7. ROAD WORK

7.1 General

This Chapter covers the construction and maintenance of roadway including control and removal of water, excavation and backfill, embankment, concreting, drainage, subbase/base and surface courses, guardrailing and other incidental work concerning roadways. The Contractor shall construct all roadways as shown on the Drawings or as directed by the Engineer. In addition, the Contractor shall be responsible for designing, constructing and maintaining various temporary construction roads as outlined in Clause 7.11. Road works in this Contract consists of the following items, but not limited to ;

- Construction of temporary haul roads.

- Heightening, maintenance and relocation of the existing public and access roads.

- Construction and maintenance of new inspection roads on approaches to the bridges, new levee and their ramps along the drainage channels including gravel metaling and/or asphalt pavement.

- Asphalt treated pavement surfacing on concrete slab of bridges.

Location and layout of these roads are shown on the Drawings.

The Contractor shall execute the above mentioned road works in accordance with the provisions of this Chapter as well as the other applicable Chapters such as Chapter 2, Earthwork, and Chapter 3, Concrete Work, of these Technical Specifications, as shown on the Drawings or as directed by the Engineer.

The Contractor shall stake out the work and secure the Engineer's approval of the stake-out before proceeding with construction. If, in the opinion of the Engineer, any modification of the line or grade is advisable, either before or after stake-out, the Engineer will issue detailed instructions to the Contractor for such modification and the Contractor shall revise the stake-out for further approval. These requirements shall be met without additional payment. Provisions for drainage shall include the construction of drainage ditches, cross drains and culverts in accordance with the provisions in Clause 5.6.

Sufficient templates and straightedges shall be furnished by the Contractor for use in checking the finished surface of the pavement structure. These templates and straightedges shall be submitted to the Engineer for his approval and shall be maintained by the Contractor at all times in a condition to produce the correct cross-sectional profile. They shall be checked at intervals and, if necessary, repaired or adjusted as directed by the Engineer. The furnishing and maintenance of the templates and straightedges will not be paid for directly, but all costs therefor shall be included in the applicable prices tendered in the Bill of Quantities for road construction.

The gradation, moisture control, density, placing, compaction and asphalt application requirements for the embankment, sub-base course, base course and surface course shall be as stipulated herein; however, the Engineer reserves the right to adjust these requirements as he deems best, and in such case no change will be allowed in the unit prices for such work as tendered in the Bill of Quantities.

7.2 Control and Removal of Water

Control and removal of water during construction of the inspection roads shall be accomplished in accordance with the stipulations of Chapter 1 of these Specifications. Payment for control and removal of water during excavation and embankment work shall not be made separately and shall be deemed to be included in the appropriate unit rates or lump sum prices for the respective work items tendered therefor in the Bill of Quantities.

7.3 Clearing

The ground over which the road is to be built, to a width of one (1) m outside the tops of all cut sections and one (1) m outside the toes of the roadway embankments as the case may be, and the ground along the lines of the drain ditches shall be cleared of trees, bush, rubbish and other objectionable matter as required. The ground surface under the roadway embankment shall be cleared of all stumps, roots, and non-perishable objects except for those which will be a minimum of one (1) m below subgrade or slope of the embankments. All cleared material shall be disposed of in the same manner as provided for in Chapter 2, or as directed by the Engineer. All timber cleared in the area which may be removed shall remain the property of the Employer, if marketable.

Measurement, for payment, of the clearing work will be made on the basis of actual square meters of acceptably cleared area within the limits shown on the Drawings or designated for clearing by

the Engineer. Areas not shown on the plans or not staked for clearing will not be measured or paid for.

Payment for the clearing works shall be made at the unit price per square meter tendered therefor in the Bill of Quantities. The unit price shall constitute full compensation for the cost of all labour, tools, equipment and materials including loading, hauling, disposing of cleared material and other items necessary to complete the work.

7.4 Drainage and Concrete Work

All drainage work for the permanent inspection roads such as drain ditches and catch basins, concrete pipe culverts and cross drains including related concrete headwalls, side walls and aprons, PVC drain pipe, etc. shall be constructed as shown on the Drawings. The detailed provisions which pertain to drainage ditches, catch basins, pipe culverts and cross drains head walls, etc. for the inspection roads including measurement and payment therefor, are stipulated in Clause 5.6.

The Contractor shall construct ditches and culverts as shown on the Drawings. In order to keep water away from the embankment, subbase and base courses during construction, the Contractor shall at all times ensure adequate drainage by scheduling ditch and culvert construction work so that the drainage is operative before work is begun on the embankment and pavement. The Contractor shall clean and trim all such drainage ditches from time to time so that there may be a free flow of water throughout the Contract period. Damage to the work due to unfavourable drainage or through failure to provide adequate drainage will result in an order by the Engineer to repair the damage at the Contractor's expense. Payment for the drainage items and related concrete work will be made at the unit prices tendered therefor in the Bill of Quantities.

7.5 Excavation

7.5.1 General

All materials encountered in the road shall be excavated to the grades and lines shown on the Drawings or as directed by the Engineer. The detailed provisions which pertain to excavation for the roads, including measurement and payment thereof, are stipulated in Chapter 2. Earthwork.

Subgrade line shall be formed to the correct transverse and longitudinal profiles as required but at a grade higher than the final grade in order to allow for the effect of compaction. The material

shall be compacted with approved rollers and prior to compaction the moisture content shall be adjusted by watering with sprinkler trucks or other approved methods, or by drying out, as may be required in order to attain the specified compaction.

7.5.2 Measurement and payment

Measurement, for payment, for material removed from the excavation for the permanent roads will be made to the lines and grades shown on the Drawings or as directed by the Engineer and such measurement shall be based on the original ground surface before excavation and the actually excavated surface as approved by the Engineer, in accordance with the provisions stipulated in Sub-clause 2.4.5.

Payment for material excavated for the permanent roads will be made at the unit prices per cubic meter as tendered therefor in the Bill of Quantities, in accordance with the provisions stipulated in Sub-clause 2.4.5.

7.6 Road Embankment

7.6.1 General

The road embankment shall be that part of the work which is prepared for the support of the sub-base of the pavement structure.

The embankment for the inspection roads shall be constructed at the locations and to the lines, grades and dimensions as shown on the Drawings or as directed by the Engineer. The earthfill material for the road embankment shall consist of suitable material excavated from cut sections of the drainage channels or from any other area as directed by the Engineer and shall be free from brush, roots, vegetation, large boulders and other unsuitable material. The material shall not be placed in the road embankment until the foundation for it has been suitably prepared and approved by the Engineer.

After being compacted, the gradation of the embankment material shall conform to the following, unless otherwise directed by the Engineer. The gradation shall be modified during the course of the work.

(1) The maximum particle size shall be thirty (30) cm.

(2) The material which is in the range between No. 4 (4.76 mm) and thirty (30) cm shall be less than fifty (50) percent of the total material.

(3) The material smaller than No. 200 sieve size shall be more than five (5) percent of the total material.

The road embankment shall be generally constructed in accordance with the applicable provisions stipulated in Clauses 2.9 and 2.10 hereinbefore of these Specifications.

The Contractor shall arrange for the construction of the road embankment, the sub-base course and the base course in an orderly and systematical manner. The road embankment when prepared rapidly in relation to the laying of the sub-base course, is liable to deterioration, and in such case the Contractor shall, without additional payment, repair, reroll or recompact the road embankment as may be necessary to restore it to the state specified herein.

7.6.2 Moisture control and density

Unless otherwise approved or directed by the Engineer, the moisture content of the embankment material during and after compaction shall be within the range from minus four (4) % to plus two (2) % of the optimum moisture content, and this moisture content shall be uniform throughout each layer which is placed.

The optimum moisture content of the embankment material shall be that moisture content which is required to produce the maximum dry density obtained from the compaction test in accordance with Sub-clause 2.9.7 of Chapter 2. The moisture content and optimum moisture content of the material placed in the road embankment shall be determined by the Engineer from random selected samples. If the moisture content as determined from the samples does not meet the requirements, the Contractor shall treat the material in such a manner that the moisture content is brought within the required range, as indicated by a further series of tests.

It is the Contractor's responsibility to obtain the specified moisture content for the road embankment and this shall be accomplished by a method which has been approved by the Engineer.

Each layer of the embankment shall be compacted to not less than ninety two (92)% of the maximum dry density in accordance with ASTM D698, JIS A-1210 or other approved standards.

7.6.3 Placing and compaction

The road embankment shall be built in approximately horizontal layers carried across the entire width of the embankment to the required slopes. The depth of each layer before compaction shall not exceed thirty (30) cm. Each layer shall be compacted to the satisfaction of the Engineer by means of vibratory or other approved rollers. The road embankment shall not be widened with loose materials dumped from the top. Any travel of equipment over the road embankment during construction shall be routed so as to obtain maximum consolidation of the embankment.

The Contractor's operations in handling, spreading and compacting the material for the roadway embankment shall be such as will result in an acceptable distribution and gradation of the materials throughout the embankment. The density shall be uniform throughout each compacted layer. When each layer of the material has been conditioned to have the specified moisture content, it shall be compacted with rollers until the dry density throughout the layer is equal to or in excess of the specified dry density. Full details on the type of rollers to be used by the Contractor shall be submitted to the Engineer for approval.

The loading, operation and speed of travel of the rollers shall be such as required to obtain the specified compaction. The immediately proceeding and adjacent roller tracks shall be lapped by at least fifty (50) cm. If more than one roller is used on any one layer of fill, all rollers so used shall be of the same type and essentially of the same dimensions. Tractors used for pulling rollers shall have sufficient power to pull the rollers satisfactorily when the drums are fully loaded.

If, in the opinion of the Engineer, the rolled surface of a layer of material is too dry or smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or worked with a harrow, scarifier, or other suitable equipment, in an approved manner to a sufficient depth to provide a satisfactory bonding surface before the next succeeding layer of material is placed. 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 removed and 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. No adjustment in the unit price will be made on account of any operation of the Contractor in regard to work which may be required as described in this Sub-clause.

When the Contractor is reasonably sure that the necessary number of passes by the roller has been made to obtain the specified density, he will request that the Engineer make a field density test to verify as such. This test will be in accordance with JIS A-1214, ASTM D 1556 or other approved

methods. After the test has been made, the Engineer will inform the Contractor of the results and if the specified density has been obtained, the Engineer will allow the Contractor to start placing and compacting the next layer.

Where embankment material is to be deposited on only one side of the culvert headwalls, wingwalls, etc., care shall be taken that the area immediately adjacent to the structure is not compacted to the extent it will cause overturning of or excessive pressure against the structure.

The roadway embankment material shall be placed to the design subgrade line as shown on the Drawings and shall be trimmed to a surface tolerance of 3 cm in a 5 m width. Any part of the subgrade line that has been completed shall be protected against drying out and cracking and any damage resulting from default of the Contractor shall be repaired as directed by the Engineer without additional payment.

7.6.4 Measurement and payment

Measurement, for payment, of the road embankment will be made for the material compacted in place in the embankment to the lines and grades as shown on the Drawings or as directed by the Engineer.

Payment for the road embankment shall be made at the unit price per cubic meter tendered therefor in the Bill of Quantities, which unit price shall constitute all related costs of labour, equipment and material including loading the previously excavated material, hauling, placing, spreading, wetting or drying as required, compacting, levelling and all required testing in accordance with these Specifications.

7.7 Sub-base and Base Courses

7.7.1 Sub-base course

(1) General

Sub-base course is that portion of the road which lies between the road embankment and the base course. Its width shall be as shown on the Drawings or as directed by the Engineer. Thickness of the sub-base course shall be twenty (20) cm after compaction.

(2) Inspection, testing and approval of materials

The Contractor shall submit to the Engineer for his approval at least thirty (30) calendar days prior to the commencement of the operations of sub-base course a complete statement of the origin and composition of all aggregates to be used for constructing the sub-base course. All material shall comply with the requirements of these Specifications.

