fifteen (15) cm may be used if approved by the Engineer, provided that such fragments shall be evenly distributed in the backfill.

The material shall be handled and placed in such a manner as to prevent segregation. The method of placing free draining backfill shall be subject to approval by the Engineer. Free draining backfill shall be placed wet in approximately horizontal layers not more than thirty (30) cm before compaction and thoroughly compacted by an approved method to sixty (60) percent of relative density or to the satisfaction of the Engineer.

2.12.3 Random backfill

Random backfill shall be placed to the line and dimensions as shown on the Drawings or as directed by the Engineer. The materials to be used for random backfill shall be all classes of disposed or excavated materials available at all in-place. The quality of such materials shall be approved by the Engineer and shall be free from any organic matter or other objectionable material such as large clods of stones, boulder, etc.

The material shall be handled and placed in such manner as to achieve favorable compaction and density. The method of handling, placing, moisture controlling and compacting random backfill shall be subject to the approval of the Engineer.

2.12.4 Measurement and payment

Measurement and payment for the relevant items of work in the Bill of Quantities will be made in accordance with Sub-clause 2.9.9 hereinbefore.

All costs incurred by the Contractor in complying with the requirements of Sub-clause 2.12.1 hereof shall be included in the respective unit prices stated in the Bill of Quantities and no claims for such extra costs shall be considered by the Employer.

2.13 Filling-up of Abandoned Drainage Channel with Compacted Material, if any

2.13.1 Scope of work

For new channel construction work, abandoned portion of the canal shall be filled-up with approved materials and compacted to the lines, levels and grades as shown on the Drawings or as directed by the Engineer. Such filling with compaction shall be carried out under the levee foundation as shown on the Drawings or as directed by the Engineer.

Material for the filling-up shall comply with the requirements of earthfill provided for under Clause 2.9 hereinbefore and it shall be placed and compacted to the same degree as the levee embankment.

2.13.2 Measurement and payment

Measurement and payment for Items of filling-up of the abandoned drainage channel in the Bill of

Quantities will be made in accordance with Sub-clause 2.9.9 hereinbefore.

All costs incurred by the Contractor in complying with the requirements of Sub-clause 2.13.1 hereof shall be included in the respective unit prices stated in the Bill of Quantities and no claims for such extra costs shall be considered by the Employer.

2.14 Filling-up by Random Materials and Dump-fill

2.14.1 Scope of work

Space created between the compacted fill placed under the levee as prescribed in Sub-clause 2.13.1 hereinabove shall be filled-up by random material as shown on the Drawings or as directed by the Engineer.

Dump-fill shall include procurement, loading, transportation, and dumping of materials in water, spreading, compacting and all other necessary works for construction of the embankments for levees and inspection roads as shown on the Drawings and filling in other parts of works as directed by the Engineer with suitable random materials obtained from the channel excavation and/or designated borrow areas.

Random materials shall be dumped into the designated space enclosed by bamboo mats and wallings together with bamboo piles by means of tipper trucks or any other earth moving or dumping equipment such as bulldozers. Care shall be taken not to damage the compacted backfill, levee or any other structure during course of dumping of the materials.

The materials shall not contain any stump, brush, weed, root, turf, clod and other organic materials that may decay. Dumped material shall be spread by means of bulldozer so as to give a sightly appearance.

The works shall be preferably made during the dry season or during the periods of relatively low precipitation.

The Contractor shall submit a schedule for the trial embankment to the Engineer for his approval at least two (2) months before the commencement of dump-fill work, and shall demonstrate to the Engineer the performance of equipment for dumping, spreading and compacting of the random material by constructing a trial embankment in water.

The damp-fill, when prepared rapidly in relation to laying the random material, is liable to deterioration, and in such case the Contractor shall, without additional payment, repair, reroll or recompact the levee embankment as may be necessary to restore it to the state designated by the Engineer.

If, in the opinion of the Engineer, the rolled surface of a layer of material in place is too wet for proper compaction of the layer of material to be placed thereon, it shall be dried or be worked in place with a harrow, scarifier, or other suitable equipment to reduce the moisture content to the required amount. It then shall be recompacted before the next succeeding layer of material is placed.

2.14.2 Measurement and payment

Measurement for the filling-up by random material and dump-fill will be made to the volume in cubic metres of the fill material placed at the designated locations shown on the Drawings and duly certified by the Engineer.

Payment shall be made in accordance with Sub-clause 2.9.9 hereinbefore, at the unit price stated in the Bill of Quantities so certified by the Engineer in the Bi-Monthly Statement of Account. All costs incurred by the Contractor including equipment, tools, materials and labours required for completing the works shall be included in the unit price stated in the Bill of Quantities and no claims for such extra costs shall be considered by the Employer.

2.15 Soil Disposal

2.15.1 Scope of work

Excavated material from the work selected by the Engineer for reuse is to be placed directly in its final position or stockpiled on the Site as directed by the Engineer.

Soil unfit for reuse or surplus excavated materials shall be disposed of in the designated disposal areas located at Teluknaga area in Tangerang region as shown on the Drawings or other places as directed by the Engineer. The Contractor shall trim and regulate the spoil tips to profiles of the designated heights and levels approved by the Engineer. The Contractor shall also maintain without interruption the flow of water courses affected by such spoil tips and he shall observe any arrangement concerning the site, arising between the Engineer and the persons or authorities concerned.

Location changes, or additions, to the disposal area for the Contractor's own convenience shall be made at the Contractor's expense subject to approval of the Engineer.

The Contractor shall submit proposals to the Engineer for approval for disposing of materials at any area other than previously approved areas and for the protection of these materials from erosion, at least thirty (30) calendar days prior to the commencement of hauling material to the area.

2.15.2 Measurement and payment

Cost incurred by the Contractor in complying with the requirements of this Clause shall be deemed to be included in the unit prices of respective excavation work items stated in the Bill of Quantities and no extra payment for the same shall be considered by the Employer.

2.16 Sodding

2.16.1 Scope of work

To protect the slope susceptible to damages by rainfall or stream water, sod facing shall be provided as shown on the Drawings or as directed by the Engineer. Sod squares used for the slope protection shall be fresh, dense and well rooted and the length of any of the cut sod piece shall not be shorter than twenty (20) cm.

The work consists of preparing, cutting, hauling and placing of topsoil and sod squares, and maintaining the slopes in order that the grass grows normally and uniformly.

The Engineer will inspect and approve topsoil and sod source. It is necessary that sod and topsoil are not separated from each other during cutting and hauling. The transplant of sod shall be done within twenty four (24) hours after its cutting and it can be stored only if the Engineer approves it. Storing and hauling of sod shall be done in such a way that two sod surfaces or two earth surfaces shall be always in contact. If sod squares prior to cutting are dry, they shall be sufficiently watered. Neither sod squares of poor quality and in bad condition nor sod squares containing weeds or unsuitable grass shall be accepted.

All areas to be covered with sod shall be fine graded to a uniform surface and shall be loosened to a depth of three (3) cm below surface. Sod squares shall be placed next to each other. After

placing them, they shall be compacted in order to avoid the creation of voids which may cause the loosening of sod due to rainfall. After compaction, gaps between sod squares shall be filled with sod and topsoil of good quality.

The Contractor shall be responsible for maintenance and cleaning of the sod faced areas until sod reaches a normal and uniform growth, and thereafter, until a Certificate of the Satisfaction of the whole Works is issued by the Engineer. The Contractor shall replace, at his own cost, any damaged area where sod has dried up or has not rooted to slope surface, which contains undesirable plants, or which has an irregular or unattractive appearance in the Engineer's opinion.

2.16.2 Measurement and payment

Measurement for payment will be made on the placed area in square metres to the lines, grades and dimensions as shown on the Drawings or as directed by the Engineer.

Payment shall be made at the unit price per square metre stated in the Bill of Quantity. The unit price shall include the cost of all equipment, material and manpower including supplying, cutting, transporting, planting the sod and maintaining it up to the issue of Certificate of Satisfaction. Payment shall be made to the area measured as prescribed above and certified by the Engineer in the Bi-Monthly Statement of Account.

2.17 Gravel Metalling, if any

2.17.1 Scope of work

All the road and levee ramps shall be surfaced with gravel with a minimum compacted thickness of twenty (20) cm placed over a ten (10) cm thick sand bedding.

Material used for road surfacing shall be crushed aggregates having appropriate gradation as metalling material duly approved by the Engineer. The material shall be free from lumps or balls of clay, organic matter, objectionable coatings or other foreign matters.

The surfacing material shall be free from flat and elongated particles, and generally, particles of the material shall be spherical or cubical in shape. The maximum size of the material shall be forty (40) mm, and the material shall be graded down to zero. The quality and gradings of the material shall be subject to the approval of the Engineer.

The gravel surfacing when thoroughly compacted, shall conform to the grades and dimensions shown on the Drawings or otherwise established by the Engineer. Depositing and spreading the material shall commence at the point farthest from the point of loading and shall progress continuously without breaks, except as otherwise directed.

Rolling of the material shall be performed under the direction of the Engineer with road rollers which shall be subject to the approval of the Engineer.

2.17.2 Measurement and payment

Measurement of gravel surfacing for roads, ramps and other areas will be made by cubic metres of gravel surfacing materials placed and compacted in accordance with the Drawings and these Specifications or as directed by the Engineer.

Payment shall be made at the unit price per cubic metre stated in the Bill of Quantities. The unit price shall include the cost of obtaining the material, processing if necessary, loading, transporting, unloading, placing, compacting and all incidentals thereto for completing the work. Payment shall be made to the volume of material as prescribed above and as determined and certified by the Engineer in the Bi-Monthly Statement of Account.

2.18 Borrow Areas

2.18.1 Scope of work

All materials required for the levee embankment construction, all kinds of backfill including filling-up of the depressed land and earthfill for the road which are not available from the drainage channel excavations or not suitable for permanent construction under these Specifications, shall be obtained from the designated or approved borrow areas located at Serpong in Tangerang region, about 20 km far from the Project site. The location of the borrow areas are shown on the Drawings of Volume IV of the Tender Documents. The earthfill material may be purchased from the licensed suppliers.

With the exception of earthfill material intended to be purchased by the Contractor from the said suppliers, the materials shall be obtained from suitable borrow areas approved by the Engineer.

The Tenderers and the Contractor must assume all responsibility for quality concerning the nature, moisture content, and texture of material, the percentages of oversize materials, the total yield of

suitable materials, the difficulties of making excavations, of breaking down or removing the oversize materials, of obtaining a satisfactory moisture content, and obtaining a uniform mixture of materials.

Some borrow areas will be open for inspection and the Tenderers should inspect the borrow areas and examine the test pits during the Site visit. The Tenderers are urged to sample and test material from borrow areas prior to submitting his Tender.

The type of equipment used and the Contractor's operations in the excavation of materials in borrow areas shall be such as will produce the required uniformity of mixture of each of the types of the materials at the borrow areas.

The location and extent of all borrow areas shall be proposed by the Contractor who shall submit his excavation programme along with necessary drawings prepared on the basis of his surveys and the Engineer reserves the right to change the limits of the borrow areas in order to obtain the most suitable material, to minimize stripping, or for other reasons.

To avoid the formation of pools in the borrow areas during the excavation operations, after the excavation operations are completed, drainage ditches from the borrow areas to the nearest outlets shall be excavated by the Contractor where, in the opinion of the Engineer such drainage ditches are necessary.

2.18.2 Roads, buildings and utility lines in borrow areas, if any

Roads, buildings, and other utility services in the Project area, if any, shall be relocated by others or by the Contractor as directed by the Engineer. Prior to the relocation of the road, the Contractor shall not excavate materials within twenty (20) m of the centreline of the road. The Contractor shall conduct his operations in such a manner as to permit continuous use of the road and to provide safety to the public until such time as the road has been relocated. The Contractor shall permit access as necessary to others for the purpose of relocation of this road.

The buildings located in the borrow areas will be disposed of by others. Prior to disposal of the buildings, they shall be protected from damage from the Contractor's operations. The Contractor shall permit access as necessary to others for the purpose of disposal of these buildings.

Power lines, pipelines, telephone lines, etc, traversing the borrow areas, if any, and as shown on the Drawings will be relocated by others or by the Contractor as directed by the Engineer. Prior to

relocation of the utility lines, the Contractor shall not excavate material within twenty (20) m of the centreline of any pipe, power, or telephone lines. The Contractor shall conduct his operations in a manner to prevent any interference with or damage to the utility lines and to permit access as necessary to others for the purpose of relocation of these utility lines.

