

TS 5 CONCRETE WORK

		Page
TS 5.01	Scope of Application	5 – 1
TS 5.02	Classes of Concrete	5 – 1
TS 5.03	Proportions	5 – 2
	(1) General	5 – 2
	(2) Selection of Proportions	5 – 2
	(3) Strength Requirements	5 – 2
TS 5.04	Materials	5 – 3
	(1) Cement	5 – 3
	(2) Admixtures	5 – 3
	(3) Water	5 – 3
	(4) Fine Aggregates	5 – 3
	(5) Coarse Aggregates	5 – 5
	(6) Joint Materials	5 – 7
	(7) Curing Materials	5 – 7
	(8) Material Storage	5 – 8
TS 5.05	Execution	5 – 9
	(1) Batching	5 – 9
	(2) Mixing	5 – 9
	(3) Slump Test	5 – 10
	(4) Compressive Strength Test in Field	5 – 10
	(5) Scaffolds, Forms, and Timberings	5 – 11
	(6) Placing Concrete	5 – 13
TS 5.06	Method of Measurement and Basis of Payment	5 – 16
	(1) Method of Measurement	5 – 16
	(2) Basis of Payment	5 – 17
TS 5.07	Reinforcement	5 – 17
	(1) Materials	5 – 17
	(2) Storage	5 – 17
	(3) Fabrication	5 – 18
	(4) Placing Reinforcement	5 – 18
	(5) Splicing	5 – 18
	(6) Method of Measurement and Basis of Payment	5 – 18

TS 5 CONCRET WORK

TS 5.01 Scope of Application

This technical specifications for the concrete work shall apply to the requirements for provision of materials, and the execution of work for reinforced and plain concrete structures of bridge abutments, bridge piers, box culverts, retaining walls, U-shaped retaining walls and other related work necessary for concrete work specified under technical specifications herein.

The Contractor shall be responsible for the execution of the work strictly in accordance with this specifications and the contract documents.

TS. 5.02 Classes of Concrete

The classes of concrete used for structures shall be as shown in Table 5-1.

Table 5-1 Classes of Concrete

Classes	Applied Structures or Members	Compressive Strength at the age of 28 days (kg/cm ²)
Bridge abutment concrete	Walls and wing walls of bridge abutment	210
Bridge abutment foundation concrete	Foundation of bridge abutments	210
Bridge pier concrete	Wall of bridge piers	210
Bridge pier foundation concrete	Foundation of bridge piers	210
Box culvert concrete	Box culverts	210
U-shaped retaining wall concrete	U-shaped retaining walls	210
Open drainage concrete	Reinforced concrete and plain concrete open drainage	180
Retaining wall concrete	Retaining walls	180
Miscellaneous concrete	Other structures such as aprons	180
Leveling concrete	Leveling concrete for structural foundations	160

TS 5.03 Proportions

(1) General

The Contractor shall select the proportions of concrete so as to obtain the placeability, strength, and durability, anticipated to cover the requirements of the work and so that the material characteristics available to the work may be introduced into the proportions suited to the work. Where the quantities of each concrete materials are changed by the change in the concrete proportions, the unit price due to it shall not be changed.

(2) Selection of Proportions

The concrete mix design standards is shown in Table 5-2.

The Contractor shall apply these standards to select a concrete proportions, carry out tests, and made correction until he obtains the concrete having characteristics satisfying the above stated requirements.

Unless otherwise directed by the Engineer, the method of selecting concrete proportions shall conform to ACI 211.1 and the finally determined concrete proportions shall be approved by the Engineer.

Where reasonably possible, the selection of concrete proportions shall be performed on the basis of the test results and experiences obtained by using the actually used materials and equipment.