In order to ascertain the properties of all sub-base course materials, the Contractor shall submit, for the approval of the Engineer, the result of laboratory tests for all materials intended to be used in the work at his own expense. The Contractor shall provide and maintain in good order the testing laboratory with necessary equipment and apparatus which shall be used by the Contractor's soil mechanical engineer and shall be available for use by the Engineer or/and inspectors designated by him.

All processed materials shall be subject to the approval of the Engineer before being stored on the Site or incorporated in the Works and may be inspected by the Engineer at any time during the progress of their processing and use. Questionable materials, shall not be unloaded and mixed with materials previously approved and accepted until approved by the Engineer with their suitability proven by laboratory testing. If the grading and quality of the materials delivered to the Site do not conform to the grading or quality as previously inspected or tested, or do not comply with the Specifications, the Engineer reserves the right to reject such materials.

(3) Material

All sub-base course material shall be free from lumps of dirt, organic matter, shale or any other deleterious matter and shall be of such quality that it will bind readily to form a firm and stable sub-base course. Aggregate for the sub-base course shall be crushed stone or crushed gravel and its gradation shall conform to the following requirements :

JIS Sieve Size (mm)	Percentage by Weight Passing (%)
50	100
25	60 - 100
10	30 - 100
5	15 - 100
2	10 - 70
0.4	5 - 40
0.074	2 - 25

(4) Execution of work

After material for each layer has been placed, the material shall be spread by means of motor graders or other approved equipment until the mixture is uniform throughout. If the material does not contain a sufficient quantity of natural cementitious material to bond readily under the action of the traffic, there shall be added to and incorporated in it a binder consisting of rock screenings, or other cementitious material obtained from approved sources. After the binder has been added, the combined grading of the mixture shall be within the specified gradation. The binder may be incorporated in the material at the place where the material is produced or may be incorporated uniformly on the sub-base course during the progress of the work and in the amount as directed.

The sub-base course material shall be placed and compacted in layers of such thickness that specified degrees of compaction can be reached with adequate compaction equipment, and in any case in layers not more than twenty (20) cm thick after compaction. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer is placed.

The placing of material shall begin at the point designated by the Engineer. Placing shall be from spreader boxes or from vehicles especially equipped to distribute the material in a continuous uniform layer. The layer shall be of such size that when spread and compacted, making due allowance for any blending material that is to be added on the road, the finished layer shall be in reasonably close conformity to the normal thickness as shown on the Drawings.

When hauling is done over previously placed materials, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer, to minimize rutting or uneven compaction.

Immediately following final spreading and smoothing, each layer shall be compacted to the full width by means of smooth wheel power rollers, pneumatic-tyred rollers or other approved compaction equipment. Rolling shall progress gradually from the sides to the centre, parallel to the centerline of the road, and shall continue until all the surface has been rolled. Any irregularity or depression that develops shall be corrected by loosening the materials at these places and adding or removing material until the surface becomes smooth and uniform. At all places not accessible to the roller, the material shall be compacted thoroughly with approved tampers or compactors. The material shall be both blended and rolled until a smooth and even surface has been obtained.

The sub-base course material shall be compacted to produce at least ninety five (95) percent of the

maximum dry density through the full depth of each layer.

The Engineer will make measurements of test holes at random during progress of the work to determine the depth of uncompacted layers required to produce the designated nominal depth of the sub-base course after compacting to obtain the specified density. Cutting of the test holes and refilling with materials properly compacted shall be done by the Contractor under the supervision of the Engineer at no extra cost to the Employer.

7.7.2 Base course

(1) General

Base course is the portion of the road which lies between the sub-base course and the bituminous surface course of surface treatment. Its width shall be as shown on the Drawings or as directed by the Engineer. Thickness of the base course shall be fifteen (15) cm after compaction.

Requirements of the inspection, testing and approval of the base course materials shall be the same as those stipulated in Sub-clause 7.7.1, Sub-base course.

(2) Material

All aggregate for base course shall consist of clean, tough, durable, sharp-angled fragments free from any excess of thin or elongated pieces, and reasonably free from soft, disintegrated or decomposed stone, dirt or other deleterious matter. It shall be crushed rubble stone or crushed gravel and its gradation shall conform to the following requirements:

JIS Sieve Size (mm)	Percentage by Weight Passing (%)
50	100
25	65 - 100
10	35 - 65
5	20 - 50
2	10 - 40
0.4	5 - 25
0.074	2 - 15

(3) Execution of work

Where the base course to be laid over the sub-base course, the surface of the sub-base course shall be cleaned from dirt and other objectionable material by using hard wire brushes or as directed by the Engineer. In general, methods and provisions stipulated in Sub-clause 7.7.1, Sub-base course, shall apply for the base course, except the following:

The base course shall be constructed by means of macadam method being divided into two (2) layers, each of seven and half (7.5) cm in thickness after compaction. The maximum thickness of layers shall not exceed fifteen (15) cm in total after compaction.

Before final finishing of the base course, the entire surface shall be rolled with a minimum of three (3) coverages of pneumatic-tyred rollers having a minimum dual wheel load of eight (8) tons and minimum contact tyre pressure of seven (7) kg/cm^2 and approved by the Engineer. Any yielding areas shall be removed, repaired or re-constructed as directed by the Engineer.

The tolerance in cross-sections and longitudinal profile shall not be more than ten (10) mm at any place on a three (3) m template.

7.7.3 Measurement and payment

(1) Sub-base course

Measurement, for payment, of sub-base course will be made on the basis of the total volume in place in cubic metres to the lines and thickness as shown on the Drawings or as directed by the Engineer.

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 for sub-base course and duly certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices for sub-base course shall include full compensation for the cost of all labour, tools, equipment and materials including procuring, processing, loading, hauling, unloading, spreading, mixing of binder, compacting, shaping, cutting of test holes and refilling and compacting with approved material, and finishing the sub-base course material and all other items necessary to complete the works.

(2) Base course

Measurement, for payment, of base course will be made on the basis of the total volume in place in cubic metres to the lines and thickness as shown on the Drawings or as directed by the Engineer.

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 for base course, and duly certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices for base course shall include full compensation for the cost of all labour, tools, equipment and materials including procuring, processing, loading, hauling, unloading, spreading, compacting, shaping, testing as directed and finishing the base course and other items necessary to complete the works.

7.8 Tack Coat

7.8.1 General

This work shall consist of furnishing and applying bituminous material to a previously prepared road bed, in accordance with these Specifications and for the width and area shown on the Drawings or as directed by the Engineer.

7.8.2 Material

Bituminous material for the tack coat shall be emulsified asphalt conforming to the requirements specified in JIS K 2208 or approved equivalent.

7.8.3 Execution of work

The Contractor shall submit the list of all the equipment to be used for the work to the Engineer for approval. The work shall not be proceeded in high winds or rains. The surface to be treated shall be dry and free from loose dirt and other foreign substances.

Bituminous material shall be applied by means of a distributor at the rate as directed by the Engineer, which will usually vary from 0.8 to 1.0 litre per square meter (lit./m^2) when applied on base course, and from 0.4 to 0.6 lit/m^2 when applied on concrete slab, at a temperature between seventy degrees (70 °C) and eighty degrees (80 °C).

The surface of structures and trees adjacent to the areas being treated shall be protected in such a

manner as to prevent them from being marred. No bituminous material shall be spattered into side ditches or drains.

The surface course shall not be placed over the tack coat until the tack coat has a proper condition for that which shall be determined by the Engineer.

Until the surface course is placed, the Contractor shall protect the tack coat from damage.

7.8.4 Measurement and payment

No measurement and no independent payment shall be made under this Clause. Cost of preparation of the tack coat shall be included in the unit price of surface course stated in the Bill of Quantities.

7.9 Surface Course

7.9.1 General

The work shall consist of spreading cover aggregate, applying bituminous surface and finishing with blotter material. Its width shall be as shown on the Drawings or as directed by the Engineer. The thickness of surface course shall be five (5) cm after compaction.

7.9.2 Material

(1) Cover aggregate

Cover aggregate shall consist of clean, tough, durable, sharp-angled fragments, free from any excess of thin or elongated pieces, and reasonably free from soft, disintegrated or decomposed stone, dirt or other deleterious matter. It shall consist of crushed stone or crushed gravel, rock screenings, sand and mineral filler conforming to the following gradation requirements and shall be approved by the Engineer :

Sieve Size (mm)	Percentage by Weight Passing (%)
25	100
19	90 - 100
12.5	0 - 30
9.5	0 - 5
2.36	0 - 2

(2) Bituminous material

Bituminous material shall be emulsified asphalt conforming to the requirements specified in JIS K 2208 or approved equivalent.

(3) Blotter material

Blotter material shall be a clean dry sand or stone screening free from any adhesive or organic material.

7.9.3 Execution of work

(1) Spreading of cover aggregate

This work shall be done after the tack coat on the base course is completed. The application of the aggregate shall proceed immediately after the application of bituminous material commences and shall be completed within five (5) minutes of the completion of spraying or a period of time as directed by the Engineer, whichever is shorter.

The aggregate shall be spread uniformly over the bituminized surface by means of approved aggregate spreaders at the rate ordered by the Engineer.

Any of insufficiently covered areas shall be re-run by a mechanical spreader or manually as necessary for giving uniform and complete coverage. Any aggregate spread in excess of the rate specified or ordered shall be scattered and evenly distributed on the road or otherwise removed and stock-piled as directed by the Engineer.

Immediately after spreading to the satisfaction of the Engineer, the aggregate shall be rolled with pneumatic rollers or, if permitted by the Engineer, by steel wheeled rollers, until the aggregate is firmly embedded in the bituminous material. Where required to ensure even distribution of aggregate, the surface shall be broom dragged after the initial rolling unless otherwise the drag broom has any tendency to dislodge aggregate particles embedded in the binder. The Engineer may order that drag brooming be deferred or eliminated, and the light hand brooming be substituted.

Rolling shall be continued, as directed by the Engineer, for as long as it is necessary to ensure

thorough embedment of aggregate into the binder.

After the binder has hardened and, in the opinion of the Engineer, no more aggregate can be pressed into it by rolling, any remaining loose particles shall be removed.

(2) Application of bituminous material

Bituminous material shall be applied in uniform distribution to all surface. Application temperature shall be within the range from one hundred and twenty degrees (120 °C) to one hundred and fifty degrees (150 °C) and application rate shall be as directed by the Engineer, which will vary between 0.8 and 1.0 lit./m^2. Equipment to be used shall be subject to the approval of the Engineer.

The area to be sprayed with bituminous material at any time shall be limited to that which can be covered with blotter material at the specified rate within five (5) minutes of the time of spraying or a period of time as directed by the Engineer, whichever is shorter.

After each application, the quantity of material sprayed shall be checked against the area covered by dipping the distributor equipment, and any necessary adjustment shall be made to ensure the specified or instructed rate of application is maintained in subsequent runs.

(3) Application of blotter material

Blotter material shall be applied at the rate as directed by the Engineer. The blotter material shall be spread from trucks or, if permitted by the Engineer, spread by hand shovels in a manner that neither wheel nor foot will travel on the uncovered underlying wet bituminous material.

The material shall be applied uniformly at the instructed rate.

7.9.4 Measurement and payment

Measurement, for payment, of the surface course including tack coat will be made on the basis of the actually placed area in square metres to the lines, rates of application and thickness as shown on the Drawings or as directed by the Engineer. Unless otherwise stated, no measurement shall be made for the materials placed outside the limits as shown on the Drawings.

Payment shall be made for the total area in square metres measured as provided above at the

respective unit prices per square metre stated in the Bill of Quantities for the surface course including tack coat and duly certified by the Engineer in the Bi-Monthly Statement of Account. The unit prices for surface course including tack coat shall constitute full compensation for the cost of all labour, tools, equipment and materials including procuring, processing, loading, hauling, unloading, heating the bituminous material to the required temperature and applying the same at the prescribed rate of application, spreading, compacting, shaping, tack coating on the base course in accordance with Sub-clause 7.8.3 hereinbefore, finishing and all other items necessary to complete the works.

7.10 Guardrailing

The Contractor shall furnish and install guardrailing, including concrete foundations for the steel posts, as shown on the Drawings or as directed by the Engineer.