2.18.3 Moisture and drainage, if any

The moisture content of the earthfill material prior to and during compaction shall be in accordance with Sub-clause 2.9.6 hereinbefore. As far as practicable, the material shall be conditioned in the borrow ares before excavation. If required, moisture shall be introduced into the borrow areas for the earthfill material by irrigation at least seven (7) days in advance of excavation operations. When moisture is introduced into the borrow areas for earthfill material prior to excavation, care shall be exercised to moisten the material uniformly to produce the required moisture content during compaction, avoiding both excessive runoff and accumulation of water in depressions. The Contractor is cautioned to control carefully the application of water and check on the depth and amount of water penetration during application so as to avoid over-irrigation.

If at any location in the borrow areas for earthfill material, before or during excavation operations, there is excessive moisture, as determined by the Engineer, steps shall be taken to reduce the moisture by selective excavation to secure the drier materials, by excavating and placing in temporary stockpiles material containing excessive moisture, by excavating drainage ditches, by allowing adequate additional time for curing or drying, or by any other approved means.

Borrow areas for sand material, if any, will not require preconditioning by irrigation but may require preconditioning by draining and lowering the water level below the elevation of the borrow excavation. (Preconditioning by draining may be accomplished by any approved method, including lowering the water level in the borrow area prior to excavation or stockpiling). If, after excavation, sandfill material has a moisture content greater than that required for placement and compaction in embankment, the material shall not be placed on the embankment, but shall be placed temporarily in stockpiles and allowed to drain or dry until the moisture content is reduced sufficiently to permit it to be placed in the embankment.

In any event, the Contractor will be required to excavate sufficient suitable material in portions of the borrow areas to complete the work under these Specifications, regardless of whether overly wet conditions encountered are due to ground water, precipitation, difficulty of draining, or any other reason. To minimize operations with overly wet material, the Contractor will be permitted to

utilize portions of the borrow areas which contain dry material and which have been designated as suitable borrow areas to the greatest extent practicable consistent with obtaining suitable material.

The Contractor shall not be entitled to additional payment beyond the unit prices stated in the Bill of Quantities on account of the requirements for excavating drainage ditches; for allowing additional time for curing or drying; for stockpiling and re-handling excavated materials which have been deposited temporarily in stockpiles; delays or increased costs due to stockpiling; poor trafficability in the borrow area, the haul roads, or the embankment; reduced efficiency of the equipment that the Contractor elects to use; or on account of any other operations or difficulties caused by overly wet materials.

No additional payment beyond the unit prices stated in the Bill of Quantities shall be made because of variation in the proportion between wet and dry material which is required to be excavated in order to obtain adequate suitable material.

2.18.4 Stripping and waste, if any

Borrow areas shall be cleared and stripped as provided in Clause 2.2 hereinbefore. Borrow areas may be designated by the Engineer as the work progresses, and stripping operations shall be limited only to designated and approved borrow areas. The Contractor shall carefully strip the designated borrow areas of boulders, topsoil, sod, loam, and other matter which is unsuited for the purposes for which the borrow area is to be excavated. The Contractor shall maintain the stripped surfaces free of vegetation until excavation operations in the borrow area are completed and the Contractor shall be entitled to no additional allowance beyond the unit prices stated in the Bill of Quantities because of this requirement. Materials from stripping which are suitable for topsoil shall be selected during stripping operations, temporarily stockpiled adjacent to borrow areas, if necessary, and spread on the suitable portions of the borrow areas as directed by the Engineer.

If materials unsuitable or not required for permanent construction purpose are found in any borrow areas, such materials shall be left in place or excavated and wasted, as directed by the Engineer. Where excavation of such material is directed, payment for such excavation and disposal of unsuitable or excess materials shall be included in the unit price per cubic metre stated in the Bill of Quantities for excavation.

2.18.5 Excavation and transportation

The Contractor shall excavate all parts of the borrow areas based upon the approved excavation

plan.

The earthfill materials delivered on the embankment site shall be equivalent to a mixture of materials obtained from an approximately uniform cutting from the full height of the designated face of the borrow excavation. Shallow cuts will be permitted in the borrow areas if unstratified materials with uniform moisture content are encountered. The Contractor shall load, transport and unload the materials to the embankment sites designated by the Engineer.

The Contractor shall be entitled to no additional payment beyond the unit prices stated in the Bill of Quantities on account of the designation by the Engineer of various portions of the borrow areas from which materials are to be obtained, on account of the depths of cut which are required to be made, or on account of the zone or location on embankment where materials are hauled.

2.18.6 Measurement and payment

No separate payment shall be made for obtaining, loading and transportation of fill material from the borrow areas and these costs shall be included in earthfill or embankment works. Payment will be made in accordance with Sub-clause 2.9.9 hereinbefore.

All costs incurred by the Contractor in complying with the requirements of Clause 2.18 hereof shall be included in the respective unit prices for earthfill or embankment works in the Bill of Quantities. No claims for such extra costs shall be considered by the Employer.

3. CONCRETE WORK

3.1 General

These Specifications apply to all concrete works and materials in connection with mass and reinforced concrete of structures which the Contractor shall provide for the fulfillment of his obligations.

All concrete works shall be performed as stipulated in these Specifications and as shown on the Drawings or as directed by the Engineer. The concrete works shall be carried out in the presence of the Engineer or the Engineer's Representative.

Not later than thirty (30) days prior to the installation by the Contractor of any Construction Plant and Equipment to be used for the processing, handling, transporting, storing and proportioning of concrete ingredients as well as for the mixing, transporting and placing of concrete and mortar, the Contractor shall submit flow charts, drawings and written descriptions to the Engineer to allow the full and proper assessment of his plans for the producing and placing of the concrete and mortar to be incorporated in the Permanent Works under the Contract.

After being installed, the operation of the plant, equipment and storage facilities shall be at all times subject to the approval of the Engineer.

If the Contractor intends to procure ready mixed concrete and mortar from manufacturers, the Contractor shall inform the Engineer in writing, at least thirty (30) days before commencement of concrete works, of his intention with detailed descriptions regarding the manufacturer's or supplier's name, location and capacity of his concrete plant and processing equipment, reputation and reliability of his products and others for the approval of the Engineer.

Without the approval of the Engineer, the Contractor shall not operate his plant and equipment of concrete processing and/or procure and purchase the ready mixed concrete from manufacturers or suppliers.

All proper precautions for safety and security shall be taken by the Contractor in accordance with the provisions stipulated in Sub-clauses G7.5 and G8.3. (15) of Vol. III, Part I-General Specifications. The Contractor shall not discharge directly disposal water from concrete placing and curing containing suspended and sediment matter into the existing drainage channels and

drain ditches in the Site.

Approval of plant and equipment or their operation, or of any construction procedure, shall not operate to waive or modify any provisions or requirements contained in these Specifications governing the quality of the materials or the finished work.

The Contractor shall not be entitled to any additional payment over the unit prices tendered in the Bill of Quantities for concrete by reason of any limitations in the batching, mixing, transporting and placing of concrete required under the provisions of these Specifications.

Prior to the commencement of concrete works, the Contractor shall establish at the construction site a laboratory furnished with required equipment and instrument necessary for performing day to day and routine tests. The Contractor shall operate and maintain the laboratory as directed by the Engineer during the Contract period and shall employ qualified supervisor and laboratory assistants to carry out the specified tests.

3.2 Cement and Admixtures

3.2.1 Cement

Cement used in the Works shall have a quality equivalent to that of Portland cement, ordinary type, as specified in No. 8 of JIS R 5210 and/or SNI 2049-90-A or ASTM Designation C 150, and/or as approved by the Engineer.

Prior to any cement being ordered, the Contractor shall inform the Engineer of the details concerning the type of cement to be purchased. Cement shall be delivered to the Site along with the manufacturer's quality and testing certificates. Upon receipt thereof, such certificates shall be submitted to the Engineer.

The Contractor shall provide adequate handling and storage facilities for the cement. Metal storage bins or silos at the batching plant for cement shall be weatherproof and shall be constructed so that there is no dead storage. If in the opinion of the Engineer, there is reason to believe that any dead storage exists in any bin, that bin shall be emptied and cleaned out at least once every four (4) months.

Cement delivered in bags shall be transported in a manner approved by the Engineer and shall be stored in completely waterproof warehouses with adequate provisions for preventing the

absorption of moisture, provided that the storage facilities shall be subject to the approval of the Engineer and so arranged as to permit easy access for inspection and identification of each cement consignment.

Cement shall be stored in a weatherproof warehouse having a floor more than thirty (30) cm above the ground level, and shall be used in such manner that the "first-in" can be "first-out". Proper spacing shall be provided between piles of cement. Not more than thirteen (13) bags shall be permitted to be placed in one (1) stack, or to a lesser number as directed by the Engineer when the storage period is expected to be longer than sixty (60) days. The cost of the cement warehouse shall be included in the lump sum price of the Contractor's temporary buildings stated in Item No. 0/05 in the Bill of Quantities.

No cement which has been stored at the Site for more than ninety (90) days shall be used in the Permanent Works unless a test proves it to be satisfactory.

If cement is damaged or deteriorated in consignment, handling or storage, it shall be promptly removed from the site of the works.

The Contractor shall take care to ensure that adequate stocks of cement are always available and shall within tenth (10th) day of each month inform the Engineer concerning the following data :

- The stock of cement on hand at the Site as of the last day of the preceding month,
- Cement delivery received during the previous month,
- Cement used in the Permanent Works during the last month, and
- Other data as required by the Engineer.

3.2.2 Admixtures

The Contractor may be permitted with the written approval of the Engineer the use of admixtures so as to improve workability and finishability of concrete and to promote other special properties.

Air-entraining admixture may be used in all concrete unless otherwise directed by the Engineer. This admixture used shall conform to ASTM Designation C 260 or equivalent approved by the Engineer. With the exception of air-entraining admixtures, the Contractor shall notify the Engineer of the sources of such admixtures as set-retarding, water reducing and strength acceleration agents from which admixtures will be obtained and shall furnish technical information and samples for testing at least ninety (90) days in advance of the time when these

agents are expected to be applied.

All tests for the admixture shall be made by the Contractor at his own expense and the results of tests shall be submitted to the Engineer for his approval.

The amount of agents used in each concrete mix and section of the concrete work where it may be used will be determined by the Engineer. The specified limits in respect of maximum slump, slump loss during transit and time allowed for concrete to remain in the mixer may be changed by the Engineer when approval to use the agent is given.

Liquid or powdered admixtures for concrete shall be kept in water-proof stores with adequate provision for the prevention of water absorption and direct exposure to sunshine. Storage shall be so arranged that the materials will be used in the order in which they arrive at the Site. If any admixture has an expiry date, it shall be conspicuously marked on the container. Sufficient quantities of admixture shall be kept in storage to ensure uninterrupted concrete placing.

All costs incidental to the use of admixtures shall be included in the unit prices per cubic metre stated in the Bill of Quantities for applicable items of concrete in which the admixtures are used and no separate payment for the same shall be considered by the Employer.

3.3 Aggregates

3.3.1 General

With the exception of ready mixed concrete intended to be procured or purchased by the Contractor from manufacturers, materials for production of coarse and fine aggregates shall be obtained from suitable quarry site approved by the Engineer.

All aggregate materials shall consist of hard, durable, clean minerals, produced naturally or manufactured, and must not contain substances which may impair the quality of concrete and reinforcing bars.

All necessary tests to be made by the Contractor on samples taken from possible quarry site indicate that it contains materials which, when processed, will be suitable for coarse and fine aggregates ; as well as, the quality of material available from the possible quarry site shall be assessed by the Contractor. All test results and information as to the materials shall be submitted by the Contractor to the Engineer for his approval.

The Contractor shall carry out the following tests with regard to samples taken from each stockpile in the quarry site in accordance with the specified standards and frequencies indicated in the table below :

Test Item	Test Standard	Frequency
Fine aggregate :		
Grading :	JIS A 1102 or SNI 1754-90-A	Once a week for each stockpile
Washing :	JIS A 1103	When directed by the Engineer
Specific gravity and absorption :	JIS A 1109 or SNI 1970-90-F	When directed by the Engineer
Moisture content :	JIS A 1111 or SNI 1971-90-F	Once a day
Coarse aggregate		
Grading :	JIS A 1102 or SNI 1753-90-F	Once a week for each stockpile
Unit weight :	JIS A 1104	When directed by the Engineer
Specific gravity and absorption :	JIS A 1110 or SNI 1969-90-F	When directed by the Engineer

The Contractor shall be required to pay by way of loyalties or otherwise for materials taken from the selected quarry site and used in the work covered by these Specifications. The Contractor shall be responsible for the specified quality of all such materials used in Permanent Works under the Contract.