Table 5-2 Concrete Mix Design

Compressive strength at the age of 28 days (Design standard strength), kg/cm ²	Nominal maximum size of coarse aggregate, in.	Range of slump, cm	Range of air content, percent by volume	Maximum permissible water-cement ratio, percent by weight
210	1	10 – 15	3 – 6	58
180	1½	10 – 15	3 – 6	63
160	1½	10 – 15	3 – 6	63

(3) Strength Requirements

The measured compressive strength of a concrete specimens at the age of 7 days shall not be than 60% of the design standard strength shown in Table 5-2. The measured compressive strength of a concrete specimens at the age of 28 days shall satisfy the following conditions:

- (a) The probable frequency of the test values failing below the 80% of design standard strength shall not exceed in 1 in 20.
- (b) The probable frequency of the test values filling below the design standard strength shall not exceed in 1 in 4.

Note: The term of design standard strength is defined as designated standard compressive strength of concrete at the age of 28 days.

TS 5.04 **Materials**

(1) **Cement**

Portland cement shall conform to the requirements of ASTM C150 (AASHTO M85) and portland cement of types I and II shall be used, unless otherwise specified. Different brands of cement, or the same brand of cement from different sources shall not be used for the same structure, without prior approval by the Engineer. Prior to the use of cement, the Contractor shall confirm its quality by carrying out physical and chemical tests, or by submitting the quality certificate of manufacture to the Engineer and accepting his approval therefor. The physical and chemical test shall be performed in accordance with ASTM C150 (AASHTO M85).

(2) **Admixtures**

(a) When the Contractor intends to use admixtures, the Contractor shall prepare the certificate by which items described in (i), (ii), and (iii) below have been certified by the tests conducted in the laboratory approved by the Engineer, and such certificate shall be submitted to and approved by the Engineer.

(i) The test results indicate that the admixture meet the initial purpose.

(ii) An advantageous effect of one item does not adversely affect other properties.

(iii) A combination of materials (cement, water, and aggregates) shall be optimum so as not to reduce the effect of admixture and or lead to the improper amount of admixtures to be added.

(b) When the Contractor use the previously approved admixtures, the Contractor shall submit a certificate stating the admixture is the same as the one previously approved, before he actually uses it.

(c) Air-entraining admixtures shall conform to the requirements of ASTM C260 (AASHTO M154); the retarding and water-reducing admixtures shall conform to the requirements of ASTM C494 (AASHTO M194).

When the Contractor intends to use other admixtures, he shall obtain the approval by the Engineer before use.

(3) **Water**

Water to be used for mixing and for washing aggregates shall be clean and free from injurious amount of substances that affect the qualities of concrete, such as oil, acid, salt, alkali, organic matter or other deleterious substances.

No water shall be used until tested in accordance with, and shall meet the suggested requirements of the AASHTO T26.

Water known as potable quality may be used without test, but with the approval of the Engineer.

(4) **Fine Aggregate**

(a) **General**

Fine aggregate shall consist of natural sand or engineer-approved crushed sand made from inorganic inert materials, and shall be composed of clean, hard, and durable.

Fine aggregate from different sources shall not be used for the same struc-

ture without the approval of the Engineer.

(b) **Grading Requirements**

The sieve analysis for fine aggregate shall be carried out in accordance with ASTM C136, and the grading shall satisfy the following conditions.

Table 5-3 Grading requirement for Fine aggregate

Sieve size	Total passing percentage by weight
3/8 inch	100
No. 4	95 – 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	25 – 60
No. 50	10 – 30
No. 100	2 – 10

When the fineness modulus of fine aggregate has changed by more than 0.20 as compared with the fineness modulus of fine aggregate measured at selection of concrete proportion, then the proportion shall be changed.

The fineness modulus of fine aggregate is determined by adding the values of weight percentage that passed the nominal sieve numbers of 3/8, No. 4, No. 8, No. 16, No. 50, and No. 100, all divided by 100.

Fine aggregate not satisfying the minimum requirements for material passing the No. 50 and No. 100 sieves may be used, when deficiency is corrected by adding an approved inorganic fine inert materials.

(c) **Allowable Deleterious Substances**

Deleterious organic impurities such as dirt and sludge shall be limited in fine aggregate to the amounts shown in Table 5-4, and it also shows the testing methods of an amount of deleterious substances.