Material to be used for the steel guardrailing shall conform to the requirements of JIS G 3101 (Structural Rolled Steel for General Use), ASTM A36-70a (Structural Steel), or equivalent standards. Steel pipe used for the posts shall conform to the requirements of JIS G 3452 (Steel Gas Pipes), ASTM A53-73 (Welded and Seamless Steel Pipe), or equivalent standards. Materials for concrete shall conform to the requirements of Chapter 3, Concrete Work, of these Specifications.

The guardrailing shall be constructed to the lines and grades, and at the locations as shown on the Drawings. Posts shall be set plumb in the concrete footings. Rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond the post at least 0.6 cm but not more than 1.2 cm. Painting of all components of the guardrail which has been erected shall be made in accordance with Paragraph (10) of Sub-clause 8.1.5 of Chapter 8.

Measurement, for payment, of furnishing and installing the guardrailing and posts will be made for the length along the centerline of the railing.

Payment for furnishing and installing the guard railing and posts shall be made at the unit price per linear meter as tendered therefor in the Bill of Quantities, which unit price shall include the cost of all labour, equipment and material required for installing the guardrailing and posts including excavation for post foundations, placing of concrete for post foundations, backfilling around the posts, painting and other necessary work.

7.11 Contractor's Temporary Construction Road

The Contractor shall be responsible for designing, constructing and maintaining various temporary construction roads which he will have to basically use as "haul roads" during the time the Project work is in process. The exact location of these temporary construction roads shall be determined based on the Contractor's design and layout drawings as approved by the Engineer.

The Contractor's design of his temporary construction roads shall be based on generally acceptable standards and shall be submitted to the Engineer for approval at least forty five (45) days prior to starting the road works.

The method of construction for the Contractor's temporary construction roads including but not limited to alignment, excavation, embankment, surfacing (if any), drainage, guardrails, signs, etc. shall be submitted in writing to the Engineer for approval at least thirty (30) days prior to starting the construction of such roads.

The Contractor shall be responsible to maintain all his temporary construction roads throughout the time they are in use, to the satisfaction of the Engineer.

All costs related to constructing and maintaining the Contractor's various temporary construction roads shall be deemed to be included in the appropriate unit prices or lump sum prices for the applicable work items.

8. GATES AND RELATED HYDROMECHANICAL EQUIPMENT

8.1 General

8.1.1 Scope of works

These Specifications cover the designing, manufacturing, testing before shipment, finishing, painting, packing, insuring, shipping, delivering to the Site including landing, customs clearance and inland transport, site storing, distributing to work spot, installation, site testing, cooperating in the commissioning and remedying defects of all the following :

(1) Steel slide gate consisting of gate leaf, guide frame and lifting hoist,
(2) Steel flap gate consisting of gate leaf and guide frame, and
(3) Timber stoplog consisting of stoplog leaf and guide frame

All Works shall be in accordance with these Specifications, the accompanying Drawings and Bill of Quantities.

The payment for all the Works covered in this Chapter shall be made at the prices specified by Payment Item Numbers in the Bill of Quantities. All the costs and expense for the Works which are not specified by the Payment Item Numbers but required for the satisfactory completion of the Works provided in these Specifications, Drawings and Bill of Quantities shall be deemed to be included in the prices related in the Bill of Quantities, and no separate payment shall be made for such Works.

8.1.2 Standards and design

(1) Standards

Further to the provisions in Clause G6.1 of Vol. III, Part I - General Specifications, the following provisions shall also apply to all equipment, materials and details of installation shall comply with the requirements and the latest revisions of the following Standards and Codes where applicable :

(a) Japanese Industrial Standards (JIS),
(b) International Organization for Standardization (ISO),
(c) Indonesia Industrial Standards (SII), and

(d) Indonesia National Standards (SNI).

Other national or international standards may be accepted provided that the requirements therein are, in the opinion of the Engineer, equivalent to or better than the current issue of the said specified Standards.

If the Contract Documents conflict in any way with any or all of the above Standards or Codes, the Contract Documents shall have precedence and shall govern, only upon confirmation of the Engineer.

(2) Working stresses and design

The design, dimensions and materials of all parts shall be such that they will not suffer damage under the most adverse conditions nor result in deflections and vibrations which might adversely affect the operation of the equipment.

Mechanisms shall be so constructed to avoid sticking due to rust or corrosion.

All parts which will have to be dismantled or which might have to be dismantled for purpose of servicing or replacement shall be held on place with anti-corrosive fasteners.

The type, material and size of all fasteners shall be selected to safely withstand the maximum superimposed load. Complete information regarding the design assumptions, loading and operating conditions, deflections and unit stresses used in the design shall be provided with the appropriate drawings by the Contractor to the Engineer.

The Contractor shall be deemed to have examined the Specifications and the Drawings herewith and to have concurred with the design and layout of the Works, as being sufficient to ensure reliability and safety in operation, free from undue stresses, adequate drainage and other essentials for a satisfactory working plant of the hydromechanical equipment.

It should be noted that the Contract Drawings show only the general type of the equipment and the governing dimensions and are not intended to define the exact details of the equipment to be furnished. Any recesses required in this structure for alignment shall be determined by the Contractor subject to the approval of the Engineer.

(3) Units of measurement

In all correspondence, in all technical schedules and on all drawings, metric units of measurement shall be employed. On drawings or printed pamphlets where other units have been used, the equivalent metric measurement shall be marked in addition.

(4) Tropicalization

In choosing materials and their finishes, due regard shall be given to the humid tropical conditions under which the equipment will be called upon to work. The Contractor shall submit details of his practices which have proven satisfactory and which he recommends for application on the parts of the hydromechanical equipment which may be affected by the tropical and local conditions. The material and finishes used shall be approved by the Engineer.

(5) Change to material or equipment

The Contractor shall not make any changes to the equipment or in the materials to be incorporated in the hydromechanical equipment from that specified or implied by these Specifications without the written approval of the Engineer. Such changes or alterations shall in no way be detrimental to the interests of the Employer and shall not result in any increase to the Contract Price.

8.1.3 Drawings and documents to be supplied by the Contractor

Further to the provisions of Chapter G3, Drawings and Documents, of Vol. III, Part ‡T- General Specifications, the following provisions shall also apply to and have precedence and shall govern.

(1) Drawings and documents for approval

The Contract award does not imply approval of the Employer and the Engineer on the technical documentation prepared for and submitted with the Contract Documents.

Before the commencement of manufacturing the equipment, the Contractor shall submit the design criteria, calculations, specifications, dimensioned drawings and diagrams showing all details of the equipment and materials to be used to the Engineer for approval and to the Employer simultaneously.

These drawings and documents with stamp of "FOR APPROVAL" shall be submitted in sufficient

time allowance to permit corrections and/or modifications to be made, if such are deemed to be necessary and/or are instructed by the Engineer without delaying the completion of the Works. The drawings which are required to be modified as necessary by the Engineer shall be submitted for reapproval. The Contractor shall allow a minimum net period of four (4) weeks for such reviewing after receipt by the Engineer and another one (1) week for return mail purpose. Claims or extensions of time will not be permitted on account of the late submission of drawings and documents being returned "NOT APPROVED" by the Engineer and resubmission by the Contractor.

It shall be understood that approval of drawings and documents by the Engineer will not exonerate the Contractor from any of his liabilities under the Contract.

The title of the drawings, the signature of the Contractor's responsible engineer, the date prepared, the drawing number, etc., shall appear in the bottom right-hand corner of the drawing. The size of drawing shall be as follows :

Drawing Size	(A1)	594 mm x 841 mm
Ledger Size	(A3)	297 mm x 420 mm
Letter Size	(A4)	210 mm x 297 mm

Blank of 200 mm wide by 100 mm high shall be kept above the title block of all drawings for the Engineer's comments.

(2) For work drawings (working drawings)

After approval of the drawings and documents by the Engineer, the Contractor shall supply copies of the approved drawings with stamp of "FOR WORK DRAWING " to the Employer and the Engineer. Only "FOR WORK DRAWING" can be used for manufacturing and erection purpose.

(3) Final drawings and documents

After completion of all contracted works, a complete set of the negatives of drawings previously approved and/or modified consequentially according to the requirements at the Site are to be submitted together with bound prints to the Employer and the Engineer. Negatives of the drawings to be submitted to the Employer shall be of "Mylar film" or other approved permanent transparent materials.

The reduced size of drawings into A3 size shall be bound in A 4 size covers and be submitted to the Employer and to the Engineer.

(4) Required numbers of drawings and documents

Numbers of drawings and documents to be submitted to the Employer and the Engineer shall be as follows :

During the Work	To the Employer	To the Engineer
Drawings and documents for approval	1 copy	3 copies
For-work drawings and documents	1 copy	2 copies
Within thirty (30) days after receipt of Completion Certificate		
Negatives of drawings	1 set	1 set
Bound prints of drawings,		
Full size	4 set	NIL
Reduced size	2 sets	2 sets
Bound prints of all inspection and test data	4 sets	1 set
Final approved specifications, design calculations and material lists	4 sets	1 set
Photographic records of Work	2 sets	1 set

Further copies of particular drawings and documents are to be provided at the Contractor's own expense if so requested by the Engineer or the Employer.

The Contractor shall include in his Contract Documents for the cost of all drawings, operating instructions and other information to be provided under this Contract.

(5) Target on submission of drawings and documents

(a) Before commencement of erection of related civil structures ;
- General layout drawings.

- Detailed drawing and data related to civil work such as the drawings showings the blockouts, foundations of the hoist, loading conditions, size and location of anchor bars, hooks, holes, etc.

(b) Before commencement of fabrication of hydromechanical equipment;
- General and shop fabrication drawings, calculation sheet and data.

(c) Documents for approval specifically stated in these Specifications;
- Erection instructions in Sub-clause 8.1.4 (2), Instructions for erection works, and test procedure at the shop and at the Site in Sub-clause 8.1.4 (3), Test procedure instructions : following after approval of drawings for main components of the hydromechanical equipment.

- Qualification documents for welder and welding operator's qualification in Sub-clause 8.1.5 (8), Welding : before one (1) month of commencement of fabrication work.

- Painting specifications, color scheme and painting sample in Sub-clause 8.1.5 (10), Protection, cleaning and painting: following after approval of drawings for main components of the hydromechanical equipment.

- Operating and Maintenance Instructions in Sub-clause 8.1.4 (1), Operating and maintenance instructions, spare parts list in Sub-clause 8.1.8, Spare parts, and maintenance equipment and tools list in Sub-clause 8.1.9, Maintenance tools : following after approval of drawings for main components of the hydromechanical equipment.

8.1.4 Instruction manuals

(1) Operating and maintenance instructions

The Contractor shall submit to the Engineer the general instructions describing the correct manner of operation and maintenance of all the hydromechanical equipment provided under this Clause with special references to any recently developed features.

The instruction manual shall be prepared for each item as outlined in Sub-clause 8.1.1, Scope of works, and shall be submitted for approval in the same manner as the Drawings. It shall be

finalized and be submitted as "For Work Drawings" before delivery of the hydromechanical equipment to the Site. Within one (1) month upon Completion of the Works provided under this Clause, two (2) copies and one (1) copy shall be submitted to the Employer and the Engineer accordingly as the "Final Drawings and Document", respectively.

The instruction manual shall include a separable and complete section describing the operating procedures for the control of the hydromechanical equipment, and shall include easily read diagrammatic drawings of such operating procedures to facilities understanding of the descriptive information.

The instruction manual shall describe and illustrate in detail the method and procedure for assembling, adjusting, operating and dismantling of each component, system and machine and the use of equipment and devices necessary for such works.

The instruction manual shall describe on the routine inspection items of each component and lubrication with recommended frequency of such work. Possible symptoms which indicate unsound condition of each component vs. permissible criteria thereof and required countermeasures therefor shall also be included in the manual.

The Contractor shall, in preparing the instruction manual, take into account the lack of experience and familiarity of the operating personnel with this type of equipment.