In case the Contractor intends to purchase the aggregates from other sources such as manufacturer or supplier, the Contractor shall submit to the Engineer for his approval all test results, data and information to prove physical and chemical properties and quality of the aggregates which will be purchased and used, at least thirty (30) days before the aggregates are required for use.

All costs incurred from production or purchase of the concrete aggregates shall be included in the unit prices per cubic metre of concrete stated in the respective items for the concrete structures itemized in the Bill of Quantities.

3.3.2 Fine aggregate

The term "fine aggregate" is used to designate aggregate in which the maximum size of particles is five (5) mm and the particles consist of innate materials.

The fine aggregate shall consist of clean, hard, dense, durable, uncoated rock fragments of proper gradation and shall be free from injurious amount of dirt, dust, silt, lumps, soft or flaky grains, shale, alkali, organic matter, loam and other deleterious substances. More than three (3) percent of material passing the 0.074 mm or No. 200 sieve by washing or more than one (1) percent of clay lumps or one (1) percent of shale shall not be contained. Use of sand deposited or obtained from beach or sea shall be prohibited without the written approval of the Engineer.

The fine aggregate to be used for concrete structures exposed or weathered shall be free from any substance which will discolour the concrete surface.

The fine aggregate shall be tested for sodium sulphate soundness in accordance with JIS A 1122 or SNI 1758-90-A for five (5) cycles and shall show the maximum loss of not more than ten (10) percent.

The fine aggregate shall be uniformly graded and when tested in accordance with PBI, 1971, N.I.-2 as stated below :

- Fine aggregate, less than two (2) percent (by weight) retained on 4 mm sieve
- Fine aggregate, less than ten (10) percent (by weight) retained on 1 mm sieve
- Fine aggregate, between eighty (80) to ninety five (95) percent (by weight) retained on 0.25 mm sieve or equivalent standard tabulated as follows:

Sieve Designation (Mean Opening (mm))	Standard % by Weight passing Individual Sieve
10	100
5	90 - 100
2.5	80 - 100
1.2	50 - 90
0.6	25 - 65
0.3	10 - 35
0.15	2 - 10

The fineness modulus of the fine aggregate shall range between 2.5 and 3.3.

The percentage of deleterious substances in the fine aggregate shall not exceed the following values :

Item	% by Weight
Clay lump	1.0
Material passing 0.074 mm sieve	3.0 *
Material retained on 0.297 mm sieve and floating on liquid having a specific gravity of 1.95	0.5

* If the material finer than 0.074 mm sieve consists of rock dust free from clay or silt, this percentage may be increased to five (5).

3.3.3 Coarse aggregate

The term "coarse aggregate" is used to designate aggregate in which the minimum nominal size is five (5) mm and which is reasonably well graded from five (5) mm to the largest size ; forty (40) mm for this Project, required in the concrete work. The coarse aggregate shall consist of crushed or unbroken stone, gravel and other innate materials with similar characteristics or a combination thereof. Coarse aggregate shall be clean, hard, fresh, unweathered, well shaped, dense, uncoated, durable rock fragments and free from objectionable quantities of flat or elongated particles, organic matter or other deleterious materials.

The coarse aggregate shall be of uniform grading with the maximum sizes as required for the various types of concrete in accordance with PBI, 1971, N.I.-2 as described below :

- Coarse aggregate, one hundred (100) percent by weight passed 31.5 mm sieve,
- between ninety (90) to ninety eight (98) percent retained on 4.0 mm sieve,
- The difference of accumulative weight between the respective sieves not more than sixty (60) percent by weight and not less than ten (10) percent by weight, and or equivalent to JIS Standard.

The coarse aggregate may be rejected if :

- The loss, using grading A in the Los Angeles abrasion test, exceeds ten (10) percent by weight at one hundred (100) revolutions, or forty (40) percent by weight at five hundred (500) revolutions.

- The weighted loss of the aggregate, when subjected to five (5) cycles of the sodium sulphate test for soundness, is more than twelve (12) percent by weight.

- The total percentage by weight of particles of unsatisfactory shape exceeds sixty (60) percent. A particle shall be considered to be of unsatisfactory shape if it has a maximum dimension exceeding three (3) times its minimum dimensions.

The coarse aggregate shall be finish-screened over vibrating screens mounted on the rock crushing plant or, at the option of the Contractor, the screens may be mounted on the ground adjacent to the rock crushing plant. Separation of the coarse aggregate into the specified sizes, after finish-screening shall be such that, when the aggregate is tested by the sieves designated in the following tabulation, the gradation obtained is as follows :

Designation of Coarse Aggregate	Standard Percentage by Weight passing Individual Sieve (%)							
(mm)	50 mm	40 mm	25 mm	20 mm	15 mm	10 mm	5 mm	2.5 mm
40 - 25	100	90-100	20-55	0-15	-	0-5	-	-
25 - 5	-	100	95-100	-	25-60	-	0-10	0-5

Handling and storing of coarse aggregate shall be in such a manner which would prevent its segregation or inclusion of foreign materials. The Engineer may require that coarse aggregate shall be stored on separate platforms provided at adequate locations.

In order to secure greater uniformity of the concrete mix, the Engineer may require that the coarse aggregate shall be separated into two (2) or more sizes. Different sizes of aggregate shall be stored in separate bins or piles sufficiently detached from each other to prevent intermixing.

The Contractor shall submit to the Engineer for his approval the detailed plans, drawings and other

particular description within thirty (30) days prior to installation of the concrete aggregates plant and equipment according to the provisions of Sub-clause G3.2. (5) of Vol. III, Part I - General Specifications.

In case the Contractor intends to procure or purchase the coarse aggregate from manufacturer or supplier, the Contractor shall notify the Engineer in writing at least thirty (30) days before the commencement of concrete work of his intention with detailed information and description as to the manufacturer or supplier accompanying with data and certificates to prove eligibility of the materials.

3.4 Water

Water for mixing concrete and mortar and for washing aggregates and for curing concrete shall be provided by the Contractor as prescribed in Sub-clause G8.3. (4) of Vol. III, Part I - General Specifications and shall be subject to the approval of the Engineer.

The water to be used in concrete and mortar shall be reasonably clean and free from injurious amount of silt, oil, acids, salts, alkali, organic and other deleterious substances. The quality of mixing water shall conform to the Standard of AASHTO T 26 (Standard Method of Test for Quality of Water to be used in Concrete).

If required by the Engineer, samples shall be taken from the proposed sources of supply and tested by comparison with distilled water. Comparison shall be made by means of standard cement test for soundness, time of setting and mortar strength. Indication of unsoundness, change in time of setting plus or minus thirty (30) minutes or more or decrease of mortar strength more than ten (10) percent compared with distilled water shall be sufficient cause for rejection of water being tested.

Sufficient water storage facilities shall be provided to ensure the continuous operation of concrete placing. The methods of delivering and storing water shall be subject to the approval of the Engineer.

All costs incurred from water used for concrete and mortar mixing, and aggregates washing shall be included in the unit prices per cubic metre of concrete or mortar stated for the respective items in the Bill of Quantities.

With the exception of the above, all costs brought from the plant, equipment, labour and materials for construction of water supply system furnished by the Contractor shall be included in the lump

sum price stated for Item No. 0/08 of the Contractor's temporary facilities in the Bill of Quantities.

3.5 Concrete Mix

3.5.1 Composition

Concrete shall be composed of ordinary Portland cement, water, fine and coarse aggregates and approved admixture, all well mixed and brought to the proper consistency.

3.5.2 Types of concrete

Types of concrete shall be designated by the following six (6) types of concrete including lean concrete. Each type of concrete shall be used in accordance with the Specification and where shown on the Drawings or where directed by the Engineer.

The various concrete types shall be typified on the basis of their cylindrical compressive strength at 28 days as well as on the maximum size of the coarse aggregates and slump of concrete as shown below :

Recommended Types of Concrete

Type of Concrete	Max. Size of Coarse Aggregate (mm)	28-day Cylindrical Compressive Strength (kg/cm^2)	Slump (cm)
1	25	270	8
2	40	240	10
3	25	180	8
4	40	180	10
5	25	100	10
6	40	270	2.5

The amount of water used in the concrete will be altered by the Engineer within the limits established by him for the water/cement ratios required to secure concrete of the proper workability, consistency, etc., taking into account the effect of the use of the admixtures approved and any variation in either or both the moisture content or grading of the aggregate as they enter the mixer.

The slump of the concrete mix shall be the lowest possible that will permit thorough compaction

with the equipment approved for the work. In general, slump would depend upon the type of application and not on the type of concrete. The application of each concrete mix to the structure will be made in principle as given below :

Type of Concrete	Application in Drainage Structures
1	Structures requiring high strength with relatively thin members such as, foundation pile, composite girder, etc.
2	RC bridge slab, pier and abutment, guardrail, curb stone, etc.
3	Secondary concrete or relatively thin structural member such as blockout of sluiceway, concrete pipes, etc.
4	Ordinary structural concrete with relatively thick member such as sluiceway, foundation concrete of revetment, concrete culvert, parapet wall, concrete wall, side walk of bridge, etc.
5	Base concrete and levelling concrete.
6	Concrete pavement.

3.5.3 Preliminary mixes

The Contractor shall propose the mix proportions to achieve the required strength and workability and the Engineer will specify the mix proportions found appropriate for the particular application. The Contractor shall undertake to provide a properly mixed concrete containing the constituents in the specified proportions tested in an approved laboratory using a sufficient number of samples to be representative of aggregates and cement to be used for the Works. The Contractor shall employ a competent and suitably qualified engineer to design the mix, to supervise and direct all stages in the preparation and placing of the concrete.

The preliminary mixes shall be prepared at least for three (3) different water-cement ratios which shall produce a range of strengths required for having adequate workability for compaction by the method to be used in placing. The amount of water used in the concrete shall be regulated by the

Engineer within the limits which will be established by him for the water-cement ratios required to secure the proper consistency of concrete, taking into account the effect of the use of the specified admixtures and any variation in either or both the moisture content or grading of the aggregate as they enter the mixer. For each grade of concrete, a set of six (6) cylinders shall be made from each three (3) batch.

From each set of six (6) cylinders, three (3) shall be tested at an age of seven (7) days and another three (3) at twenty eight (28) days in accordance with the specified standards. From the relationship derived between the strength and water-cement ratio a trend line shall be established reasonably.

If at any time during construction of the Works, the source of cement or aggregate is changed, the grading of the aggregate alters or the compressive strength of the concrete is not acceptable then further preliminary mixes shall be undertaken in the manner explained above.

3.5.4 Trial mixes of concrete

At least sixty (60) days prior to the start of permanent concrete work, the Contractor shall produce a trial mix for each type of the concrete specified under the supervision of the Engineer, using cement, admixture and the entire aggregate and by operating , batching and concrete mixing plants provided by the Contractor for the execution of the Works. Such trial mixes shall be continued until concrete complying with these Specifications is produced.

Where the Engineer has approved the concrete mix design for each type of concrete, the Contractor shall, before the commencement of concreting, have trial mixes prepared, preferably under the full-scale production conditions in the presence of the Engineer to ensure that concrete is sufficiently strong and workable and that segregation of the mix during transportation and placing does not occur.

For the trial mix, six (6) test cylinders shall be made by the Contractor and three (3) test cylinders shall be tested at an age of seven (7) days and the remaining three (3) at twenty eight (28) days in accordance with the specified standards. The target concrete mix shall be established through such procedure with consideration of a reasonable margin so as to enable the variations of the original source of cement, aggregate conditions and by the workmanship and construction plant employed for the Works to be controlled within an estimated range. The Engineer shall review all data of the specified mix proportions for each type of concrete as notified to the Contractor.

If the average value of the ultimate compressive strength of the three (3) cylinders taken from any trial mix is less than the specified twenty eight (28) day compressive strength given in Sub-clause 3.5.2 hereinbefore, the Contractor shall re-design to make a further preliminary mix, trial mix and set of test cylinders. If the workability and consistency required are not obtained in the opinion of the Engineer during any trial mix for any type of concrete, the trial mix shall also be re-designed by the Contractor.

Tests specified in Sub-clause 3.3 (Aggregates), 3.4 (Water) and 3.5 (Concrete Mix) shall be conducted by the Contractor in his laboratory or at an approved laboratory in accordance with the provisions of Sub-clause G8.3. (13) of Vol. III, Part I - General Specifications, thereof.

All cost incurred from trial mix and laboratory tests shall be deemed to be included in the respective items of works in the Bill of Quantities and no extra payment for the same shall be made to the Contractor.