Table 5-4 Allowable deleterious substances in fine aggregate

	Test method	Maximum limit, percent by weight
Clay lumps	ASTM C142 (AASHTO T112)	1
Material passing through ASTM No. 200 sieve	ASTM C117 (AASHTO T11)	3

The colorimetric test for organic impurities shall be carried out according to ASTM C40. Fine aggregate showing a color darker than the standard shall not be used unless it has passed the motor-strength test. When fine aggregate test during the course of the work indicates a color darker than the specimens approved for the work, the work shall be suspended until tests are performed to the satisfaction of the Engineer.

When fine aggregate having a color darker than the standard is used to make a motor specimens to be tested, and after being washed with a 3% by drated natorium (NaOH) solution and a sufficient amount of water, its compressive strength is found to be greater than 95% of the compressive strength of a motor specimens made from the same fine aggregate, then the fine aggregate may be used with the approval of the Engineer.

The motor test containing fine aggregate shall be carried out according to ASTM C87 (AASHTO T71), using at the age 7-days samples for both Types I and II.

(d) **Durability Requirement**

When a fine aggregate undergoes five successive soundness tests using sodium sulfate in accordance with ASTM C88 (AASHTO T104), the weighted percentage of loss shall be not more than 10 percent of the original weight. Fine aggregated failing to meet the requirements for soundness may be accepted by submitting the verification which can be shown by evidence satisfactory to the Engineer that concrete of comparable size made from similar fine aggregate from the same source has been exposed to weathering under conditions similar to those occurring at the site of the structure for a period of at least five years without appreciable disintegration.

(5) **Coarse Aggregate**

(a) **General**

The coarse aggregate for concrete shall consist of crushed stone, crushed or uncrushed gravel, or engineer-approved inorganic inert materials, and shall be composed of clean, hard, durable, uncoated particles.

(b) **Grading Requirements**

The sieve analysis for coarse aggregate shall be carried out according to ASTM C136 and the grading shall conform to the following conditions:

Table 5-5 Grading Requirements for Coarse Aggregate

Size Number	Nominal Size (Sieves with Square Openings)	Amounts Finer than Each Laboratory Sieve (Square Openings), Percent by Weight												
		4 in. (100 mm)	3 in. (75 mm)	2 1/2 in. (63 mm)	2 in. (50 mm)	1 1/2 in. (37.5 mm)	1 in. (25.0 mm)	3/4 in. (19.0 mm)	3/8 in. (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)	No. 16 (1.18 mm)		
1	3/4 to 1 1/2 in. (90 to 37.5 mm)	100	90 to 100	...	25 to 60	...	0 to 15	...	0 to 5	...	...	...	...	...
2	2 1/2 to 1 1/2 in. (63 to 37.5 mm)	...	100	...	90 to 100	35 to 70	0 to 15	...	0 to 5	...	...	...	...	...
357	2 in. to No. 4 (50 to 4.75 mm)	...	...	...	100	95 to 100	...	35 to 70	...	10 to 30	...	0 to 5	...	...
467	1 1/2 in. to No. 4 (37.5 to 4.75 mm)	...	...	...	...	100	95 to 100	...	35 to 70	...	10 to 30	0 to 5	...	...
57	1 in. to No. 4 (25.0 to 4.75 mm)	...	...	...	...	...	100	95 to 100	...	25 to 60	...	0 to 10	0 to 5	...
67	3/4 in. to No. 4 (19.0 to 4.75 mm)	...	...	...	...	...	...	100	90 to 100	...	20 to 55	0 to 10	0 to 5	...
7	1/2 in. to No. 4 (12.5 to 4.75 mm)	...	...	...	...	...	...	...	100	90 to 100	40 to 70	0 to 15	0 to 5	...
8	3/8 in. to No. 8 (9.5 to 2.36 mm)	...	...	...	...	...	...	...	...	100	85 to 100	10 to 30	0 to 10	0 to 5
3	2 to 1 in. (50 to 25.0 mm)	...	...	...	100	90 to 100	35 to 70	0 to 15	...	0 to 5	...	...	...	...
4	1 1/2 to 3/4 in. (37.5 to 19.0 mm)	...	...	...	...	100	90 to 100	20 to 55	0 to 15	...	0 to 5	...	...	...