The manual shall also include a complete list of all drawings prepared for the hydromechanical equipment in this Clause, the approved painting specifications, the tool list, the spare parts list, the parts list for each component of item of equipment with necessary catalogues, etc. The parts list shall include manufacturer's code and serial numbers and ordering instructions. The parts list shall be detailed for only the equipment supplied and shall not include general reference or description of similar equipment which is of the same model but different only in detail. The manual shall be prepared in English language.

(2) Instructions for erection works

The Contractor shall submit to the Engineer for approval the instruction manual for the erection work of the hydromechanical equipment to be executed at the Site.

The instruction manual shall be submitted for approval in the same manner as the drawings and three (3) copies shall be submitted to the Employer and to the Engineer as "For Work Drawings"

before delivery of the hydromechanical equipment to the Site. The Contractor shall ensure that the erection supervisor has a copy in his office at the Site.

The instruction manual shall describe and illustrate in detail the methods and procedures for installation of the hydromechanical equipment, the use of the construction facilities and measurement devices together with their capacity and required number, field shop to be provided for the installation work and other necessary explanations on the installation work.

(3) Test procedure instructions

The Contractor shall submit to the Engineer for approval, during or immediately following the submission of drawings, the instructional test procedures, describing each test to be performed at the Contractor's shop and at the Site within the time mentioned in Sub-clause 8.1.3, Drawings and documents to be supplied by the Contractor. The test procedures shall define the sequence of the tests, the equipment preparation and operation procedures to be followed and the detailed procedures for conducting the tests, tolerances for dimension and/or quality controls and other necessary items for the tests. The test procedures shall be separately prepared for the tests to be performed at the shop and at the Site. These procedures shall be submitted and distributed in the same manner as the drawings.

8.1.5 Mechanical and structural works

(1) General

All materials shall be new, the best of their respective kinds and of such as are usual and suitable for work of like character.

All workmanship shall be of the highest class throughout the Works to ensure smooth and vibration free operation under all possible operating conditions, and the design, dimensions and materials of all parts of the hydromechanical equipment shall be such that the stresses to which they may be subject shall not render them liable to distortion, undue wear, or damage under the most severe conditions encountered in service.

All parts of the hydromechanical equipment shall conform to the dimensions shown on and shall be built in accordance with "For Work Drawings". All joints, datum surfaces, and matching components shall be machined and all castings shall be spot faced for nuts. All machined finishes shall be shown on the Drawings. All screws, bolts, studs and nuts and threads for pipes shall

conform to the latest standards of the International Organization for Standardization (ISO) covering these components and shall conform to the standards for metric size. The Contractor shall use exclusively the standards and size system accepted and incorporated in the Contract.

(2) Castings

All castings weighing 226.8 kg (500 pounds) or more shall have test coupons attached from which test specimens may be prepared. The number, size and location of the test coupons shall be to the approval of the Engineer. Faulty material or materials found to be inferior to that specified shall be rejected and removed at once, and shall not be used in any part of the hydromechanical equipment.

All castings shall be dense, sound and true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage cracks or other injurious defects, and shall be satisfactorily cleaned for their intended purpose. All castings shall checked for defects before final machining.

Casting shall not be repaired, plugged, or welded without permission of the Engineer. Such permission will be given only when the defects are small and do not adversely affects the strength, use or machinability of the castings. Excessive segregation of impurities or alloys at critical points in a casting will be cause for its rejection. The largest fillets compatible with the design shall be incorporated wherever a change in section occurs.

Surfaces which do not undergo machining and are exposed in the final installation shall be dressed to provide a satisfactory appearance so that they will not require surface smoothing at Site prior to painting.

(3) Forgings

The ingots from which the forgings are made shall be cast in metal molds. The workmanship shall be first-class in every respect and the forgings shall be free from all defects affecting their strength and durability, including seams, pipes, flaws, cracks, scales, fins, porosity, hard spots, excessive nonmetallic inclusions and segregation.

The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. All finished surfaces of forgings shall be smooth and free from tool marks.

The forging shall be clearly stamped with the heat number in such location as to be readily

observed when the forging is assembled in a complete unit.

(4) Machine work

(a) General

All tolerances, allowances and gauges for metal fits between plain cylindrical parts shall conform to the appropriate standards for the class of fit as shown or otherwise required. Sufficient machining stock shall be allowed on locating pads to ensure true surfaces of solid material. Bearing surfaces shall be true and exact to secure full contact. Journal and sliding surfaces shall be polished and all surfaces shall be finished with sufficient smoothness and accuracy to ensure proper operation when assembled. Parts entering any machine shall be carefully and accurately machined. All drilled holes for bolts shall be accurately located and drilled from templates.

(b) Finished surfaces

Surfaces finished shall be indicated on the Contractor's drawings and shall be in accordance with the appropriate standards. Compliance with specified surface will be determined by sense or feel and by visual inspection of the work compared to standard roughness specimens, in accordance with the provisions of the above stated standards.

(c) Unfinished surfaces

So far as is practicable, all works shall be arranged to obtain proper machining of adjoining unfinished surfaces. When there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the approved drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner.

(d) Pins and pin holes

Pin holes shall be bored to gauge, smooth and straight, and at right angles to the axis of the member. The boring shall be done after the member is securely fastened in position. Pins shall be of hardened and ground steel and positively held in position.

(5) Balancing

All revolving parts shall be truly balanced both statically and dynamically so that when running at

normal speeds and at any load up to the maximum, there shall be no excessive vibration due to lack of such balance and the hydromechanical equipment shall operate with the least possible amount of noise.

(6) Joints of structural members

The connections between each structural member shall be made by means of bolting or welding and designed in such a manner that all forces are transmitted by one of such method of connection as bolting or welding. No sharing of specific load by two (2) types of connection shall be accepted.

When bearing type bolts are used, they shall be so proportioned that unthreaded part of the bolts shall resist the load at the reamed holes of the materials together with washers having a minimum of five (5) mm in thickness. For all sloping surfaces, beveled washers shall be provided. For high strength tensile bolt connections, lock nuts and washers shall be provided.

All edges of plates to be welded shall have the edge prepared by machine or other approved methods so as to be suitable for the type of weld employed.

(7) Embedded steelworks, opening, etc.

The Contractor shall supply and install all anchors, fasteners, embedded steelworks and sleeves associated with and required for the equipment being provided and installed under this Clause, except as otherwise provided in the Specifications and Drawings.

The Contractor shall show the location and full details of all embedded components on his drawings and shall be responsible for the completeness and accuracy of his drawings.

Any steel work which is to be set into the concrete foundations shall not be painted nor coated unless otherwise approved.

(8) Welding

(a) General

All welding shall be done either manually by the shielded metallic arc process or automatically by the shielded arc or submerged arc method. The Contractor shall develop a welding procedure and the weld sizes and types shall be shown on all Contractor's drawings where welding is employed.

All important welds which, in the opinion of the Engineer, may be subject to the full stress induced in the adjacent plate, or which in the opinion of the Engineer or Inspector, do not appear to conform to the welding standards, shall be non-destructively tested.

Suitable mettles shall be provided to show the welding current and the arc voltage at all times during the welding operations. Unless otherwise specifically stated, welded parts requiring machine finish shall be completely welded before being finished.

All welds shall be usually made continuous and watertight. The minimum throat dimension of fillet welds shall be four and half (4.5) mm. Plates to be jointed by welding shall be accurately cut to size.

(b) Qualification of welding procedure

The technique of welding employed, the appearance and quality of the welds made and the methods used in correcting defective work, shall conform to the requirements in American Welding Society (AWS) Standard D. 1. 1, or other standard, as proposed in the Contract Documents.

(c) Qualification of welders and welding operators

All welders and welding operators assigned to the Works shall have an authorized license. The Contractor shall furnish the Engineer with certified copies of license.

If, in the opinion of the Engineer, the work of any welder at any time appears questionable, he shall be required to pass the appropriate qualification test. All costs of such qualification tests shall be borne by the Contractor.

(d) Welding electrodes

The welding electrodes for the mild steel shall conform to JIS Z 3211 or Z 3212, low hydrogen type covering or other approved equivalent.

Stainless type weld metal, where used in the water passages for protection against pitting, shall be of chromium nickel steel. The welding electrodes for the stainless steel shall conform to JIS Z 3221, SNI 0049-89-A or other approved equivalent.

The welding electrodes for the copper or copper alloy shall conform to JIS Z 3231 or other approved equivalent.

(e) Repair

If the workmanship is not satisfactory to the Engineer, the welding shall be chipped out to sound metal, tested and repair welded, subject to approval of the Engineer. The welding work which contained such defect shall be inspected and tested all along the line by the same method used first as instructed by the Engineer to his satisfaction.

(9) Lubrication

Provision shall be made for lubricating all bearings including ball and roller bearings, by a pressure gun system. All lubrication nipples shall be readily accessible.

Where accessibility to a bearing for lubricating purposes is so hard, provision shall be made for remote lubrication of safe access to the lubrication point. Ball and roller bearings shall be packed with grease during initial assembly.

All bearings and gear cases shall be made grease and oil-tight and drip pans shall be provided where necessary to prevent excess oil or grease dripping to the floor or deck. The oil and grease shall be of a type available in Indonesia as approved by the Engineer. The type available in Indonesia shall be investigated by the Contractor himself.

(10) Protection, cleaning and painting

(a) General

The painting of the hydromechanical equipment shall include the preparation of the metal surfaces, paint application, protection and drying of the paint coating, as well as the supplying all tools, labors and materials necessary for the entire painting work.

The finish color of all hydromechanical equipment shall be approved by the Engineer under the confirmation of the Employer. The Contractor shall propose a color scheme for the equipment and shall submit color chips or paint samples. Color chips shall be included with the approved painting specifications for each type of finish. The color of all undercoats shall match the color of the finish coat.

The paint shall be a product of reputable manufacturer and shall be delivered in the manufacturer's sealed tins, stored under cover and used within the guaranteed time and with the method recommended by the manufacturer.

The Contractor shall prepare and submit the painting specifications for approval of the Engineer in the manner as stipulated in Sub-clause 8.1.3, Drawings and documents to be supplied by the Contractor. The painting specifications shall cover paint schedule, manufacturer's statement of the physical and performance characteristics for paint materials to be selected, and manufacturer's recommended procedures for the surface preparation, application, handling instructions, equipment, ambient conditions, mixing instructions, safety and storage instructions, etc. The procedures shall also include any special requirements for the field repairs to the damaged coating and for the coating of field joints.

All parts which will ultimately be buried in concrete shall be cleaned and protected, before leaving the manufacturer's shop, by a portland cement wash or other approved method. Before being installed they shall be thoroughly descaled and cleaned of all rust and adherent matter.

(b) Surface preparation

All oil, paraffin, grease and dirt shall be removed from the surfaces to be painted, by wiping the surfaces with a clean cloth dipped in mineral solvent. Following solvent cleaning, all weld spatter, slag, burrs, loose rust and mill scale and other foreign substances shall be removed by shot or grit-blasting to "Sa 2 1/2" of Swedish Standard SIS 055900 or SSPC-SP10 of Steel Structures Painting Council Manual Volume 2. Special attention shall be given to cleaning of corners and converging angles. Blast cleaned surfaces showing plate surface defects such as scabs or sharp gouges shall be repaired in an approved manner prior to painting.

After blast cleaning, the surface shall be dusted off or blown off with compressed air free of detrimental oil and water. All surfaces to be painted shall be completely dry, clean and free from moisture just prior to and during painting. If rust forms or the surface becomes contaminated in the interval between cleaning and painting, recleaning to the same degree shall be required.

(c) Application procedure

The application of protective coating shall be carried out at the Contractor's shop and/or field shop, whenever possible. Painting work at erection site shall be limited to touch-up coatings for damaged areas and coatings for field welding portions or top (finish) coating.

All paint, when applied, shall provide a satisfactory film and a smooth and even surface. Paint shall be thoroughly stirred, strained, and kept at the uniform consistency during application. Paint shall not be applied when the temperature of the metal or surrounding air is below ten degree (10 °C) and that of the metal is above fifty degree (50 °C), or when the humidity is above ninety percent (90 %), or when it threatens to rain before the painted coat gets dry. Each coat shall be protected during the initial curing period against the possibility of moisture condensation or contamination with foreign matter. All painting works shall be performed by brushing and/or airless spraying.