The determination of the mix proportions by the Engineer shall not relieve the Contractor of his responsibilities for producing and placing concrete conforming to the specified requirements. Before mixing concrete for any structure or part thereof, the Contractor shall satisfy himself that the concrete mixed in the proportions determined by the Engineer will permit the Contractor to produce and place concrete complying with the specified requirements.

3.5.5 Batching

The Contractor shall either provide batching equipment or may purchase concrete from manufacturers. The equipment shall be capable of combining the aggregates, cement, admixtures and water into a uniform mixture and of discharging this mixture without segregation. It shall also be capable of readily adjusting to compensate for the varying moisture content of the aggregate and to change the weights of the materials being batched.

The amount of each of the materials comprising the concrete shall be determined by weighing, except the amount of water and admixtures which will be measured either by volume or weight.

Unless the Engineer otherwise determines, materials shall be weighed within the following degrees of accuracy, inclusive of scale and operating errors:

Cement	plus two percent (+ 2 %)
Fine aggregate	plus two percent (+ 2 %)

Coarse aggregate	plus three percent (+ 3 %)
Water	plus one percent (+ 1 %)
Admixtures	plus one percent (+ 1 %)

Cement scales shall be in divisions of not more than two (2) kg and aggregates in divisions of not more than ten (10) kg both readily discernible. At the time of installation, or of reconditioning, the indicated weight at any point of scale shall not vary from the correct weight by more than zero decimal two (0.2) percent of the maximum marking of the scale. At any time of operation, the indicated weight at one point on the scale shall not vary from the correct weight by more than zero decimal four (0.4) percent of the maximum marking of the scale.

The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the accuracy of scale. Cement scale shall be tested not less than once a month with the standard weights and the result recorded. In addition, all scales shall be inspected and tested by approved technicians at least every six (6) months.

The following written, printed or graphic records shall always be kept at the equipment for each batch :

(a) Weight of aggregates and cement
(b) Amount of water used
(c) Amount and kind of admixture added

3.5.6 Concrete mixing

(1) Mixing concrete by mechanical mixer

Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer. The pick-up and throw-over blades of mixers shall be restored or replaced when any part or section is worn twenty (20) mm or more below the original height of the manufacturer's design. Mixers and agitator which have an accumulation of hard concrete or mortar shall not be used.

When bulk cement is used and volume of the batch is one-half (0.5) m^3 or more, the scale and weigh hopper for cement shall be separate and distinct from the aggregate hopper or hoppers. The discharge mechanism of the bulk cement weigh hopper shall be interlocked against opening when the amount of cement in the hopper is underweight by more than one (1) percent or overweight by

more than three (3) percent of the amount specified.

When the aggregates contain more water than the quantity necessary to produce a saturated surface-dry condition, representative samples shall be taken and the moisture content determined for each kind of aggregate. Water content and aggregate quantities shall be adjusted accordingly.

The batch shall be so charged into the mixer that some water will enter in advance of cement and aggregates. All water shall be in the drum by the end of the first quarter of the specified mixing time.

Cement shall be batched and charged into the mixer by means that will not result in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of conveyors or hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

The entire contents of a batch mixer shall be removed from the drum before materials for a succeeding batch are placed therein. The materials composing a batch except water shall be deposited simultaneously into the mixture.

All concrete shall be mixed for a period of not less than 1.5 minutes (90 seconds) after all materials, including water, are in the mixer. During the period of mixing, the mixer shall operate at the speed for which it has been designed.

Mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanism shall be so interlocked that during normal operation no part of the batch will be discharged until the specified mixing time has elapsed.

The first batch of concrete materials placed in the mixer shall contain a sufficient excess of cement, sand and water or mortar batching with same proportion of concrete to coat the inside of the drum without reducing the required mortar content of the mix. When mixing is to cease for a period of one hour or more, the mixer shall be thoroughly cleaned.

(2) Mixing concrete in truck

No truck mixer, unless otherwise specified in the Contract, shall be used for the Works.

(3) Mixing concrete by hand

In cases where the Engineer may authorize hand mixing, the mixing shall be done on a watertight platform and in such a manner as to ensure a uniform distribution of the materials throughout the mass. Mixing shall be continued until a homogeneous mixture of the required consistency has been obtained.

(4) Ready mixed concrete

Ready mixed concrete may be used with the written approval of the Engineer. Such approval will not be unreasonably withheld, but the Contractor shall satisfy the Engineer that the materials used in ready-mixed concrete comply with the Specifications in all respects. The specified requirements as to the sampling, preliminary and trial mixes, testing and quality of concrete of various types shall apply equally to ready-mixed concrete.

3.6 Equipment for Transporting and Placing Concrete

3.6.1 General

The methods and equipment used for transporting and placing concrete and the time that elapses during transportation shall be such that concrete having the required composition and consistency will not cause appreciable segregation of coarse aggregate, a slump loss in excess of two point five (2.5) cm, or a loss in air content before consolidation of more than one (1) percent in the concrete as it is placed in the work.

In case that concrete is transported and/or placed by any of the types of equipment listed below, such equipment shall be installed and handled according to the following stipulations:

3.6.2 Agitator truck

The agitating speed of the drum shall be between two (2) and four (4) revolutions per minute. The volume of mixed concrete in the drum shall not exceed the manufacturer's rating nor exceed seventy (70) percent of the gross volume of the drum. Upon approval of the Engineer, truck mixers may be used instead of agitator trucks for transportation of concrete. The interval between feeding of water into the mixer drum and final discharging of the concrete from the agitator shall not exceed one (1) hour. During this interval, the mixture shall be agitated continuously at the above mentioned speed.

3.6.3 Non-agitator truck

Bodies of non-agitator trucks shall be smooth and watertight. Covers shall be provided when needed for protection against rainfall. The non-agitator truck shall deliver concrete to the work site in a thoroughly mixed and uniform mass.

Uniformity will be deemed satisfactory if samples from one-quarter and three-quarter points of the load do not differ more than two point five (2.5) cm in slump. Placing of concrete shall be completed within one (1) hour after feeding mixing water into the cement and aggregates.

Under conditions contributing to quicken stiffening of concrete or the air temperature is thirty degrees (30 °C) or above, the time limit for the final discharging of the concrete shall be less than one (1) hour.

3.6.4 Chutes

In general, transportation of concrete by the use of chutes will not be permitted unless approved by the Engineer. If approved, the chute shall have a section with round corners and shall have a properly fixed slope so as to allow the concrete to flow easily and without segregation. The lower end of the chute shall be provided with a drop chute or baffle plate and hopper not more than one and half (1.5) m in height to avoid segregation of falling concrete. Chutes shall be protected from direct rays of the sun.

3.6.5 Concrete pump or placer

The type and capacity of pump shall be determined to meet the specified requirements, taking into account the placing speed, construction schedule, quality of concrete, location to which concrete is poured, etc. Diameter of the delivery pipes shall be not smaller than three (3) times of the maximum size of aggregates to be used in the concrete.

Delivery pipes shall be so installed as to permit easy removal. Before starting the pump or placer operation, about one (1) m^3 of mortar with the same proportion of water, admixture, cement and fine aggregate as designated for the regular concrete mix shall be passed through the pipe.

The pipe shall be set as straight and horizontally as possible to prevent clogging of the concrete mix in the pipe. Air boosters shall not be used except in conditions where the outlet of the pipe is

completely embedded at least two (2) m in fresh concrete. The supports of the pipe line shall be stiff enough to fix the pipes firmly without adverse effect on forms and reinforcing steels already set at the position. Care shall be taken to prevent leakage of the concrete mix from the pipe line or any other part.

3.6.6 Belt-conveyor

Transporting concrete by belt-conveyors will not be permitted unless approved by the Engineer. If authorized, belt-conveyors shall be used with such precaution that belts are protected from rain, wind and sunlight, and that a proper hopper or vertical chute is used at the end of each conveyer to limit the drop of the concrete being placed to a maximum of one and half (1.5) m.

Full details consisting of manufacturer's catalogs, blueprints, etc. for each type of the above described items of equipment shall be submitted to the Engineer. All such equipment shall be operated and maintained in accordance with the manufacturer's printed instructions.

Types of equipment other than listed above shall be approved by the Engineer at least thirty (30) days prior to their being used.

3.7 Placing of Concrete

3.7.1 General

No concrete shall be placed until all form-work, installation of parts to be embedded and preparation of surfaces involved in the placing have been completed by the Contractor, and inspected and approved by the Engineer.

Unless otherwise permitted by the Engineer, no concrete shall be placed in the rain or standing water, and in no case shall concrete be placed in running water.

Check of slumps shall be taken after concrete has been placed but before it has been consolidated. The use of buckets, chutes, hoppers, or other transporting and handling equipment which cannot readily handle and place concrete of such lesser slump shall not be permitted.

Communication facilities between the mixing plant and placing site shall be furnished, operated and maintained by the Contractor where necessary, or desirable as determined by the Engineer. No special payment or allowance will be made to the Contractor for providing such communication

facilities.

3.7.2 Preparation for placing

Immediately before concrete is placed, all surfaces of the formation foundation to which concrete is to be bonded shall be cleared of oil, mud, organic matter, wooden pieces, objectionable coating, debris, or other perishable materials by the use of high-velocity air-water jet or other effective means approved by the Engineer.

All surfaces of forms and embedded materials that have become encrusted with dried mortar from concrete previously placed shall be cleaned of all such mortar before the surrounding or adjacent concrete is placed.

The surface of soil or sand and gravel foundations to which concrete is to be placed shall be free from standing or running water, wooden piece or other objectionable materials mentioned above. For soil or sand and gravel foundation, the foundation shall be in a damp condition before placing concrete.

The surface of construction joints of old concrete to which new concrete or mortar is to be placed shall be roughened by chipping or other approved methods and then cleaned, and kept moist for a time specified by the Engineer prior to placing the new concrete. Cleaning shall consist of the removal of all laitance, loose or defective concrete, coating and foreign materials.

The surface of all contraction joints shall be cleared thoroughly of accessions of concrete or other foreign materials by scrapping, chipping or other means satisfactory to the Engineer. Contraction joints will be filled with rubber joint filler or given a coat of a compound approved by the Engineer to prevent bonding with concrete to be placed on the other side of the joint.

3.7.3 Temperature of concrete during placing

Temperature of concrete when it is being placed shall be not more than thirty two degrees (32^{o}) C. The aggregates stockpiles shall be, in hot weather shield or sprayed with water and the mixing water shall be adequately cooled or insulated to ensure the temperature of concrete below the specified limit. The Contractor shall not entitled to any additional compensation on account of the requirements of this Sub-clause.

3.7.4 Concrete placed in water

Concrete shall not be placed under water except where inevitable in which case approval must be sought from the Engineer and the work shall be carried out under his meticulous supervision.

The quantity of cement in any type placed in water shall be increased so that the water / cement ratio of the mix is not more than 0.47. The slump shall be maintained below ten (10) cm to prevent segregation. Concrete shall be carefully placed in a compact mass, in its final position, by means of a trim, a bottom-dump bucket, or other approved methods. The detailed placing method in water shall be proposed by the Contractor for the Engineer's approval.

3.7.5 Concrete placed along the slope

If slump in concrete are so large that the placed concrete may possibly flow down along the slope, adequate forms shall be used to prevent the concrete from flowing down.

3.7.6 Placing

The Contractor shall keep the Engineer's advice as to when the placing of concrete is to be performed. Placing of concrete shall be made only in the presence of the Engineer or his representative.

Any concrete which has become so stiff that proper placing can not be assured unless retempered, except with the addition of water or of which the slump has been reduced by two point five (2.5) cm or more, as determined by the Engineer, shall be wasted to places designated by the Engineer, and no payment will be made to such concrete.

In so far as it is practicable, concrete shall be deposited directly in its final position and shall not be caused to flow in a manner to permit or cause segregation. Methods and equipment employed in depositing concrete in forms shall be such as will not result in coarse aggregate being separated from the concrete mass. The Contractor shall provide suitable methods to confine and control the falling concrete so as not to cause segregation or strike hard against the reinforcing bars and assembled forms. The vertical free drop of filling concrete shall not exceed one and half (1.5) m.

All formed concrete shall be placed in horizontal layers, the thickness of which shall not exceed forty (40) cm. The Engineer reserves the right to require less depths of layers where concrete in forty (40) cm layers can not be placed in accordance with the requirements of this Specification.

The height of one lift of concrete placing shall be as designated on the Drawings or as directed by the Engineer.