(c) **Allowable deleterious substances**

Deleterious substances shall be limited in coarse aggregate to the amount shown in Table 5-6, and Table 5-6 also shows the testing methods of an amount of deleterious substances.

Table 5-6 Allowable deleterious substances in coarse aggregate

	Test method	Maximum limit, percent by weight
Clay lumps	ASTM C142 (AASHTO T112)	0.25
Materials passing through ASTM No. 200 sieve	ASTM C177 (AASHTO T11)	1

(d) **Requirements for Hardness**

Weighted percentage of abrasion loss of coarse aggregate shall be not more than 40% of the original weight at 500 rotations of abrasion resistance test, according to ASTM C131.

(e) **Durability Requirements**

When coarse aggregate undergoes five successive operations of the aggregate soundness test using sodium sulfate in accordance with ASTM C88 (AASHTO T104), the weighted percentage of loss shall be not more than 12 percent of the original weight. Coarse aggregate failing to meet the requirements for soundness may be accepted by submitting the verification which can be shown by evidence satisfactory to the Engineer that concrete of comparable size made from similar coarse aggregate from the same source has been exposed to weathering under conditions similar to those occurring at the site of the structure for a period of at least five years without appreciable disintegration.

(6) **Joint Materials**

The Contractor must shall propose to the Engineer for approval of joint materials such as joint fillers and joint sealants which is to be applied at the places shown on the design drawings, and appropriate for the structure.

(7) **Curing Materials**

The curing materials shall conform to the following standards:

- o Burlap cloth made from jute or kenaf: AASHTO M182
- o Sheet materials for curing concrete: ASTM C171 (AASHTO M171)

(8) **Material Storage**

(a) **Cement**

(i) **General**

Cement shall be stored in a moisture-proof buildings or silos. Cement stored by the Contractor for a period of more than 60 days shall be approved by Engineer before use. Cement slightly solidified during storage not be used for the work. Different brands and types of cement, or the same brand of cement from different sources, shall be stored separately.

(ii) **Sacked Cement**

Sacked cement shall be stored in moisture-proof building(s) previously approved by the Engineer, the floor of which is not less than 300 millimeters above from the ground level.

Sacked cement shall be stacked close together to reduce circulation of air and in such a manner as to permit easy access for inspection. The stacks shall not exceed 15 sacks.

(iii) **Bulk Cement**

Bulk cement shall be stored in the same silos as the one already used in the Republic of Bolivia, or in silos approved by the Engineer.

(b) **Aggregates**

Fine and coarse aggregates shall be stored in separate groups of types, gradings, and sources so as to prevent contamination with earth or impurities.

When storing and handling aggregates, care shall be taken, in general, not to cause segregation of fine and coarse grains, and to prevent grains from being crushed especially for coarse aggregate by arranging the installation in order to achieve this purpose.

The aggregate storage installation shall be a proper size and shall be built and maintained to keep the surface moisture uniformly.

(c) **Admixtures**

(i) **General**

The admixtures shall be stored to prevent the inclusion of dirt and other foreign materials. Where the storage period is extended and the Engineer considers a test to be required, the Contractor shall carry out the test to confirm how it affects concrete, and accept the Engineer's instructions whether or not the admixtures can be used.

(ii) **Powder Admixtures**

Powder admixtures shall be protected from moisture absorption or solidification by storing it in a moisture-proof warehouse or silo. When storing various types of admixtures, care shall be taken not to confuse the storage containers or mix for use.

(iii) **Liquid Admixtures**

The liquid admixtures shall be protected from separation or degrada-

tion, by storing it in clean and weather-tight tanks. Iron tanks shall not be used until it is made certain that such tanks will not degrade the admixtures. Care shall be taken to protect the tanks from exposure to direct sunlight, and to keep fire away from the tanks.