When the coating material is applied by spraying, suitable means shall be provided to prevent segregation during the coating operation. Free oil and moisture shall be removed from the air supply lines of all spraying equipment. Each coat shall be uniform and free from runs, sags and other imperfections. The time between successive coats shall not be less than the minimum nor more than the maximum recoating time specified by the paint manufacturer.

The paint shall be applied so that the thickness at any point is not less than that stipulated in the approved painting specifications.

Surfaces not required to be coated, but adjacent to surfaces which are to be cleaned and coated, shall be adequately protected during cleaning and coating.

Repairs to damaged areas of the coating shall be carried out strictly in accordance with the approved painting specifications.

Because of the flammable and toxic nature of the coating materials, the Contractor shall take precautions to eliminate any health or safety hazard that may arise during the application of the coating. Smoking and welding shall not be allowed within ten (10) m of the place when painting is in progress.

Painting shall be stopped off seventy five (75) mm from the edges of interface areas for high strength friction-grip bolts. Painting over and around such bolts shall be completed as specified after assembly.

(d) Surfaces not to be painted

Bronze, brass, machined parts surfaces of gear teeth, finished ferrous surfaces, surfaces

in rolling or sliding contact after field assembly shall not be painted. All corrosion-resisting steel surfaces for bearings and machinery parts shall also not be painted.

On completion of cleaning, the surfaces not to be painted shall be coated with an approved rust preventive coating material or an adhesive plastic film to protect the surfaces from minor mechanical damage and corrosion during shipment and storage at the Site. The coating material shall be stripped off after field erection of equipment.

Unassembled fittings, pins, bolts and nuts shall be oiled and wrapped with moisture-resistant paper or protected by other approved means.

(e) Paint schedule

One epoxy resin zinc rich primer coat (20 mm) and two or three coats of coal-tar epoxy resin paint (more than 150 mm per one coat), total dry film thickness of 0.45 - 0.60 mm, shall be applied to the following items:

- All gate leaves
- Exposed surfaces of guide frames below elevation of top of concrete deck
- All parts submerged in water

All un-finished surfaces of ferrous metal except those specified above shall be so given one zinc rich primer coat (20 mm) and four coats of chlorinated rubber paint (two undercoats (40 mm x 2 times),one intermediate coat (30 mm) and one finish coat (30 mm)) as to have the total dry film thickness of 0.15 - 0.18 mm.

Commercial equipment other than those specified above may be painted in accordance with the manufacturer's standard practice, subject to approval of the Engineer.

(f) Inspection

All painting works shall be inspected by the Contractor himself in accordance with the approved test procedure prescribed in Sub-clause 8.1.4 (3), Test procedure instructions, subject to approval of the Engineer.

Following the visual inspection on surfaces that have been coated, the dry film thickness of coating shall be checked at as many spots of the coated area as possible to prove the thickness overall to be to the specified minimum thickness by the electro-magnetic thickness meter.

(11) Mechanical equipment and parts

The mechanical equipment and parts for the hydromechanical equipment shall conform to the following requirements unless otherwise specifically mentioned :

(a) Gearing

All gears shall be machine cut, preferably by hobbing, from solid blanks and, wherever possible, they shall be a forced fit on their shafts. The minimum requirements for materials are as follows :

Wheels	: Carbon steel or forged steel
Pinions	: Carbon steel or forged steel
Worm wheels	: Carbon steel with bronze rims
Worms	: Carbon steel or forged steel

Where worm gearing is used as a first motion drive, it shall be designed to have the same load as the driving handle so as to prevent undue movement and to have housing with lubrication grease.

All gear wheels and pinions shall be completely enclosed by steel or other metal guards, unless effectively guarded by adjacent structures.

Key in gear trains shall be so fitted and secured that they cannot work loose.

(b) Manual operating devices

The manual operating devices shall be a grip handle or a crank handle type. The operation force on the manual operating device shall be less than ten (10) kgf under normal design condition. The diameter of the handle shall be six hundred (600) mm in maximum which shall be located at approximately eight hundred (800) mm in height from the operation deck.

(c) Base frames of hoist

The base frame of hoist shall be of cast iron in one piece or welded steel construction. Necessary anchor bolts and nuts for the base frames shall be supplied by the Contractor.

(d) Screwed spindles

The screwed spindles having a minimum diameter of forty (40) mm shall be made of corrosion resisting steel which shall be machine-cut with trapezoid thread at the necessary length. Lock nuts shall be provided to limit the upper and lower traveling of gate leaf. The spindle joint shall be fixed flange type with bolts, nuts and washers.

(e) Spindle supports

If necessary, the spindle supports for each hoist mechanism shall be provided at proper position (s) to avoid the buckling of spindle due to over-lowering force when the gate is jammed or closed.

The support shall be removable to permit lifting the gate for maintenance purpose. Corrosion resisting steel bolts, nuts and washers shall be used for fixture of the support.

(f) Mechanical position indicators

The mechanical type position indicators shall be mounted on each hoist mechanism, and shall be of an easily readable dial type to rotate about three hundred (300) degrees for full travel. The dial plate shall be of stainless steel or brass with engraved graduation, and main parts of the indicators shall be made of anti-corrosive materials which shall be housed in a dust-tight and weather-proof enclosure. The indicators shall be capable of reading accurate vertical height of the equipment opening by five (5.0) cm.

8.1.6 Packing, delivery and storage

(1) Packing

Each item shall be packed properly or protected for shipment from the place of manufacturer's shop to the Site.

Each crate of package shall contain a packing list in a water proof envelope and a copy in triplicate shall be forwarded to the Engineer prior to delivery. All items of material shall be clearly marked for easy identification against the packing list.

All cases, packages, etc., shall be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

Cases which cannot be marked as above shall have metal tags with the necessary marking on them. The metal tags shall be securely attached to the package with strong steel wire or equivalent.

The Engineer shall reserve the right to inspect the packing before delivery to the Site. The Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor from responsibility for any loss or damage due to faulty packing.

All packing materials shall remain the property of the Contractor and shall be removed from the Site at the earliest opportunity and be disposed at the places/areas which will be instructed by the Engineer.

The shipping mark shall consist of the following information in sequence and in frame commensurate with the size of container :

(a) Consignee : _____
(b) Contract No. : _____
(c) Port of destination : _____
(d) Item No., if applicable, package No. in sequence, and quantity per package : _____
(e) Description of contents : _____
(f) Net and gross weight, cubic measurement : _____

(2) Delivery

The Contractor shall deliver all hydromechanical equipment including Construction Plant and Equipment provided under this Clause to the Site in adequate time for its preparation and erection according to the construction schedule.

Notification of such delivery shall be given to the Employer and to the Engineer in writing not later than thirty (30) days prior to the actual shipping date for any equipment to be shipped. Each notification shall include a complete shipping list of the contents of each package to be delivered and shall indicate the expected date of delivery and the serial number for each component to be used for identification and copies of the insurance policy arranged for it.

The Contractor shall be responsible for the reception at the Site of all deliveries for the purpose of the Contract.

The Contractor shall at his responsibility inspect the cargoes at the Site upon arrival of the cargoes and shall report in writing the particulars, quantities, conditions, damages, if any, of the cargoes to the Employer and to the Engineer within three (3) days after arrival.

(3) Storage at site

The Contractor shall be responsible for all routine maintenance, i.e., lubricating, inspection and adjusting of all hydromechanical equipment, until the issuance of the Certificate of Satisfaction.

The Contractor shall arrange at his own expense for covered storage or other protection of all materials and equipment against corrosion and mechanical damage. Any corrosion or damage that may occur to any item of the hydromechanical equipment shall be made good before that item is to be installed.

The Contractor shall provide all drainage and weather protection for storage of the hydromechanical equipment to meet the requirements of the Engineer.

The minimum requirement is that all items shall rest on wooden blocks which elevates the base at least one hundred and fifty(150) mm above floor or ground level. No item shall be rested on the floor or ground directly.

Weatherproof items and structural steel members may be stored in the open, but in all instances shall be protected to the Engineer's approval. The Contractor shall be responsible for the adequacy of all protection.

8.1.7 Tests and inspection

(1) General

During the manufacturing, the construction and after the installation work of each item of the hydromechanical equipment in this Clause, the Contractor shall perform the tests as described in the test procedures to establish the accuracy of assembly and to prove the adequacy of the materials and workmanship.

The Contractor shall give the Engineer written notice of the date of the tests not less than twenty one (21) days in advance.

The Contractor shall provide all manpower, tools, meters, materials, etc., necessary to conduct the tests and shall be fully responsible for the tests.

Any defect observed during the tests shall be repaired and improved by the Contractor and be tested until it fulfills the Specifications. No part of the hydromechanical equipment shall be considered acceptable until it has successfully complied with the Specifications.

(2) Material inspection and test

Materials, parts and assemblies thereof, entering into the hydromechanical equipment shall be tested, unless otherwise directed, according to the best commercial method for the particular type and class of work. When the manufacturer desires to use stock material not manufactured specifically for the equipment furnished, satisfactory evidence that such material conforms to the requirements herein stated, shall be furnished, in which case tests on these materials may be waived. Certified mill test reports of plates and sections will be acceptable.

Witness tests and inspection of material may be made at the place of manufacture by the Inspector appointed by the Engineer, unless otherwise specified. Such witnessing and inspecting will be conducted so as to interfere as little as possible with manufacturing operation. The Contractor shall, however, comply with any reasonable request made by the Inspector concerning the method of test or correction of defective workmanship.

The Contractor shall furnish, free of charge, all test pieces, blankets, etc., cut and machined to the sizes, shapes and dimensions as directed by the Engineer. The testing of the specimen shall be carried out by the Contractor at his own cost and expense, and shall be performed in accordance with the approved test procedure instructions.

Test pieces which represent rejected material shall be preserved and become the property of the Employer.

Waiving of inspection by the Engineer/Inspector shall not exonerate the Contractor from any of his responsibility for supplying material and workmanship acceptable to the Engineer.

(3) Tests at manufacturer's shop

All items of equipment shall be assembled in the shop prior to shipment and tests shall be performed by the Contractor as may be required to demonstrate to the satisfaction of the Engineer the adequacy of the equipment and its component parts. All tests should be simulated to normal operating conditions as closely as possible. All dismantled parts shall be properly matchmarked to ensure correct assembly at the Site.

Tests at manufacturer's shop shall be performed in accordance with requirements of the appropriate paragraph of the equipment in the Specifications and approved test procedure instructions.

(4) Tests at site

The Contractor shall take out the equipment from their packing and shall inspect the equipment for damage. The Contractor shall repair or replace any damaged portion of the equipment, subject to the approval of the Engineer.

During the construction and after the installation of each item of equipment, tests shall be performed, as specified in the Specifications, to establish the accuracy of the assembly and to prove the adequacy of the equipment and the workmanship. All tests shall be made upon approval of the Engineer.

(5) Tests on completion

After any section or the whole of hydromechanical equipment under this Clause has been fully installed, adjusted, tested and approved and parts under other Clauses for operating the hydromechanical equipment are fully installed, the Contractor shall conduct the Tests on Completion in presence of the Employer and the Engineer to demonstrate that the hydromechanical equipment has been correctly installed, all necessary adjustment and setting made, and is free from vibration and leakage under load, and meets the Specifications in all respects.

(6) Test and inspection reports

Unless otherwise specified, the Contractor shall submit to the Engineer all test and inspection reports in accordance with following manner :

Place of test or inspection	Number of reports	Submitting time
Manufacturer's shop	5	Before application for shipment
Site	5	Within 14 days after the test

8.1.8 Spare parts

The Contractor shall furnish the following spare parts:

(1) Ten percent (10 %) of connection and fixing bolts, nuts and washers (count fractions as a whole number)
(2) Two hundred percent (200 %) of each size and type of grease nipples and caps
(3) Any other recommendable spare parts

Any spare part supplied shall be packed or treated in such a manner as to be suitably stored in the climate at the Site for a period of not less than two (2) years, and each part shall be clearly marked with its description and purpose on the outside of the packing.