Struts, stays and braces, serving temporarily to hold the forms in concret shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached and elevation rendering their service unnecessary. These temporary members other than metal shall be entirely removed from the forms and not buried in the concrete.

In the event of equipment breakdown, on if for any other reason continuous placing will be interrupted, the Contractor shall thoroughly consolidate the concrete at such joints to a reasonably uniform and stable slope while the concrete is plastic. The cold joint shall thereafter be treated as a construction joint.

If concrete is placed monolithically around openings having vertical dimensions greater than sixty (60) cm, or if concrete in decks, floor slabs, beams, girders or other similar parts of structures is placed monolithically with supporting concrete, the following instructions shall be observed :

(1) Placing of concrete shall be delayed not less than one (1) hour nor more than three (3) hours at the top of openings and at the bottom of bevels under decks, floor slabs, beams, girders or other similar parts of structures when bevels are specified and at the bottom of such structure members when bevels are not specified, but in no case shall the placing be delayed so long that the vibrating unit will not of its own weight readily penetrate into the concrete placed before the delay.

(2) The last sixty (60) cm of concrete placed immediately before the delay shall be placed with as low slump as practicable and the Contractor shall ensure that thorough consolidation of the concrete is effected.

(3) The surfaces of concrete where delays are made shall be clean and free from loose and foreign material when concrete placing is started after the delay.

(4) Concrete placed over openings and in decks, floors, beams, girders and other similar parts of structures shall be placed with as low slump as practicable and the Contractor shall ensure that thorough consolidation of the concrete is effected.

The Contractor shall not be entitled to any additional payment beyond the unit prices stated in the Bill of Quantities for concrete by reason of any limitations in the placing of concrete required

under the provisions of this Sub-clause.

3.7.7 Compaction and consolidation of concrete

Each layer of concrete shall be immediately compacted and consolidated with suitable appliances so that the concrete is compacted to the maximum practicable density and closes snugly against all surfaces of forms and embedded materials. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified.

In general, concrete shall be consolidated with electrical or pneumatic power driven, internal-type vibrators, operating at a speed of at least seven thousand (7,000) revolutions per minute when immersed in concrete. The vibrating head shall be inserted in concrete vertically and at least five (5) cm into underlying layer. Where it is difficult to use internal vibrators, concrete may be consolidated with the external-type form vibrators as discussed hereinunder or compacted with a hand plunger as directed by the Engineer.

Compaction of concrete in part of structures exposed to view shall be by immersion-type vibrators supplemented where directed by the Engineer, by approved heavy-duty form vibrators. Form vibrators shall be firmly attached to the form during compaction but the vibrators shall be capable of being quickly removed and re-attached to other positions on the forms and shall operate at speeds of at least eight thousand (8,000) revolutions per minute when vibrating concrete.

Care shall be taken to ensure that vibrations shall be made systematically and at such intervals that the zones of influence overlap and the concrete is properly compacted.

In the area where newly placed concrete in each layer adjoins previously placed and hardened concrete, more than usual vibration shall be performed, the vibrator penetrating deeply at close intervals along these contacts. Contact of the vibrating head with surface of the form shall be avoided.

3.7.8 Blockouts in concrete

Blockouts in concrete shall be constructed, as shown on the Drawings or as directed by the Engineer, to permit the installation and adjustment of metalwork for the mechanical equipment which is to be embedded in concrete. Such blockouts shall be filled with Type 3 concrete unless otherwise directed by the Engineer after the installation is completed.

Before type 3 concrete is placed in the blockouts, the existing concrete surfaces of the blockouts shall be roughened and cleaned. The roughening shall be performed by chipping or other approved methods and in such a manner as not to loosen, crack or shatter any part of the concrete beyond the roughened surface. After being roughened, the surface of the concrete shall be cleaned in accordance with the provisions of Sub-clause 3.7.2 and shall be sound and hard and in such a condition as to ensure a good mechanical bond between the existing and the new concrete. All concrete which is not hard, dense and durable shall be removed to the depth required to secure a satisfactory surface. After cleaning the roughened surface to the satisfaction of the Engineer, it shall be kept moist for at least twenty four (24) hours prior to placing the concrete in the blockout.

The Contractor shall place the concrete in blockouts in such a way as to ensure a satisfactory bond with the existing concrete, to secure complete contact with metalwork to be embedded in the blockout concrete and to avoid displacement of the metalwork being embedded. Where directed by the Engineer, concrete placed in blockouts shall contain an approved expander or shall be delayed between mixing and placing to reduce subsequent shrinkage. The cost of preparing the surface of the concrete against which blockout concrete is to be placed, shall be included in the unit price for type 3 concrete for the blockout.

Measurement, for payment, of blockout concrete will be made of the dimensions as shown on the Drawings or as directed by the Engineer and in accordance with the provisions of Sub-clause 3.14.1.

Payment for blockout concrete shall be made in accordance with the provisions of Sub-clause 3.14.1 at the unit prices per cubic meter tendered in the Bill of Quantities.

3.7.9 Construction and contraction joints

(1) Construction joints

Concrete surfaces, upon or against which concrete is to be placed and to which new concrete is to adhere, that have become so rigid that the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints

Certain joints have been shown on the Drawings with full lines or broken lines as compulsory construction joints. These construction joints shall not be altered and no concrete shall be placed against the joint for at least three (3) days for sections up to ninety (90) cm in thickness and for seven (7) days where the thickness exceeds ninety (90) cm, unless otherwise approved by the

Engineer.

Other construction joints have non-compulsory locations. Subject to approval of the Engineer, the Contractor may vary the locations of this type of construction joint and the sequence of concrete placement where shown on the Drawings, provided that the Contractor shall make all necessary adjustments to the reinforcement to the satisfaction of the Engingeer and without cost to the Employer.

In addition to those construction joints shown on the Drawings, the Contractor shall prepare his own drawings showing the locations of construction joints he desires to make including a sequence of concrete placement. The necessary reinforcement shall also be detailed on his drawings so as to match such joint. If approved, all necessary work related thereto shall be made at no extra cost to the Employer.

Construction joints shall be approximately horizontal or vertical unless otherwise shown on the Drawings or prescribed by the Engineer and shall be given the prescribed shape by the use of forms, where required, or by other means that will ensure suitable joining with subsequent work ; Provided, that unless otherwise shown on the Drawings, keyways will not be required at construction joints. All intersections of construction joints with concrete surface which will be exposed to view shall be made straight and level or plumb.

The surfaces of construction joints shall be clean and damp when covered with fresh concrete or mortar. Cleaning shall consist of the removal of all laitance, loose or defective concrete, coatings, sand, sealing compounds if used, and other foreign material. The surfaces of all construction joints shall be roughened and then washed thoroughly. The roughening and washing shall be performed at the last opportunity prior to the placing of concrete.

The surfaces of all construction joints, including surfaces of blockouts shall be washed thoroughly with air-water jets immediately prior to placement of adjoining concrete.

All pools of water shall be removed from the surfaces of construction joints before the new concrete is placed.

The cost of construction joints shall be included in the unit prices per cubic meter tendered in the Bill of Quantities for the concrete which require such joints.

(2) Expansion and contraction joints

Expansion joints with the types shown on the Drawings shall be provided in wall, floor, etc., where indicated on the Drawings or as directed by the Engineer. The joint shall be made by forming the concrete on one side of joint and allowing it to set before concrete is placed on the other side of the joint. Waterstops and PVC pipes for dowel bars where those shall be necessary as shown on the Drawings or directed by the Engineer shall be embedded in the concrete first placed. Joint fillers as specified in Sub-clause 3.1χ3.5 hereof shall be placed on the entire surface of concrete first placed at the expansion joint.

Contraction joints shall be located and constructed as shown on the Drawings or as directed by the Engineer. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The surface of the concrete placed at contraction joints shall be cleaned and then coated with a curing compound, oil paint or other approved material to break the bond before concrete on the other side of the joint is placed.

The entire cost of constructing all joints shall be included in the unit prices per cubic meter tendered in the Bill of Quantities for the concrete which require such joints, except that payment for expansion joint filler, waterstops and anchor bars, as required, will be made as provided in Sub-clause 3.14.4.

3.8 Curing Concrete and Protection

3.8.1 General

All concrete placed shall be cured in accordance with the Specifications and as directed by the Engineer. The Contractor shall submit adequate curing and protection method for the Engineer's approval before actual concrete placement begins. The curing shall be applied so as to prevent loss of moisture from the concrete. Concrete shall be protected from heavy rains for twelve (12) hours, flowing water for fourteen (14) days and direct rays of the sun for three (3) days after placing. All concrete shall be adequately protected from traffic, fire or excessive heat including heat resulting from the welding of steel. Concrete surfaces of construction joints shall be water cured. The unformed top surfaces of walls, slabs and piers shall be moistened by covering with water-saturated material or by other effective means as soon as the concrete has hardened sufficiently to prevent damage by water. These surfaces and steeply sloping and vertical formed surfaces shall be kept completely and continuously moist, before and during form removal, by water applied on the unformed top surfaces and allowed to pass down between the forms and the formed concrete

faces. This procedure shall be followed by the specified water curing or membrane curing. The following curing methods shall be deemed to be applicable.

3.8.2 Moisture curing method

The concrete shall be kept continuously wet by the application of water for a minimum period of seven (7) days after the concrete has been placed.

The entire surface of the concrete shall be kept damp by applying water with nozzle. Cotton mats, rugs, carpets, or earth or sand blankets may be used to retain the moisture. At the expiration of the curing period, the concrete surfaces shall be cleared of the curing medium.

3.8.3 Curing compound method

Where approved by the Engineer, surfaces exposed to air may be cured by the liquid curing compound in accordance with ASTM C309, PBI,1971,N.I.-2 or equivalent.

The compound shall be applied with a pressure spray in such a manner as to cover the entire concrete surface with a uniform film, and shall be of such character that it will harden within thirty (30) minutes after application. The amount of compound applied shall be ample to seal the surface of the concrete thoroughly. Power operated spraying equipment shall be equipped with an operational pressure gauge and means of controlling the pressure.

The curing compound shall be applied to the concrete following the surface finishing operation immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay, in the application of the curing compound, which results in any drying or cracking of the surface, application of water with an atomizing nozzle shall be started immediately and shall be continued until the application of the compound is resumed or started; however, the compound shall not be applied over any resulting free standing water. Should the film of compound be damaged from any cause before the expiration of seven (7) days after the concrete is placed in the case of structures, the damaged portion shall be repaired immediately with additional compound.

Curing compound shall not settle hard in storage. They shall not be diluted or altered in any manner after manufacture. At the time of use, the compound shall be in a thoroughly mixed condition. If the compound has not been used within one hundred and twenty (120) days after the date of manufacture, the Engineer may require additional testing before use to determine

compliance to the requirements.

Curing compound may be sampled by the Engineer at the source of supply and on the Site.

3.8.4 Form in place method

Formed surfaces of concrete may be cured by retaining the form-in-place. The forms shall remain in place for a minimum period of seven (7) days after the concrete has been placed, except that for members over fifty (50) cm in least dimension, the forms shall remain in place for a minimum period of five (5) days. Wooden forms shall be kept wet by watering during the curing period.

3.8.5 Steam curing method

If steam curing for precast units shall be made at the manufacture's factory, the Contractor shall submit the detail of curing procedure, all equipment and materials for the Engineer's approval.

3.9 Concrete Surface Finishes

3.9.1 General

The type of finish and the requirements for finishing of concrete surfaces shall be as herein specified or as indicated on the Drawings. Finishing of concrete surfaces shall be performed only by workmen who are skillful in that trade.

Unless inspection is waived in specific cases, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits hereinafter specified. Surface irregularities are typified as "abrupt" or "gradual". Offsets caused by displaced form sheathing or lining or form sections, or otherwise defective form lumber will be considered as "abrupt" irregularities, and will be tested by direct measurement. All other irregularities will be considered as "gradual" irregularities, and will be tested by use of a template consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be one and half (1.5) m for testing of formed surfaces and three (3) m for testing of unformed surfaces. All surfaces shall be sloped as indicated on the Drawings or, even if not indicated, sloped sufficiently to prevent accumulation of water.

3.9.2 Formed surfaces

The types of finish for formed concrete surface, except surfaces for which special finishes are required, are designated by use of symbols F1 and F2.

Finish F1 applies to formed surfaces upon or against which fill material or concrete is to be placed. Correction of surface irregularities measured as previously described shall be required only for depressions which exceed thirty (30) mm.

Finish F2 applies to formed surface which will be permanently exposed and where a reasonably attractive appearance is required. Surface irregularities measured as previously described shall not exceed ten (10) mm for abrupt irregularities and twenty (20) mm for gradual irregularities.