TS 5.05 Execution

(1) Batching

Every material of concrete shall be accurately weighed according to the following items to avoid variations in concrete qualities.

(a) Cement

The cement shall be weighed with a weight measuring device approved by the Engineer.

(b) Water

Water shall be weighed with a weight measuring device approved by the Engineer, however, volumetric measurement may be allowed when approved by the Engineer.

(c) Aggregates

All fine and coarse aggregates shall be weighed with a weight measuring device approved by the Engineer.

(d) Admixtures

Admixtures be weighed with a weight measuring device approved by the Engineer, however, volumetric measurement may be allowed when approved by the Engineer.

Every material shall be measured in units of quantity required for every batching. The tolerance per measurement shall be less than 3% for aggregates, 2% for cement, and 1% for both water and admixtures.

The accuracy of respective measuring devices shall be maintained with a measuring tolerance of less than 0.5% throughout the range of use. The measuring devices shall be tested, inspected, and sealed each time the Engineer may deem necessary to maintain accuracy. When tests in the field have revealed that the specified accuracy has been maintained all the time, the Engineer approves the uses of such weighing device for a reasonable period even before it is sealed.

(2) Mixing

Concrete shall be mixed in a mixer whose type and capacity are approved by the Engineer.

The mixing time shall be determined based on the test results. Water shall be charged prior to cement and aggregates are added into the mixer. Care shall be taken to maintain the drum rotating at the specified rotating speed of the mixer.

Basically, materials are to be charged into the mixer all at the same time and uniformly.

The mixing shall not be conducted longer than three times the specified time. No new materials for a fresh batch shall be charged into the drum before the whole of mixed batch left inside of drum are thoroughly removed.

The mixer shall be thoroughly cleaned before and after use. Any concrete which has started an initial setting after mixing shall not be used. In emergencies concrete

may be manually mixed, provided that it is approved by the Engineer. In such a case, concrete shall be mixed until it becomes uniform.

- (3) **Slump Test**
Slump test shall be carried out in accordance with ASTM C172 (AASHTO T141) and ASTM C143 (AASHTO T119). The measurement shall be carried out every batch.

- (4) **Compressive Strength Test in the Field**

- (a) **General**

The Contractor shall carry out a compressive strength test to confirm the qualities of concrete. The characteristic values of concrete shall be determined based on a set of compressive strength test results performed on specimens taken from the same batch.

The concrete tests shall be performed by the Contractor at his cost, in a laboratory specified in G.S. 13 (3) with the Engineer present as a witness.

- (b) **Specimen preparation and test**

The Contractor shall prepare specimens cured for 7 and 28 days, of for a period specified by the Engineer in order to measure the compressive strength of concrete during the period of the work. The specimens for tests shall be prepared and cured in accordance with ASTM C31 (AASHTO T23) and ASTM C617 (AASHTO T231), and the test carried out with ASTM C39 (AASHTO T22).

More than six specimens shall be prepared per 50 cubic meters of concrete, or stroke thereof placed during one day's run, or quantity deemed necessary by the Engineer. Out of the above six specimens, three shall be taken at age of 7 days and three at age of 28 days to carry out the compressive strength tests.

The Engineer may increase the number of tests, or order other tests when he deem necessary to confirm that the concrete is in the conditions specimens and has the specified strength required for the project.

The Contractor shall prepare a stout packing boxes to transport specimens from the filed to the laboratory and the cost for preparing the packing boxes and for transporting or delivering the specimens from the filed to the laboratory shall be included in the unit cost of concrete.

- (c) **Test results evaluation**

As a result of the compressive strength test at 28 days, if the strength conforms to the requirements specified in TS 5.03 (2), then the concrete is considered satisfactory. Where the test result does not comply with the requirements, the Engineer may instruct that the Contractor either improves or removes the defect work at the Contractor's cost, in accordance with (i) or (ii) described below.

- (i) Required reinforcement to be carried out according to the Engineer's instructions.