Spare parts so provided shall be delivered into such stores as may be designated by the Employer and delivery will not be deemed to be complete until the packages have been opened by the Contractor, their contents checked by a representative of the Employer and the articles reprotected and repacked by the Contractor to the satisfaction of the Employer, or assembled into units at the Employer's option.

8.1.9 Maintenance tools

The Contractor shall furnish one (1) lot of maintenance tools sufficient for the proper maintenance of all the hydromechanical equipment provided under the Specifications. The maintenance equipment and tools shall include, but shall not be limited to :

(1) One (1) lot of tools for general use such as wrench sets, iron level, cutting pliers, screw drivers, wire brushes, hammers, vices, jacks, files, saws and oil and grease guns,

(2) One (1) set of spindle joint flange holding jig to support any size of slide gate using wire ropes and chain blocks of item (3) hereunder,

(3) Two (2) sets of 1-ton chain block, each two (2) sets of wire rope having 2m, 3 m and 4 m length and having circle end and six (6) shackles,

(4) One (1) lot of measuring instruments such as calipers, steel rule and thickness gauge, and

(5) Any other recommendable equipment and tools.

The maintenance equipment and tools shall be delivered with the hydromechanical equipment, in lockable cabinet(s) fitted internally so that the tools may be safely stored in an orderly manner.

8.1.10 Procedure of payment

All payment for the hydromechanical equipment priced in the Bill of Quantities shall be incorporated to the statement of bi-monthly payment stipulated in Clause 60.(5), Monthly Statement of Account, of Vol. II : General and Special Conditions of Contract, and made in the following manner. Provided always that the payment of the hydromechanical equipment shall also be subjected to the deduction of the Advance Payment and the rules stipulated in Clause 60. (5), Monthly Statement of Account, of Vol. II : General and Special Conditions of Contract.

(1) The foreign currency portion of the hydromechanical equipment to be imported payable upon respective shipment against the presentation of the shipping documents stipulated by irrevocable at Site Letter of Credit.

The shipping documents shall consist of the following documents :

- Inspection Certificate issued by the Engineer
- Manufacturer's Certificate
- Inspection Certificate issued by S.G.S.(Sociate General de Surveillance S.A.)
- Clean on board ocean vessel bill of lading or charter party bill of lading
- Contractor's detailed invoice showing commodity description, quantity, unit price, total price and basis of delivery
- Packing list and weight certificate
- Insurance policy

The foreign currency portion for local products is payable upon respective ex-go factory documents plus insurance of inland transportation through inspection certificate for payment issued by the Engineer.

Remaining of the foreign currency portion shall be paid to the Contractor in the form of bi-monthly progress payment, by bi-monthly progress rate certified by the Engineer. The bi-monthly progress rate of each item should be calculated in breakdown of working items of which the Contractor quotes himself with weight component.

(2) The local currency portion shall be paid to the Contractor in the form of bi-monthly payment, by bi-monthly progress rate certified by the Engineer.

(3) Measurement and payment shall be made in accordance with the Sub-clauses 8.3.10, 8.4.9 and 8.5.10 hereinafter.

8.2 Design Criteria and Particulars

8.2.1 Design loads

(1) General

The equipment shall be designed with the worst combination of the acting loads.

The loads specified herein shall be considered as minimum requirements and the Contractor shall use additional loads and combination thereof which the Contractor considers to be applicable and necessary.

(2) Gate leaf and stoplog

(a) Hydrostatic load
Hydrostatic load shall be of the water head difference between upstream and downstream sides of the gate and stoplog.

(b) Dead weight
Reaction due to self weight.

(c) Operating load
Operating load shall conform to the equipment load specified in paragraph (4), Hoist.

(d) All loads imposed during operating the stoplog due to the overload hoist or stoplog

jammed conditions.

(3) Trashrack (Not Applicable)

(a) Hydrostatic load
Hydrostatic load shall be of the water head difference between upstream and downstream sides of the trashrack.

(b) Dead weight

(4) Hoist

The hoist shall be designed taking into account of the following loads :

(a) Dead weight of the gate leaf. Such connecting devices with the hoist as spindle, etc., shall be included into the dead weight of the gate.

(b) Friction force due to sliding parts

(c) Friction force due to seal rubbers

(d) Buoyancy

(e) All loads imposed during raising the gate due to the overload hoist or gate jammed condition

(5) Mesh cover for open culvert of Saluran Cengkareng drainage channel
(Not Applicable)

(a) Trash load : 10 kgf/m^2

(b) Dead weight of the mesh panel

(6) Other equipment

(a) Platform, etc.
Crowded load : 500 kgf/m^2

(b) Handrail

Horizontal load : 30 kgf

8.2.2 Design stresses

(1) Design stresses for gates and other steel structures

(a) Structural steel members

The allowable stresses for normal loading condition of structural steel members with a thickness of forty (40) mm or less shall be as shown in the following table :

Kinds of Stresses	SS 400 or Equivalent (thickness <40 mm) SM 400
1) Axial tensile stress (per net sectional area)	1,200 kgf/cm^2
2) Axial compressive stress (per gross sectional area) Compressive members	On condition of $(l/r) \leq 20$, 1,200 kgf/ cm^2 On condition of $20 < (l/r) \leq 93$ 1,200-7.5{(l/r)-20} kgf/ cm^2 On condition of $93 \leq (l/r)$, 10,000,000/ {6,700 + $(l/r)^2$ } kgf/ cm^2
Compressive splice member	1,200 kgf/ cm^2
3) Bending tensile stress (per gross sectional area)	1,200 kgf/ cm^2
4) Bending compressive stress (per gross sectional area)	On condition of $(l/b) \leq (9/K)$ 1,200 kgf/ cm^2

where, l : buckling length of member (cm)

r : radius of gyration of sectional area of member (cm)

Compressive members	On condition of $(9/K) < (l/b) \leq 30$	$1{,}200 - 11\ (K \cdot l/b - 9)$ kgf/ cm^2

where, l : distance between fixed point of compressive flange (cm)
b : width of compressive flange (cm)
K : Squ. Root {3 + (Aw/2Ac)}
Aw : sectional area of web plate (cm^2)
Ac : sectional area of compressive flange (cm^2)
In case of (Aw/Ac) < 2, K is taken as 2

On condition that compressive flange is directly fixed to skin plate, etc.	1,200 kgf/ cm^2

5) Shearing stress (per gross sectional area) — 700 kgf/ cm^2

In case the thickness exceeds forty (40) mm, the allowable stresses for normal loading condition of the structural steel members shall be 0.92 times that of the allowable stress as mentioned above.

6) Combined stress resulting from combination of biaxial or triaxial principal stress — 1,800 kgf/ cm^2

7) Stress in the bar elements of trashrack shall not exceed the following critical stress.

$$Fcr = 0.6 \cdot fy \times (1.23 - 0.0153L/t)$$

where,
fcr : critical allowable stress (kg/cm^2)
fy : yield stress of the material (kg/cm^2)
L : laterally unsupported length of bar elements (cm), but $L \leq 70t$
t : thickness of the bar elements (cm), decreased a corrosion allowances as specified.

Notes:

(a) Bj 44 (SNI 0722-89-A) is equivalent to SS 400 (JIS G 3101).

(b) The allowable stresses in case of overloading condition and/or the combined stresses resulting from combination of biaxial or triaxial principal stresses may be increased by fifty percent (50 %) than those for normal loading condition. In no case, however, shall any stress exceed ninety percent (90 %) of the yield point strength and/or minimum elastic limit of the steel material used.

The combined stress shall be calculated by the following formula as developed by Mises, Hencky and Hubber :

$$fg = \text{Squ. Root} \{ fx^2 + fy^2 - fx ¥ fy + 3\, fq^2 \}$$

Where,

fg : Combined stress (kgf/cm^2)

fx : Direct stress (tension is considered as positive) (kgf/cm^2)

fy : Direct stress acting perpendicular to axis of fx (tension is considered as positive) (kgf/cm^2)

fq : Shearing stress (kgf/cm^2)

(c) When steel material other than those mentioned in the table is used, its allowable tensile stress for normal loading condition shall not exceed fifty percent (50 %) of the yield point strength of the steel material used.

All other allowable stresses shall be computed in proportion to the allowable stresses given in the table based on the yield point and/or ultimate strength of steel material used whichever is the least.

(2) Machine parts of hoisting equipment

All mechanical parts of the equipment subjected to normal or rated capacity loading condition shall be designed with the following factors of safety (FS) against the ultimate strength of the steel material used :

Material	FS for Tensile Stress	FS for Compressive Stress	FS for Shearing Stress
Rolled steel for general or welded structure	5	5	8.7
Carbon steel forgings	5	5	8.7
Carbon steel for machine structural use	5	5	8.7
Corrosion-resisting steel	5	5	8.7
Carbon steel castings	5	5	8.7
Gray iron casting	10	3.5	10
Bronze casting	8	8	10

(3) Concrete

The allowable concrete bearing and shearing stresses shall not exceed 60 kgf/cm^2 and 3.6 kgf/ cm^2. respectively.

8.2.3 Design particulars

(1) Minimum thickness

The thickness of all structural members shall not be less than six (6.0) mm, except those of the following parts or part as approved by the Engineer :

Parts	Min. thickness (mm)
- Skin plate of gates	6.0
- Corrosion resisting steel plate for sealing plates	6.0
- Steel sections	5.0
- Bar element	6.0

(2) Critical slenderness ratio

The critical slenderness ratio for major compressive members shall be less than 120, and 150 for

secondary members. The said ratio in case of tension members shall be read as 200 and 240, respectively.

(3) Maximum deflection

The maximum deflection of each horizontal main beam member shall be less than the following value at full load:

Equipment	Max. deflection
Slide gate	1/800 of supporting span
Flap gate	1/800 of supporting span

(4) Corrosion allowance

The corrosion allowance shall be the following value to the water contact face members of gates:

Equipment	Corrosion allowance
Slide gate	0.5 mm
Flap gate	1.0 mm

(5) Coefficient of friction

For the purpose of designing the equipment, the coefficient of friction shall not be less than the following values:

Kinds of Friction Force	Frictional Coefficient
- Sliding friction force of bearing plate	0.4
- Sliding friction force of seal rubber (Against stainless steel plate)	
* Dry condition	1.2
* Wetted condition	0.7
- Sliding friction force of sedimentary silt	0.4

(6) Rubber seals

Seals shall be designed and mounted in such a manner that they are adjustable, water tight and shall be readily removed and replaced. Seals shall be molded. Extruded seals shall not be permitted. Where seals are installed curved, they shall be clamped in a jig which will form them to the proper radius before the holes are laid out and drilled, and the ends trimmed. Holes in related parts of the seal assemblies shall be carefully drilled, using a template, to ensure proper matching when the seal units are assembled.

All adjusting screws, bolts and washers for securing the seals and seal assembly in place shall be of corrosion resisting steel.

Seals shall be made of natural or synthetic rubber suitable for the temperature ranges and conditions at the Site and shall be of a material that has proven successful in similar applications.

The seal materials shall have the following physical properties as determined by tests made in accordance with the relevant standards:

Property	Limits
- Tensile strength	210 kgf/cm^2 minimum
- Ultimate elongation	450 % minimum
- Durometer hardness (shore, type A)	60 to 70
- Specific gravity	1.1 to 1.3
- Water absorption (70 °C for 48 hours)	5 % maximum by weight
- Compression set (as a percent of total original deflection)	30 % maximum
- Tensile strength after oxygen bomb aging for 48 hours at 70 °C	80% minimum of tensile strength before aging
- Adhesion of metal insert to rubber	
* Sheared test	16 kgf/ cm^2
* Tension test (90 degree to axis)	2kgf/ cm^2

The gate seal shall be spliced at the corners by shop vulcanizing to provide a single continuous seal. The tensile strength of all shop splices shall not be less than fifty percent (50 %) of the tensile

strength of unspliced material.

(7) Materials

The materials used in structures of the steel gate shall be new and of high quality, selected particularly to meet the duties required for the proper operation of the gate, and indicated fully in the Contractor's detailed drawings for approval.