3.9.3 Unformed surfaces

The types of finish for unformed concrete surfaces are designated by use of symbols U1 and U2. The requirements of this Clause, however shall not be applied to unformed surfaces such as those specified in concrete floor finishes, and mortar under equipment bases.

Unless the use of other slopes or level surfaces is indicated on the Drawings or directed by the Engineer, surfaces which will be exposed to the weather and which are nominally level shall be sloped approximately one (1) vertical to fifty (50) horizontal. Unless otherwise specified or indicated on the Drawings, the types of finish shall apply as follows :

Finish U1 is a screeded finish applied to unformed surfaces which will be covered by fill material or by concrete. Finish U1 is also the first stage of finish U2. Finishing shall consist of sufficient levelling and screeding to produce uniform surfaces. Surface irregularities measured as previously described shall not exceed twenty (20) mm.

Finish U2 is a floated finish applied to unformed surfaces of waterways (sluiceway) or surfaces which will be generally exposed to view such as weir crests, stairway treads and landings, decks, sump inverts, tops of walls and piers and surfaces of gutters. Floating shall be started as soon as the screeded surface has stiffened sufficiently, and shall be minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed five (5) mm.

3.9.4 Monolithic concrete floor finish

Where monolithic concrete floor finish is shown on the Drawings, placing concrete shall proceed continuously for the full thickness of the course of slab without change in concrete mix. Mixing water shall be the minimum required for proper placing and will be specified by the Engineer. After placing concrete, floors and other surfaces shall be floated with a wood float to a true surface and to elevation as shown on the Drawings. Where indicated on the Drawings or in these Specifications, floor surfaces shall be steel trowel finished. Troweling shall be the minimum amount consistent with maintaining a smooth dense surface, and shall not be done until the mortar has hardened sufficiently to prevent excess fine material from being worked up the surface. The addition of water, dry cement, or dry cement mortar to the surface of the concrete to facilitate finishing will not be permitted.

3.9.5 Concrete surface finish for concrete bridge slab

After the concrete has been deposited in place, it shall be compacted and the surface shall be struck off by means of strike board and floated with a wooden or cork float. An edging tool shall be used on all edges and at all expansion joints. The surface shall not vary more than three (3) mm under a three (3) m straight edge. The surface shall have a granular or matted texture which will not be slipped when wet.

3.9.6 Repair of damaged or defective concrete surfaces

Defective concrete and concrete damaged from any cause shall be removed and replaced with acceptable concrete by the Contractor at no cost to the Employer. Irregularities of alignment due to inaccurate finishing of surface, bulging of forms, or other defects shall be rectified by and at the expense of the Contractor. Before final acceptance of the work, the Contractor shall clean all exposed concrete surfaces of all encrustations of cement, mortar, or grout, and shall remove all unsightly stains to the satisfaction of the Engineer.

Unless otherwise approved by the Engineer, repair of imperfections in concrete shall be completed within twenty four (24) hours after removal of forms, or in the case of unformed concrete within twenty four (24) hours after the placing of concrete. Fins and encrustations shall be neatly removed from surfaces for which F2 finish is specified and encrustations shall be removed from surfaces for which U2 finish is specified.

Repair of concrete shall be performed by skilled workmen. The Contractor shall keep the

Engineer advised as to when repair of concrete is to be performed. Unless inspection is waived by the Engineer, in each specific case the repair of concrete shall be performed only in the presence of the Engineer or his representative.

Concrete that is damaged from any cause and concrete that is honeycombed, fractured or otherwise defective, and concrete which must be excavated and built up to bring the surface to the prescribed lines because of excessive surface depressions, shall be removed and replaced with dry-pack mortar, or concrete, as directed by the Engineer.

The detailed and definite specifications for repair of damaged or defective concrete surfaces shall be approved or directed by the Engineer. The cost of all materials, labour and equipment required in the repair of concrete shall be borne entirely by the Contractor.

3.10 Quality Control

3.10.1 General

Various tests required to be carried out for quality control, test standards and frequency of testing shall be in accordance with Sub-clause 3.3.1 hereinbefore. In addition, following tests shall also be conducted by the Contractor.

3.10.2 Compressive strength test

During manufacture and placing of concrete, not less than two (2) samples during each day and not less than one (1) sample for each fifty (50) m^3 of concrete shall be taken. Each sample shall consist of six (6) compression test cylinders. The cylinders ten (10) cm in diameter and twenty (20) cm high shall be moulded from each sample, standard cured and tested at seven (7) day testing for three (3) cylinders and twenty eight (28) day testing for the remaining three (3) cylinders in accordance with the requirements of JIS A 1132 or AASHTO T23. In case that maximum size of aggregate is forty (40) mm, the cylinders shall be moulded fifteen (15) cm in diameter and thirty (30) cm high.

The compressive strength of the concrete shall be deemed acceptable if the average of three (3) consecutive strength test results is equal to or exceeds the specified strength and no individual test result falls below the specified strength.

The test result shall be progressively analyzed and evaluated statistically. Evaluation shall be

made for more than ten (10) successive test results on the following basis :

(1) The probability of strength test being below the specified strength in Sub-clause 3.5.2 herein shall not be more than twenty five (25) percent.

(2) The probability of strength test being below eighty (80) percent of the specified strength in Sub-clause 3.5.2 herein shall not be more than five (5) percent.

If considered necessary by the Engineer, compressive strength of the placed concrete shall be checked by using Schmidt Hammer method. Frequency of this test shall be as directed by the Engineer.

3.10.3 Slump test

A slump test shall be made immediately before concreting is commenced and at all times when compression test samples are taken and at such other times when directed by the Engineer. The slump tests shall be in accordance with JIS A 1101, AASHTO T119 or SNI 1972-90-F.

3.10.4 Failure to pass tests

If the specified values are not obtained for compressive strength test on any concrete mix, no further concrete of that mix shall be placed in the works, and the Contractor shall establish the cause of the failure, provide three (3) cores taken in accordance with JIS A 1107 or AASHTO T24 for the further test and supply such remedies as are necessary for the Engineer's decision which may be one of the following :

- The Engineer may order the concrete corresponding to the cylinders to be cut out and replaced in accordance with Clause 50 of Vol. II, Part I - General Conditions of Contract.

- When the failure relates to concrete used in structural members which lend themselves to being load tested such as beams, columns or slabs, the Engineer may order the affected member to be so tested in accordance with his instructions. If cracking or any other sign of failure appears, the concrete shall be cut out to the extent ordered by the Engineer and replaced with sound material, otherwise the member may be accepted as satisfactory.

- When the failure, in the opinion of the Engineer, is slight and occurs in a continuing concreting operation for a large mass of concrete, the next works may be awaited and if the

failure then persists, the Engineer may order that concreting shall cease forthwith and not be resumed until further preliminary tests indicate that the mix has been corrected, otherwise the concreting may be allowed to continue with the same mix.

- When the failure is serious and relates to a concrete mass which lends itself to it, the Engineer may order one or more test cylinders to be drilled out and tested in accordance with the standards above in accordance with Clause 50 of Vol. II, Part I - General Conditions of Contract.

The cost of these tests including the provision and placing of jacks, kentledge, deflectometers, etc., and the cutting out and replacing or repairing concrete of inferior quality shall be borne by the Contractor.

3.10.5 Concrete material test

Where directed by the Engineer, the Contractor shall test concrete materials to be used in the Works in accordance with the following specifications at the frequency to be determined and directed by the Engineer :

Aggregates	JIS Standard	AASHTO Standard	SNI Standards
- Sieving analysis for coarse, fine aggregate and for stone fineness	A - 1102	T - 27	1968-90-F
- Weight of aggregates per unit volume	A - 1104	T - 19	1750-90-A
- Organic impurities in fine aggregate	A - 1105	T - 21	1755-90-A
- Specific gravity and water absorption test in fine aggregate	A - 1109	T - 84	1970-90-F
- Specific gravity and water absorption test in coarse aggregate	A - 1110	T - 85	1969-90-F
- Los Angeles abrasion test	A - 1121	T - 96	03-2417-1991
- Soundness of aggregates by use of Sodium Sulphate	A - 1122	T - 104	1758-90-A
- Sand equivalent test	A - 1137	T - 176	0351-89-A
- Fineness test on cement	R - 5201	T - 128	15-2530-1991
- Strength test on mortar specimens	R - 5201	T - 106	M-111-1990-03

3.10.6 Record of concreting and tests

An accurate and up-to-date record showing dates, times, weather and temperature conditions (when various positions of the works were concerted) shall be monitored by the Contractor and a quality control report based upon test results shall be submitted on the monthly basis to the Engineer for his review and the Project record. The Contractor shall also record the results of all tests of concrete and shall identify these results with parts of which the sampled material is representative.

3.11 Tolerance for Concrete Construction

Allowable deviation from plumb or level and from the alignment, profile, grades and dimensions shown on the Drawings are defined as "tolerances". Tolerances shall be inclusive of surface irregularities as defined in Clause 3.9.

The intent of this Clause is to establish tolerances that are consistent with modern construction practice, yet governed by the effect that permissible deviations will have upon the structural action or operational function of the structure. Deviations from the established lines, grades and dimensions will be permitted to the extent set forth herein. Provided that the Engineer reserves the right to diminish the tolerances set forth herein if such tolerances impair the functional behaviour of a structure. Where tolerances are not stated in the Specifications or Drawings for any individual structure of feature thereof, permissible deviation will be interpreted conformably to the provisions of this Clause.

The Contractor shall be responsible for setting and maintaining concrete forms sufficiently within the tolerance limits so as to ensure completed work within the tolerance specified herein. The concrete work that exceeds the tolerance limits specified in the following tabulation shall be remedied or removed and replaced at the expense of and by the Contractor.

Tolerances for Concrete Structures

1. Monolithic concrete structures
   - (1) Departure from established alignment ..... 5 cm
   - (2) Departure from established profile grade..... 5 cm
   - (3) Variation in thickness
     - Minus ..... 2.5 % or 1 cm, whichever greater

Plus .....5 % or 1 cm, whichever greater

(4) Variation from inside dimension ..... 0.5 %

2. Bridges, bridge abutments, bridge piers

(1) Departure from established alignment ..... 5 cm

(2) Departure from established grades..... 5 cm

(3) Variation from the plumb or the specified batter in lines and surfaces of columns, piers, walls and in risers

Exposed in 3 m ..... 1 cm

Backfilled in 3 m..... 5 cm

3. General structures

(1) Variation from the level or from the grades indicated on the Drawings in slabs, beams, horizontal grooves and railing offsets

Exposed in 3 m ..... 1 cm

Backfilled in 3 m..... 5 cm

(2) Vibration in cross sectional dimensions of columns, piers, slabs, walls, beams and similar parts of the structures in paragraph (1) above

Minus ..... 1 cm

Plus..... 2 cm

(3) Variation in thickness of bridge slabs

Minus ..... 1 cm

Plus..... 2 cm

(4) Footings

(a) Variations of dimension in plan

Minus ..... 1 cm

Plus..... 5 cm

(b) Misplacement or eccentricity 2 % of the footing width in the direction of misplacement but not more than ..... 5 cm

(c) Reduction in thickness..... 5 %

(5) Variation in the size and location of slab and wall openings..... 5 cm

(6) Deviation from the plumb or level of sills and side walls for gates and similar water tight joints..... 0.1 %

4. Placing of reinforcement steel

(1) Variation for protective covering..... 10 %

(2) Variation from indicated spacing..... 2 cm

5. Laying of precast concrete units
   (1) Departure from established alignment 1 % of length of precast unit not more than ..... 5 cm
   (2) Departure from established grades 1 % of length of precast unit, not more than ..... 5 cm
   (3) Variation from the plumb of precast unit placed vertically in 3 m .... 1 cm

6. Placing embedded metalwork
   (1) Minus ..... 6 mm
   (2) Plus ..... 6 mm

7. Color of concrete
   Abrupt changes in color of external concrete surfaces exposed to public view will not be permitted. The Contractor shall ensure that as far as possible these surfaces shall be of uniform color or that changes in color, where permitted, are gradual.

3.12 Formwork

3.12.1 General

The work shall consist of providing, erecting and removing concrete forms of sufficient strength with all necessary fasteners, bracings, etc. in conformity with the requirements specified hereinafter.