The materials shall meet with the requirements mentioned in the latest issue of the following standards, and in accordance with those as listed below or equivalent and/or better in quality or as approved in advance by the Engineer, unless otherwise specified:

(a) Steel plates, bars, etc.

- Steel plates for structural main parts of the equipment, except for rolled steel shapes	JIS G3106 SM400B, JIS G3101 SS 400, SNI 0552-89-A or equivalent
- Steel plates for general structures or equivalent	JIS G 3101, SS400, SNI 0552-89-A or equivalent
- Rolled steel shapes	JIS G 3192, SNI 0945-89-A or equivalent
- Expanded metals	JIS G 3351 or equivalent
- Steel bolts, nuts and washers	JIS B 1180, B 1181 and B 1256, SNI 0541-89-A or equivalent
- High-strength steel hexagon bolts, hexagon nuts and plain washers	JIS B 1186, SNI 0541-89-A or equivalent
- Spring lock washers	JIS B 1251, SNI 0571-89-A or equivalent
- Corrosion-resisting steel plates and bars, etc.	JIS G 4304, G 4305 ,G 4306 and G 4307 or equivalent

	- Corrosion-resisting clad steel plates	JIS G 3601 or equivalent
(b)	Castings	
	- Iron castings	JIS G 5501, FC 200, SNI 0813-89-A or equivalent
	- Steel castings	JIS G 5101, SC 410, SNI 1812-90-A (to be fully annealed) or equivalent
	- High tensile strength carbon steel castings and low alloy steel castings	JIS G 5111, SCMn Cr 3B or equivalent
	- Bronze castings	JIS H 5111 or equivalent
	- Phosphor bronze castings	JIS H 5113 or equivalent
(c)	Forgings	
	- Carbon steel forgings	JIS G 3201, SF 490 A, SNI 1855-90-A or equivalent
(d)	Wire ropes	JIS G 3525, Grade G(galvanized), SNI 0076-87-A or equivalent

8.3 Slide Gate and Hoist of Each Drainage Channel

8.3.1 General

The following number of vertical lift, steel made slide gate with guide frame, manual spindle hoist and appurtenant parts complete with necessary accessories shall be designed, supplied and installed at each drainage channel by the Contractor. The drainage channel gate works are as follows:

No.	Dimension			Gate Type	Q'ty	Design Head (m)	Operation Water Head Difference (m)
	Clear Span (m)		Clear Height (m)				
1.	0.7	×	0.7	Slide gate	1	1.967	1.0
2.	0.8	×	0.8	Slide gate	7	2.387	1.0
3.	0.9	×	0.9	Slide gate	1	1.876	1.0
4.	1.0	×	1.0	Slide gate	4	2.835	1.0
5.	1.1	×	1.1	Slide gate	3	2.644	1.0
6.	1.2	×	1.2	Slide gate	2	2.739	1.0
7.	1.3	×	1.3	Slide gate	1	2.558	1.0
8.	1.5	×	1.5	Slide gate	1	2.391	1.0

The drainage channel gates shall be used to close off the respective culvert section during flood. The general arrangement of the typical gate shall be shown on the Drawings enclosed in Vol. IV - Drawings, and the details of gates and guide frames shall also be as shown on the Drawings enclosed in Vol. IV - Drawings, of the Contract Documents.

The general data for the design of the slide gate are given in Sub-clause 8.3.3, Design data, hereinafter and these data shall remain fixed and shall not be altered.

The Contractor shall exercise special care in the design and fabrication of the gate to avoid vibration during any operating condition and water leakage under the fully closed condition.

8.3.2 Design stresses

The design stresses shall conform to those specified in Sub-clause 8.2.2, Design stresses, hereinbefore.

8.3.3 Design data

The gate, guide frame and hoist shall be designed for the following conditions :

(1) General data

Quantity	:	Refer to Sub-clause 8.3.1, General
Type of gate	:	Steel made slide gate
Clear span	:	Refer to Sub-clause 8.3.1, General
Clear height	:	Refer to Sub-clause 8.3.1, General
Design head	:	Refer to Sub-clause 8.3.1, General
Operation head	:	Water head difference of 1.0 m
Sealing method	:	4 edges rubber seal at downstream
Corrosion allowance	:	1.0 mm for water contact face members
Type of hoist	:	Manually driven single stem screwed spindle hoist
Hoisting height	:	Clear height + 5 cm in normal operation
Operating force	:	Less than 10 kgf

Other design data such as hoist deck elevation, HWL, sill elevation, etc., are given in the Table of Drawings related together with the name of drainage channel and required quantity.

(2) Gate

(a) Hydrostatic load
Head water at HWL + 1.0 m
Tail water below gate bottom seal EL
(b) Self weight of gate
Operating load
(d) All loads imposed during operating gate due to gate jammed condition

(3) Guide frame

The loading on the guide frame shall be the bearing load and all other loads due to the most adverse operation of the gate.

The guide frames and their anchors shall be capable of transferring all the loads to the concrete structure and of preventing harmful deflection of guide frames due to placing the secondary concrete in blockouts.

(4) Hoist

The hoist shall be designed to open, close and hold the gate in any position between fully opened and fully closed positions.

The rated capacity of the hoist and the strength of screwed spindle shall be adequate for the following combination of loads :

(a) Self weight of the gate leaf and spindle
(b) Friction force due to bearing plates
(c) Friction force due to seal rubbers
(d) Buoyancy

8.3.4 Gate details

(1) General

The gate shall be welded steel construction consisting of skin plate, main horizontal beams, vertical beam(s), bearing-cum-rubber clamp plates, seals, side and front guides, lifting lug and all other necessary components. Provision shall be made to drain water from the horizontal members.

The skin plate shall be at the opposite side against the water pressure.

The main horizontal beams shall be of H-beam, channel beam or built up plate girder construction.

The vertical beams shall be of channel beam or built-up plate girder construction and be connected with the main horizontal beams and skin plate.

The bearing-cum-rubber clamp plates shall be of mild steel to close fit with the track frame surface.

The gate seals shall be of molded rubber shape and be clamped to the skin plate using the flush head corrosion-resisting steel bolts with washers through the seat plates. The upper and side seals shall be "Hollow music note" shape which shall be activated by the water pressure, while the bottom seal shall be of plain bar type of rubber seal.

Two (2) side guides made of corrosion-resisting steel shall be provided on each side of the gate to

limit the lateral movement of the gate. Two (2) tapered wedges made of corrosion-resisting steel shall be provided on each side of downstream surface of the gate to limit the longitudinal movement of the gate. The tapered wedges shall withstand the load due to possible most adverse operation of the gate.

One lifting lug shall be provided on the top of the gate for the connection of hoist spindle by the corrosion-resisting steel pin with corrosion-resisting steel split pin or key plate.

(2) Tolerances

The gate shall be accurately fabricated and installed within the following tolerances;

Point to be measured	Tolerances (mm)
Gate width	± 4
Gate height	± 4
Gate depth	± 2
Diagonal length difference	± 4
Distance of center to center of bearing plates	± 4
Distance between side seal rubbers	± 10

The tolerances not specified herein shall be defined by the Contractor himself and subject to the Engineer's approval.

8.3.5 Guide frame details

(1) General

The guide frame shall consist of the sealing frames, lintel beam, sill beam, track frames, front frames and all other components necessary for the complete and satisfactory installation of the guide frame.

The sealing frame shall consist of corrosion-resisting steel plate attached to the track frames, sill beam and lintel beam. When the guide frame has been assembled, the sealing surfaces shall be straight, true and in the same plane within the specified tolerances.

The lintel beam shall be true to form and free from twist and warp to provide a close fit with the upper rubber seal of gate. The corrosion-resisting steel plate shall be welded to the beam by

continuous welding and be finished smooth and straight within the specified tolerances when assembled.

The sill beam shall be true to form and free from twist and warp to provide a close fit with the bottom seal of gate. The surface of the sill beam shall be flushed with the sill elevation and shall be fitted and attached to the side sealing frames at the corners to form a continuous seal when the gate is fully closed. The surface plate of the sill beam shall be of corrosion-resisting steel.

The track frames shall be capable of transferring the water pressure load from the gate to the concrete structure. The surface of the track frames shall be furnished with corrosion-resisting steel plates, and be true and flat.

The side guide frames shall have ample strength to resist the load of the side guides. The assembled side guide frames shall be straight over their entire length and no offset shall exist at joints.

The front frames shall have ample strength to resist the load of the front guides and be true and flat.

(2) Tolerances

The guide frames shall be accurately fabricated and installed within the following tolerances;

Point to be measured	Tolerances (mm)
Clear span	± 4
Clear height	± 4
Sealing span	± 4
Diagonal length difference	± 4
Distance between front and track frame face	± 1
Distance of center to center of track frame	± 3
Height of guide frame	± 6
Distance between side guide frame	0, + 6
Flatness of lintel and side sealing frames	± 0.5/m
Straightness of lintel and side sealing frames	± 2
Flatness of sill beam surface	± 0.5/m
Straightness of sill beam surface	± 2
Flatness of track frame surface	± 0.5/m
Straightness of track frame surface	± 2

Straightness of side guide frame	± 2
Straightness of front guide frame surface	± 2

The tolerances not specified herein shall be defined by the Contractor himself and subject to the Engineer's approval.

8.3.6 Hoist details

The hoist shall be manually operated single stem screwed spindle hoist suitably mounted on the steel deck to open, close and hold the slide gate in any position between fully opened and fully closed positions.

The hoist shall consist of stand, mechanical equipment, i.e., bearings, gear reducer unit, screwed and extension spindles, removable spindle support(s) with bracket(s), manual operating device, mechanical position indicator and all other necessary components including the hooks for proper and efficient operation of the hoist.

The hoist shall be designed to withstand the rated hoist load at the specified allowable stresses and the factors of safety. The spindle shall be of corrosion-resisting steel.

The mechanical equipment shall conform to the requirements of Sub-clause 8.1.5 hereinbefore.

Two hooks shall be provided at the horizontal beam as shown on the Drawings related for installation and maintenance purposes of the gate.

8.3.7 Shop assembly and tests

(1) Gate and guide frame

The gate including seals, side guides, lifting lug, etc., shall be assembled at the shop in the approximate position that it will have after installation at the Site. While assembled, the gate shall be checked for dimensions, tolerances and accuracy of alignment.

Any error and misalignment discovered shall be promptly corrected. The seals shall be fitted to their supports during the shop assembly.

The track frames, side guide frames, sealing frames, sill beam, lintel and front frames for the guide

frames shall be assembled at the shop. All dimensions of the guide frames, that correspond to the gate dimensions, shall be checked and any error and misalignment discovered shall be corrected. Parts shall be clearly match-marked before disassembling for shipment.

(2) Hoist

The hoist shall be completely shop assembled and tested for smooth and proper performance. All units shall be tested at rated load and closely checked to ensure that all necessary clearance and tolerances have been provided and that no binding occurs in any moving part. All bearings shall be carefully checked. All lubricating grease and oil required for the performance of the test shall be furnished. Any improper operation discovered shall be corrected and the entire test shall be repeated.

8.3.8 Installation and tests at the Site

(1) Guide frame

The guide frame shall be assembled in the blockout in accordance with the "FOR WORK DRAWINGS" and approved erection manual, brought to line and grade within the tolerances specified and firmly secured in place. Alignment bolts or other necessary devices shall be used to install the guide frame at corresponding accurate position. Connections between guide frame, anchored materials and the alignment devices shall be adjusted, firmly tightened and welded to hold the guide frame securely in position while concrete is being placed in the blockout.

Additional bracing shall be provided where necessary to ensure the required alignment. Extreme care shall be taken to ensure that the sealing surfaces lie in a true plane within the tolerance specified for their entire length.

Placement of concrete in blockout shall not proceed until the guide frame has been completely assembled and secured. During and after concrete placing, alignment and tolerances shall be checked and remedial action taken if readings indicate that displacement has occurred.

(2) Gate

The gate complete with side guides, lifting lugs and seals shall be assembled and erected in accordance with the details shown on the "FOR WORK DRAWINGS" and approved erection manual.