Form sheathing shall have such smoothness and uniformity as required to meet the requirements for tolerance and finish as hereinafter specified and shall be manufactured in such a way that any horizontal joints are not continuous across the entire formed surface. Forms shall be true to line and grade, mortar tight and sufficiently rigid to prevent objectionable deformation under load. Curved surfaces shall be formed to conform to the curve data shown on the Drawings ; construction of such curved section in chorded lengths will not be permitted except where such construction is shown on the Drawings or specifically approved by the Engineer. The surfaces of all forms to be in contact with the concrete shall be clean, rigid, and sufficiently tight to prevent loss of mortar. Responsibility for their adequacy shall rest with the Contractor ; however, the type, shape, size, quality, and strength of all material of which the forms are made shall be subject to the Engineer's approval. All forms shall be so constructed that they can be removed without damage

to the concrete. All exposed joints, edges, and external corners shall be chamfered not less than two (2) cm at forty five degrees (45°) except as otherwise shown. Internal corners shall be filleted where indicated or required by the Engineer.

3.12.2 Material requirement

All materials for form sheathing shall be subject to the approval of the Engineer. Lumber shall be sound, straight, free from warp, decay and loose knots and shall be dressed smooth and uniform in width and thickness prior to fabrication of form work. Forms to be used in concrete for water passages which will ultimately be exposed to view shall be faced with either plywood (symbolized F2) or other wood (symbolized F1) and shall be free of all defects which will be reproduced as blemishes on the concrete surfaces.

Where plywood is used, it shall be non-warping, non-wrinkling and manufactured with special waterproof glues. In so far as is practicable, plywood sheets shall be of uniform width and length.

Timber sheathing or lining shall be of such kind and quality or shall be so treated or coated that there will be no chemical deterioration or discolouration of the formed concrete surfaces. The type and condition of form sheathing and lining, the ability of the forms to withstand distortion caused by placement and vibration of the concrete, and the workmanship used in form construction shall be such that the formed surfaces will conform to Sub-clause 3.9.2 hereinbefore pertaining to finish of formed surfaces.

Form sheathing and lining shall conform to the requirements authorized by the Engineer.

3.12.3 Placing and preparation

Forms shall be placed so that the joint marks on concrete surfaces are in alignment both horizontally and vertically, and the joints between surfaces shall be smooth. All edges or corners of the concrete exposed permanently shall be chamfered as shown on the Drawings or as directed by the Engineer.

Before placing concrete, all forms shall be rigid and tight and shall be thoroughly cleaned, and all wooden chips, saw dust, dry mortar lumps, foreign matter, and excess water shall be removed from the forms. The surface of the forms shall be oiled with a refined mineral oil of a type approved by the Engineer. The form oil shall be applied before the reinforcing steel is placed. Forms, which have been left in place for such a period that they have dried out, shall receive further surface

treatment as directed by the Engineer.

Where forms for continuous surfaces are placed in successive lifts, care shall be taken to fit the forms tightly over the entire surface so as to prevent leakage of mortar from the concrete and to maintain accurate alignment of the surface.

Forms to be used more than once shall be maintained in serviceable condition and shall be thoroughly cleaned before being reused. Forms on exterior faces on walls shall be kept clean by means of splash boards whenever practicable.

Immediately before concrete is placed, precautions shall be taken to see that all forms are in proper alignment, and that all form supports and scaffolding (if any) are thoroughly secure and tight.

The rate of depositing concrete in forms shall be such to prevent deflections of the forms or form panels in excess of the deflections permitted by the Specifications.

Form for exposed concrete surface shall be designated and constructed so that the formed surface of the concrete does not undulate excessively in any direction between studs, joists, form stiffeners, form fasteners, or walls. Undulations exceeding either two (2) mm or 1/270 of the centre distance between studs, joists, form stiffeners, or walls will be considered to be excessive. Should any form of forming system, even though previously approved for use, produce a concrete surface with excessive undulations, its use shall be discontinued until modifications satisfactory to the Engineer have been made. Portions of concrete structures with surface undulations in excess of the limits herein may be rejected by the Engineer.

All exposed surfaces of similar portions of concrete structure shall be formed with the same forming material or with materials which produce similar concrete surface textures, colour and appearance. Forms for exposed surfaces shall be made of form materials of even thickness and width and with uniform texture and constructed with triangular fills at least twenty (20) mm wide attached so as to prevent mortar runs and to produce smooth straight chamfers at all sharp edges of the concrete.

Form fasteners consisting of form bolts, clamps or other devices shall be used as necessary to prevent spreading of the forms during concrete placement.

Wire ties passing through the forms shall not be used unless authorized by the Engineer. The ties shall be constructed so that removal of the ends or end fasteners can be accomplished without

causing appreciable spelling at the faces of the concrete. Recesses resulting from removal of the ends of form ties shall be filled in accordance with the provisions stipulated in Sub-clause 3.9.6.

Anchor devices may be cast into the concrete for later use in supporting forms or for lifting precast members. The use of driven types of anchorage for fastening form support to concrete will not be permitted.

3.12.4 Removal of forms

The Contractor shall not remove forms until the concrete has hardened and is of sufficient strength to carry its own weight safely, together with any construction loads likely to be imposed upon it. Forms shall be removed only with the approval of the Engineer in a manner which will prevent injury to the concrete and, in general, the form shall be left for periods not less than forty eight (48) hours after the concrete is placed, or as directed by the Engineer. In no case, however, the Engineer's consent for removal of forms relieve the Contractor of his responsibility for the safety of the work.

When concrete strength tests are used for removal of forms and supports, such removal of forms and supports shall be in line with the following :

Requirement for Removal of Forms

Item of Work	Minimum Time		Minimum Percentage of Design Strength
Centering under girders, beams, frames or arches	14 days	or	80 %
Floor slabs	14 days	or	70 %
Mass concrete	2 days	or	70 %
Sides of beams and all other vertical surfaces	1 day	or	70 %

In order to determine the condition of column concrete, forms shall be removed from columns before releasing support from beneath beams and girders.

The forms may be left in place when, in the opinion of the Engineer their removal would endanger the safety of the structure, and when the forms so left intact will not be exposed to view in the

finished structure. All other forms shall be removed whether above or below the ground line or water level.

To facilitate finishing, forms used for ornamental work, railings, parapets, and exposed vertical surfaces shall be removed in neither less than twelve (12) nor more than forty eight (48) hours depending upon the weather conditions. In order to determine the condition of concrete in columns, forms shall always be removed from them before the removal of supporting pole from beams and girders.

3.12.5 Support and scaffolding of form

Support of form shall be made of timber or metal, to keep the form conforming to the shape, lines and dimensions of the members as shown on the Drawings and shall be so rigidly constructed as to prevent deformation due to load, drying and wetting, vibration and other causes. The support shall be designed to carry the maximum loads which may be imposed.

Scaffolding shall be built on foundation of sufficient strength to carry the loads without appreciable settlement and its type and structure shall be approved by the Engineer. Extent of chamber of form shall be decided after approval by the Engineer.

No separate payment shall be made for support and scaffolding of form and these costs incurred by the Contractor shall be included in the respective form works stated in the Bill of Quantities.

3.13 Reinforcing Bars and Other Miscellaneous Items

3.13.1 General

This work shall consist of furnishing, fabricating and placing of steel reinforcements and other miscellaneous items of the type, size, shape, and grade required in accordance with these Specifications and in conformity with the requirements shown on the Drawings or as directed by the Engineer.

The Contractor shall prepare the delivery schedule of these reinforcing bars to provide with sufficient stocks of bars to commence cutting and bending reinforcement for a structure at least sixty (60) days before the scheduled placement of concrete around the reinforcement. The delivery schedule is to based on the Contractor's detailed construction programme, including amendments, if any, as reviewed by the Engineer.

3.13.2 Reinforcement bars material requirement

The Contractor shall furnish, cut, bend, and place all steel reinforcing bars as indicated on the Drawings or as directed by the Engineer. Except where shown otherwise on the Drawings, the reinforcing bars shall be deformed steel bars, shall be made by an approved manufacturer, and shall comply with JIS G 3112, SD 295, SNI 2052-89-A or approved equivalent. All reinforcements when surrounding concrete is placed, shall be free from loose, flaky rust and scale, and free from oil, grease or other coating which might destroy or reduce its bond with the concrete.

Reinforcing bars shall be sampled by the Engineer either at the source of supply or at the point of their distribution, or both. Contractor shall notify the Engineer in advance to permit sampling and testing before shipment is made. Engineer may select two (2) or more samples from each size at random representing five (5) tons or fraction thereof of each size and direct the Contractor to get the selected samples tested at an approved laboratory at the Contractor's cost. Reinforcement shall only be allowed to be placed at work site if duly certified by the laboratory to the satisfaction of the Engineer. In no case, the Engineer's consent shall relieve the Contractor of his responsibility for supplying and placement of correct type of reinforcing bars in concrete.

3.13.3 Fabrication and assembly

The Contractor shall prepare at his own expense all detailed reinforcement drawings. These drawings shall include all bar-placing drawings, bar-bending drawings, bar lists and any other reinforcing drawings as may be required to facilitate fabrication and placement of reinforcing bars. Such drawings shall be approved by the Engineer before the fabrication and placing of reinforcing bars. Clear distance between bars or between bars and concrete surfaces, and details of hooks, bends, splicing and anchorage shall all conform to the standard details shown on the Drawings.

Bending of bars with the aid of heat shall not be performed unless otherwise approved by the Engineer. Permission may be granted on specific request and submission by the Contractor of his proposed method including precautions to assure that the particular steel bars will not undergo any injury whatsoever. Such permission shall not relieve the Contractor from sole responsibility for the adequacy of the method and the bars.

The reinforcing bars shall be secured firmly in their correct position so that no displacement will occur during concrete placing or as a result of vibration. Horizontal reinforcing bars shall be supported with precast concrete or steel saddles placed in such a manner that they shall be

adequate to maintain the bars at the correct level.

The intersecting points and laps of the reinforcing bars shall be securely tied with soft iron wire of not less than 0.9 mm in diameter. The minimum clear cover to main reinforcing bar shall generally be between five (5) and ten (10) cm as shown on the Drawings or as directed by the Engineer. Notwithstanding the minimum clear cover to reinforcement shown on the Drawings, the Engineer may as often as he deems necessary, vary the clear cover to reinforcement during the construction.

Reinforcing bars shall be lapped where necessary. The length of overlapping shall not be less than twenty five (25) times of the diameter of the larger bar or as directed by the Engineer. The location of laps in reinforcement shall be subject to the approval of the Engineer.

The Contractor shall be responsible for the accuracy of the cutting, bending and placing of the reinforcement. Reinforcement will be inspected for compliance with the requirements as to size, shape, length, splicing locations, position and amount after it has been placed. When a long period of time has elapsed after placing reinforcing bars, they shall be inspected again by the Engineer before placing concrete.

3.13.4 Anchor bars and joint bars

The anchor or joint bars shall be provided for the bridge structures as shown on the Drawings or elsewhere directed by the Engineer.

The Contractor shall furnish, cut and place all anchor bars or joint bars as indicated on the Drawings or otherwise required.

The cutting and placing of anchor or joint bars shall be in accordance with Sub-clause 3.13.3 hereinbefore or as directed by the Engineer.

3.13.5 Joint filler

The Contractor shall furnish and install the expansion joint filler at locations indicated on the Drawings or as directed by the Engineer. Expansion joint filler material shall be of the expanded polystyrene type satisfing the requirements of ASTM D2125, Type 1, Grade 15, or approved equivalent and shall be thick enough to cover all voids.

Requirements for Joint Filler

Physical Characteristic	Requirement	Code No.
Tensile strength	more than 20 kg/cm^2	JIS K 6301
Ultimate elongation	more than 100 %	-
Hardness	more than 50 HS	JIS K 6301 - 52
Water absorption	less than 0.5 %	JIS A 9511
Recovery	more than 90 %	ASTM D 544 - 48
Apparent density	more than 0.3 g/cm^3	-

Prior to installing the expansion joint filler, the Contractor shall submit the proposed material sample along with its test certificates, manufacturer's specifications and installation method of expansion joint filler he intends to use for approval of the Engineer.

The Contractor shall cut the joint filler to cover the required surface of the concrete at expansion joints and to fit around all openings.

Where placed against vertical surfaces the joint filler shall be held in place against the completed side of an expansion joint by an approved material applied to the face of each piece of joint filler for not less than forty (40) mm from each edge of the face. Splices or joints of the joint filler shall be made with cold applied cementing material so that mortar from the concrete will not seep through to the opposite concrete surface. The number of field joints shall be kept to a minimum by using factory produced joints wherever possible. The water tightness of the joints and structures for which joint filler has been provided shall be the Contractor's responsibility.

3.13.6 Waterstops

The Contractor shall furnish and install the waterstops as shown on the Drawings or as directed by the Engineer and as specified herein. The waterstops which have the following physical characteristics shall conform to the requirements of JIS K6773-74, Flexible Polyvinyl Chloride (PVC) Waterstops, or equivalent and shall be subject to the approval of the Engineer ;

Requirements for Waterstops

Physical Characteristic	Requirement
Specific gravity	1.40 or less
Tensile strength (kg/cm^2)	120 or more
Elongation (%)	350 or more
Hardness	65 or more

The waterstops shall be fabricated from a plastic compound, the basic resin of which shall be polyvinyl chloride. All waterstops shall be moulded or extruded and free in such a manner that any cross section will be dense, homogeneous and free from porosity and other imperfections. The waterstops shall be symmetrical in shape and the dimensions of both type shall be as follows:

Dimension (mm)	Type A (3-bulb type)
Width	200
Thickness	9
Allowance : width + 3 %, thickness + 10 %	

All waterstop shall be stored in a place as cool as practicable, so as to permit free circulation of air about it and in no case shall waterstop be stored in the open or exposed to the direct rays of the sum.

The number of joints in the waterstops shall be the minimum practicable and all joints and bends shall be made as shown on the Drawings or as approved by the Engineer. The number of straight field joints shall be kept to a minimum and all "Tee", "Cross" and "Ell"joints shall be factory produced or prepared at the Contractor's field shop to the satisfaction of the Engineer. The equipment used for making field joints in polyvinyl chloride waterstops shall be furnished by the Contractor and shall be as approved by the Engineer.

All joints shall be made with a temperature contolled apparatus as specified by the manufacturer and in such a manner as to ensure :

- that the material is not damaged by heat, searing or by the application of cementing materials;

- that the splices have a tensile strength not less than 80% of that required of the specified material;

- that the splice is watertight; and

- that the ribs and central bulb, where applicable, match up exactly and are continuous.

For the waterstop strips which are to be placed at contraction joints, close attention is required to see that they are properly embedded. The waterstops shall be installed with equal widths of the material embedded in the concrete on each side of the joint. The concrete shall be carefully placed and vibrated around the waterstops to ensure that the waterstops are not damaged and a complete bond is secured between the concrete and all embedded areas of the waterstops. After installation and before embedment in concrete, the waterstop shall be protected from the direct rays of the sun.

The Contractor shall replace or repair, at his expense, any waterstops torn, punctured or otherwise damaged before final acceptance of the work.

The Contractor shall provide all necessary supports and ties required for placing the waterstops and protect them from damage, deterioration or warping during the progress of work.

The water tightness of joints and structures for which waterstops are provided shall be the Contractor's responsibility. The Contractor shall supply all materials and labour and perform all the work necessary to rectify leaking joints and structures to the Engineer's directions and satisfaction.

3.14 Measurement and Payment

3.14.1 Concrete and mortar

Measurement, for payment, of concrete or mortar will be made on the basis of actual placed volume of concrete or mortar in cubic metres within the neat lines of the structures as indicated on the Drawings or as otherwise established by the Engineer.

Measurement of concrete against the sides of any excavation without the use of intervening forms shall be made only within the pay lines or designated lines of the structure. No deduction shall be made for rounded or beveled edges or space occupied by metal work, electrical conduits, nor for voids or embedded items which are less than 0.05 m^2 in cross section.

Payment shall be made for the number of cubic metres measured as provided above at the respective unit prices per cubic metre stated in the Bill of Quantities and duly certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices for concrete or mortar shall constitute full compensation for the cost of all labour, tools, equipment, and materials, which are the cost of cement, water, preparation of joints, handling and incorporating the cement and admixtures into the work, transportation of aggregates from specified stockpile yard or elsewhere to the Site, including furnishing, loading, hauling, unloading, stockpiling, mixing, placing the concrete or mortar, placing in joints, treatment of joints, curing, testing as specified and all other items necessary to complete the works.

Payment will not be made for concrete required to be placed outside the designated lines beyond the excavation paylines due to over excavation or for any other reason, except as otherwise provided. No payment will be made for defective and wasted concrete or mortar. Any concrete which the Contractor places or uses for his own installations or on his own initiative, shall be at the expense of the Contractor.

3.14.2 Formwork

Measurement, for payment, of formwork for concrete will be made of the area in square meters of formed surfaces of concrete as shown on the Drawings or as directed by the Engineer. The measurement will include sloping surfaces steeper than 1 vertical to 2 horizontal, the formed surface of contraction joints and construction joints shown on the Drawings or directed by the Engineer and the formed surfaces of blockouts larger than 0.1 m^2 in cross-sectional area. The following surfaces will not be measured for payment for formwork :

(a) Sloping surfaces not steeper than 1 vertical to 2 horizontal, whether formed or not.
(b) Surfaces of materials, structures and installations which are required to remain in place after the concrete poured against them has hardened.
(c) Formed surfaces of construction joints not shown on the Drawings.
(d) Forms used to fill over-excavation.
(e) Grooves and chamfers at joints and elsewhere.
(f) Blockouts not larger than 0.1 m^2 in cross-sectional area.
(g) Other surfaces as designated by the Engineer.

Payment for forms, and scaffolding where required, for concrete shall be made at the respective unit prices per square metre stated in the Bill of Quantities and duly certified by the Engineer in the

Bi-Monthly Statement of Account. The unit prices for formwork shall constitute full compensation for the cost of all labour, tools, equipment and materials required to perform the forming work including furnishing, transporting, fabricating, erecting, surveying, fixing, scaffolding work, dismembering, removing the form and all other items necessary to complete the works.

3.14.3 Reinforcing bars

Measurement, for payment, of reinforcing bars will be made on the basis of actual installed weight of steel bars in concrete for the Permanent Works in kilograms determined by the lengths and numbers of bars as shown on the Drawings or as directed by the Engineer, converted to weight for the size of bars listed by the use of unit weights per linear metre.

Steel in laps indicated on the Drawings or required by the Engineer shall be paid for at the unit price stated in the Bill of Quantities. No payment shall be made for the additional steel in laps and spacer or hanger bars which are authorized for the convenience of the Contractor.

Payment for reinforcement bars shall be made at the respective unit prices per kilogram stated in the Bill of Quantities and duly certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices for reinforcing bars shall constitute full compensation for the cost of all labour, tools, equipment and materials including furnishing, transporting, bending, cutting, fabricating, cleaning, placing, supporting the bars and all other items necessary to complete the works.

3.14.4 Other miscellaneous items

(1) Expansion joint filler and bitumen coating

Measurement, for payment, of furnishing and installing expansion joint filler or bitumen coating will be made on the basis of actual installed or coated area in square metres determined by the dimensions as shown on the Drawings or as directed by the Engineer.

Payment shall be made for the number of square metres measured as provided above at the respective unit prices stated in the Bill of Quantities and duly certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices for expansion joint filler or bitumen coating shall constitute full compensation for the cost of all labour, tools, equipment and materials including furnishing, transporting, fabricating, installing the expansion joint filler or coating and all other items necessary to complete the works.

(2) Waterstops

Measurement, for payment, of furnishing and placing the waterstops will be made on the basis of actual installed length of waterstops in place in linear metres determined by the locations, size and lengths as shown on the Drawings or as directed by the Engineer. In computing the quantities, no allowance shall be made for laps at splices, joints and intersections. Waterstops installed by the Contractor in construction joints in locations other than those shown on the Drawings or as directed by the Engineer will not be measured for payment.

Payment for furnishing and placing the waterstops shall be made for the number of linear metres measured as provided above at the respective unit prices stated in the Bill of Quantities and duly certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices for waterstops shall constitute full compensation for the cost of all labour, tools, equipment and materials including furnishing, transporting, fabricating, installing, jointing the waterstops and all other items necessary to complete the works.

(3) Anchor bars and joint bars

Measurement, for payment, of anchor or joint bars will be made on the basis of actually set number as shown on the Drawings or directed by the Engineer.

Payment shall be made for the number of pieces measured as provided above at the respective unit prices per number stated in the Bill of Quantities and duly certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices for anchor or joint bars shall constitute full compensation for the cost of all labour, tools, equipment and materials including furnishing, transporting, setting and all other items necessary to complete the works.

3.15 Gravel and Rubble Bedding

3.15.1 General

Gravel or rubble bedding shall be furnished underneath the levelling concrete for the foundation of concrete structures such as entrance and outlet aprons of the sluices to be built in the drainage channel.

Gravel or rubble bedding shall be made in accordance with the lines, grades and dimensions as

shown on the Drawings or as directed by the Engineer.

Materials to be used for gravel or rubble bedding shall be well graded, sound and hard. Size of the materials shall be combined as follows :

Maximum size : less than twenty (20) cm
Minimum size : more than ten (10) cm

The materials shall be natural angular stone selected from river deposits or quarry sites approved by the Engineer. The materials shall be placed and spread in layers with well graded blind materials and compacted by methods approved by the Engineer.

3.15.2 Measurement and payment

Measurement, for payment, of gravel or rubble bedding will be made on the basis of volume of gravel in cubic meters actually placed as shown on the Drawings or as directed by the Engineer.

Payment for gravel or rubble bedding shall be made at the unit price per cubic metre stated in the respective items of the Bill of Quantities and duly certified by the Engineer in the Bi-Monthly Statement of Account.

The unit price for gravel or rubble bedding shall constitute full compensation for the cost of all labour, tools, equipment and materials including furnishing, transporting, subsequent mixing and placing the gravel or rubble stones and all other items necessary to complete the works.

3.16 Precast Concrete

3.16.1 General

This work shall consist of fabricating or procuring pre-fabricated concrete units such as precast concrete pipes, piles, beams, etc. and their installation at the Site, and the requirements of type, shape, size and grade in accordance with the Specifications and the Drawings or as directed by the Engineer.

If the Contractor decides to use such items, they can be either purchased from a reputable manufacturer or precast by the Contractor at the Site. If such items are purchased, they shall conform to the applicable standards, such as JIS A 5302-1975 for concrete pipe or equivalent

approved by the Engineer. If the Contractor decides to precast the items at the Site, the shall submit full details concerning such to the Engineer for approval at least forty five (45) days before commencing manufacture of the precast concrete units.

These details shall include the methods to be used in manufacturing the units such as type of prestress system, type of prestress wire or cable, size of aggregate, concrete mix, reinforcing steel, forming, placing, finishing, curing, handling, transport, storage, erection, etc. Upon receipt of such details, the Engineer will review them and if necessary will have the Contractor modify them until they are found to be satisfactory at which time they will be approved as specifications and incorporated herein. All precast concrete units manufactured by the Contractor shall comply with the approved specifications.

3.16.2 Manufacturing of precast concrete units

Precast concrete units shall be manufactured in the type 1 of concrete and to the sizes shown on the Drawings and the concrete shall comply in every respect with the provisions of these Specifications whether such precast concrete units are manufactured at the Site or are procured from approved manufacturers.

When casting concrete units, the concrete shall be placed continuously in the forms and compacted by vibrating, supplemented by spading and tamping, in a manner acceptable to the Engineer. The forms shall be overfilled and the surplus concrete shall be screeded-off.

Special care shall be exercised in tamping and vibrating the concrete so as not to displace the reinforcement. The concrete units shall be allowed to remain in their forms for three (3) days before being stripped, during which time the exposed face shall be covered with sacking or matting and kept constantly wet. In addition, sides of the forms shall be shielded from direct rays of the sun.

3.16.3 Curing of precast concrete units

After removal of the forms, the precast concrete units shall be kept moist continuously for a minimum period of eleven (11) days. After stripping, the concrete units shall be stacked for a period of not less than thirty (30) days before they are used for the work, unless otherwise permitted and approved by the Engineer. The precast concrete units shall be so stacked as to leave a free air space between each of these units. Each unit shall be clearly marked with the date of its casting.

3.16.4 Measurement and payment

Measurement, for payment, of the various items of precast concrete units will be made to the actual quantities of the respective works done in linear meters, square meters, cubic meters, numbers, pieces, tons or kilograms, etc. so measured as provided in the Bill of Quantities and duly certified by the Engineer.

Payment for the various items of precast concrete units shall be made at the unit prices per linear meter, square meter, cubic meter, number, piece, ton or kilogram and/or the lump sum price and to the actual volume of works so certified by the Engineer in the Bi-Monthly Statement of Account. The unit price of precast concrete units shall constitute full compensation for the cost of all labour, tools, equipment and materials including curing, stacking, furnishing, transporting, setting and installing at site and all other items necessary to complete the works.