The bottom of the gate, when erected, shall be in true alignment to ensure a tight and even bearing of the rubber seal on the embedded sill beam. The sides of the gate shall be true alignment so that the rubber seals, when installed, will have a tight and even bearing on the sealing surface embedded in the concrete. The gate shall be assembled and erected within the shop test tolerance necessary to meet the specified tolerances.

(3) Hoist

Before assembly, all bearing surfaces, journals, grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. Before operation, all lubricating system shall be checked by the Contractor.

The hoist shall be completely assembled and installed in accordance with the "FOR WORK DRAWINGS" and approved erection manual. The hoist shall be located and adjusted so that they are in true alignment with lifting lugs of the gate.

After installation of the hoist and prior to setting the spindle, the hoist shall be operated and checked for proper operation. After completion of the above tests, the spindle shall be set and connected to the gate and the gate shall be tested. Any defect or improper operation discovered during the test shall be corrected and the entire test shall be repeated.

8.3.9 Tests on completion

After completion of installation work at the Site, the following tests shall be performed by the Contractor in accordance with the approved test procedure:

(1) Preliminary tests

(a) Inspection by feeler gauge measurement of satisfactory sealing of all seals, and
(b) Inspection of satisfactory installation of all components.

(2) Operation test

The operation tests shall include but shall not be confined to :

(a) Check of manual operation of hoist
(b) Check of satisfactory operation under dry and available maximum water level, and

(c) Check of gate position indicator.

8.3.10 Measurement and payment

Measurement, for payment, of steel slide gate and hoist will be made on the basis of actual installed number of steel slide gate and hoist in sets as shown on the Drawings or as directed by the Engineer.

Payment shall be made for the number of sets measured as provided above at the Contract unit price per set stated in the Bill of Quantities, which unit price for steel slide gate and hoist shall constitute full compensation for the cost of all labour, tools, equipment and materials including designing, procuring, transporting, storing, handling, assembling, erecting, installing, galvanizing and painting as well as supply, installation of all related materials and fittings, and other items necessary to complete the Works.

Payment shall be made to the Contractor subsequent to the tests on completion specified in the preceding Sub-clause 8.3.9 and the Engineer has ascertained the gate and hoist have been completed and have become operational.

8.4 Flap Gates

8.4.1 General

The following square type steel flap gate shall be designed, supplied and installed at each small drainage channel which are located at arban areas in tributary by the Contractor.

- Type : Square type steel flap gate

- Location and size;

Location	Clear Span (mm)	Clear Height (mm)	Q'ty	Design Head (m)
SKE-2L	400	400	1	1.562
SKE-3L	400	400	1	1.574
SKE-5L	400	400	1	1.620
SKE-3R	400	400	1	1.790

In order to standardize the design, the design head shall be taken as 1.79 m commonly for all the flap gates of the Project.

- Operation : Automatically operated by water pressure difference.

8.4.2. Design stresses

Gate shall be designed taking into account of the hydrostatic load and the dead weight of itself. The design stresses shall conform to those specified in Sub-clause 8.2.2, Design stresses.

8.4.3. Design data

The gate and seating frame shall be designed for the following conditions:

(1) General data

Quantity	:	Refer to Sub-clause 8.4.1,General
Type of gate	:	Steel made flap gate
Clear span	:	Refer to Sub-clause 8.4.1,General
Clear height	:	Refer to Sub-clause 8.4.1,General
Design head	:	Refer to Sub-clause 8.4.1,General
Corrosion allowance	:	1.0 mm for water contact face members
Sealing method	:	4 edges rubber seal at anti-pressure side

Other design data such as HWL, elevation of conduit center, etc. are given in the Table of Drawings related together with the name of drainage channel and required quantity.

(2) Gate

(a) Hydrostatic load
Pressure side head water at HWL + 1.0 m
Anti-pressure side head water at lower sealing elevation of the gate

(b) Self weight of gate

(3) The loading on the seating frame shall be the bearing load and all other loads due to the flap gate. The seating frames and their anchors shall be capable of transferring all the loads to the

concrete structure and of preventing harmful deflection of seating frames due to placing the secondary concrete in blockouts.

8.4.4 Gate details

The flap gate consists of skin plate, main beams, edge beams, upper hinge, connecting plate and other necessary components. The skin plate shall be provided at the river side (pressure side) of gate leaf, but the seal rubber shall be provided at the land side of gate leaf. Hinge pins and plate shall be of corrosion resisting steel.

8.4.5 Seating frame details

The seating frame consists of upper, under and side frames, hinge brackets and other necessary components. The seating frame should be embedded in the secondary concrete. The corrosion-resisting steel plates are attached to four edge frames. The seating frame and anchors are capable of transferring the load of the metal seals of the gate to the concrete structure. The hinge brackets are rigidly fixed by the anchors.

8.4.6 Shop assembly and tests

The gate including seating frames shall be assembled in the shop in an approximate position so as to be installed at the Site. While assembled, the gate shall be checked for dimensions, accuracy of alignment and operating performance. Any error and misalignment discovered shall be promptly corrected.

8.4.7 Installation

The gate and seating frames shall be assembled and erected in accordance with the final approved drawings. The seating frame shall be accurately set, aligned and surely anchored prior to placing of secondary concrete.

The sealing surface of the gate shall be in true alignment to ensure an even bearing on the seating frame.

8.4.8 Measurement and payment

Measurements, for payment, of steel flap gate will be made on the basis of actual installed number

of flap gates in sets as shown on the Drawings or as directed by the Engineer. Payment shall be made for the number of sets measured as provided above at the Contract unit price per set stated in the Bill of Quantities, which unit price for steel flap gate shall constitute full compensation for the cost of all labor, tools, equipment and materials including designing, procuring, transporting, storing, handling, assembling, erecting, installing, galvanizing and painting as well as supply and installation of all related materials and fittings, and other items necessary to complete the Works.

Payment shall be made to the Contractor subsequent to the tests on completion and the Engineer has ascertained the gate has been completed and has become operational.

8.5 Timber Stoplog

8.5.1 General

The following number of timber stoplogs shall be designed, supplied and installed at each sluiceway by the Contractor. These sluiceway stoplog works are as follows.

No.	Dimension			Stoplog Type	Q'ty		Design Head (m)
	Clear Span		Clear Height		Stoplog (set)	Guide frame	
1.	0.7m	×	0.7m	Timber stoplog	1	24 sets in total	1.883
2.	1.5m	×	1.3m	Timber stoplog	1		2.391

Stoplogs shall be used for maintenance and repair of the slide gate slots.

Stoplogs shall be stored at storage yard and transported by the ordinary truck to the designated place.

The general data for the design of stoplogs are given in Sub-clause 8.5.3, Design data, hereinafter and these data shall remain fixed and shall not be altered.

The arrangement of stoplogs shall be as shown on the Drawing enclosed in Vol. IV- Drawings.

8.5.2 Design stresses

The allowable bending and shearing stresses of first class teak wood shall not exceed 110 kgf/cm^2

and 11 kgf/cm^2, respectively. The other design stresses shall conform to those specified in Sub-clause 8.2.2, Design stresses.

8.5.3 Design data

The stoplogs and guide frames shall be designed for the following conditions :

(1) General data

Quantity	:	Refer to Sub-clause 8.5.1, General
Stoplog type	:	Timber stoplog
Clear span	:	Refer to Sub-clause 8.5.1, General
Clear height	:	Refer to Sub-clause 8.5.1, General
Design head	:	Refer to Sub-clause 8.5.1, General
Operation head	:	Water head difference of 0.2 m
Height of each block	:	200 mm

Other design data such as HWL, sill elevation, operation deck elevation, etc., are given in the Table of Drawings related together with the name of drainage channel and required quantity.

(2) Stoplog

(a) Hydrostatic load
Head water at HWL
Tail water below sill elevation

(b) Self weight of the stoplog leaf

(c) Operating load

(3) Guide frame

The loading on the guide frame shall be the bearing loads and all other loads due to most adverse operation of the stoplog. The guide frame and the anchors shall be capable of transferring all loads from the stoplog to the concrete structure.

(4) Portable hanger (Not Applicable)

The portable hanger shall be designed to lift the dead weight of stoplog, plus all friction load due to the stoplog block.

8.5.4 Stoplog details

(1) General

Each block of stoplog shall be a timber piece with two lifting eye bolts. Timber quality shall be hard wood and well seasoned first class teak wood. Timber shall be treated with coal tar creosote. Two lifting eye bolts including nuts and plain washers shall be hot-dip galvanized.

(2) Tolerances

Each stoplog block shall be accurately fabricated and installed within the following tolerances;

Point to be measured	Tolerances (mm)
Stoplog width	± 5
Stoplog height	± 5
Stoplog depth	± 5
Distance between lifting eye	± 3

The tolerances not specified herein shall be defined by the Contractor himself and subject to the Engineer's approval.

8.5.5 Guide frame details

(1) General

Two guide frames shall be provided at both the slots as shown on the Drawing. The guide frame shall be of angle beam and the anchors. The frames shall be straight and flat for providing a close fit with the stoplog block.

(2) Tolerances

The guide frame shall be fabricated and installed within the following tolerances ;

Point to be measured	Tolerances (mm)
Clear span	± 5
Height of frame	± 5
Flatness of frame	± 1/m
Straightness of frame	± 2

The tolerances not specified herein shall be defined by the Contractor himself and subject to the Engineer's approval.

8.5.6 Portable hanger details (Not Applicable)

Each portable hanger shall be provided at the outlets conduit of Saluran Cenkaren drainage channel for easy handling the timber stoplogs. The portable hanger shall consist of a hanger support, required number of stands and a handling tools with slings and hooks.

The hanger support shall be of a steel pipe construction with a U - hook for suspending a handling tool. The stand for hanger shall be adequate for removing the hanger. The handling tool shall be of manually operated chain block type and the capacity and lift shall be suitable for the timber stoplog to be handled. The structure of the portable hanger shall be as shown on the Drawing or as directed by the Engineer.

8.5.7 Shop assembly and tests

Each stoplog block shall be manufactured at the shop. After manufacturing, each stoplog block and guide frame shall be checked for dimensions, tolerances and accuracy of alignment. Any error or misalignment discovered shall promptly be corrected.

8.5.8 Installation and tests at Site

The guide frame and the anchors shall be erected with reinforcement bars and form works in accordance with the "FOR WORK DRAWINGS" and approved erection manual, brought to line and grade within the tolerances specified and firmly secured in place. Placement of concrete shall not proceed until the guide frames and the anchors have been completed, assembled and secured. During and after placing the concrete, alignment and tolerances shall be checked and remedial action taken if readings indicate that displacement has occurred.

Each stoplog block shall be erected in accordance with the "FOR WORK DRAWINGS".

8.5.9 Tests on completion

After completion of installation work at the Site, the following tests shall be performed by the Contractor in accordance with the approved test procedure:

(1) Inspection of satisfactory installation of all components, and
(2) Check of satisfactory operation of handling tool.

After completion of final test, the Contractor shall store the stoplogs at the storage yard designated by the Employer.

8.5.10 Measurement and payment

Measurement, for payment, of stoplogs, handling tool and slings will be made on the basis of actual installed number thereof in sets as shown on the Drawings or as directed by the Engineer.

Payment shall be made for the number of sets measured as provided above at the Contract unit price per set stated in the Bill of Quantities, which unit price for stoplogs, handling tool and slings shall constitute full compensation for the cost of all labour, tools, equipment and materials including designing, furnishing, fabricating, transporting, painting, preparing and submitting shop drawings and other necessary documents, and installing stoplogs and other items necessary to complete the Works.

Measurement, for payment, of embedded guide frame for stoplog slot will be made on the basis of the actual installed weight of steel in kilograms determined by the "FOR WORK DRAWINGS" or as directed by the Engineer.

Payment shall be made for the kilograms measured as provided above at the respective Contract unit price per kilogram stated in the Bill of Quantities, which unit price shall constitute full compensation for the cost of all labour, tools, equipment and materials including designing, furnishing, fabricating, transporting, installing the embedded metals, painting, preparing and submitting shop drawings and other necessary documents, and other items necessary to complete the Works.