- (ii) The Engineer instructs that the concrete should be removed from the field, with the consent of the Contractor. Should the Contractor make objections to the result of the test, the Engineer may request

the Contractor to carry out confirmatory tests at the cost to the Contractor as specified by items (iii) and (iv) described below.

- (iii) In accordance with the Engineer's instructions, the compressive strength is measured by conducting a compressive test for a test cylinders obtained by means of a rotary core borer from the portion in dispute of the already executed structure. The test shall be performed with an authoritative test method which has been appropriately agreed upon, for its application.
- (iv) The completed plain or reinforced concrete undergoes a non-destructive compressive strength tests by using a sclerometer to measure the compressive strength is carried out as follows.
 - o Around the point selected by the Engineer, an area less than 0.1 square meters shall be fixed, on which blows with the sclerometer shall be made, and the values of the index, read each time, shall be recorded;
 - o Calculate the arithmetic means of the above values;
 - o Discard the values differing from the arithmetic means by 1/1500 of the total range of the scale of the sclerometer.
 - o Again calculate the arithmetical means of the remaining values and obtain the compressive strength of concrete from the calibration table of sclerometer. Generally, for each type of sclerometer the table supplied by the manufacturer will be used.

Despite the above regulations, when the Engineer considers it necessary, he has the right to have a crush test performed using a core and the sclerometer directly calibrated from the simple compressive strength.

When the compressive strength given by the compressive strength test of 7 days is less than the required values defined in TS 5.03 (2), the Contractor shall not place new concrete until he has clarified the cause of the low test value and taken appropriate action capable of surely providing concrete, in accordance with the specifications to the satisfaction of the Engineer.

(5) Scaffolds, Forms, and Timberings

(a) Scaffolds

The scaffolds shall be designed to have sufficient strength to carry the loads during the work period, and to reliably transmit such loads to the footing. The footing of the scaffolds shall safely carry the full loads applied to the scaffolds.

The shop drawings of important scaffolds must be submitted from the contractor shall submit working drawings of principal scaffolds to the Engineer for review and approval.

(b) **Forms and Timberings**

(i) **General**

All forms and timberings shall be designed and executed to have sufficient strength and rigidity to prevent harmful deformations and deflections due to the pressure and vibration of concrete during and after placing the concrete, and also due to any other construction loads. The design and execution also shall provide for satisfactory concrete, ensuring the correct dimensions, lines, and shapes of completed structures.

The Contractor shall submit principal working drawings of the forms and timberings to the Engineer for review and approval.

(ii) **Materials**

All forms and timberings shall be constructed from wood, steel, or other materials approved by the Engineer and selected in consideration of strength, rigidity, durability, workability, and the effect (forms shall be mortar tight and of structure to prevent loss of mortar from the concrete.) to cast-in-place concrete.

(iii) **Execution**

- o The surfaces of forms in contact with concrete shall be smooth and flat. Wood form surface contiguous to concrete shall be finished with a plane.
Wood forms shall be made so that the joints will not open and shall be maintained rigidly in position.
- o Steel form shall have sufficient thickness to maintain the correct shape of the forms. Care should be taken to prevent steel forms from rust and deposition of grease or foreign matter.
- o The timberings shall provide sufficient strength and stability.
- o Metal fixtures to fasten the forms shall not remain on the surface of the concrete when the forms are removed. Metal fixtures remaining in concrete 2.5 cm depth from the surface shall be removed by making holes into the concrete. The holes shall be filled with mortar of cement and sand with a 1:2 ratio by volume, and the surface shall be finished firmly and smoothly. When the use of iron-wires is approved by the Engineer, sufficient tightening shall be done by using wedges.
- o At the time concrete is placed in the forms, all surfaces of the forms in contact with the concrete shall be clean. When wood forms are used, their surface in contact with the concrete shall be sufficiently wet with water immediately before placing concrete. When steel forms are used, the surfaces shall be coated with an agent approved by the Engineer. A release agent that may cause bonding of concrete or softening shall not be used.
- o After construction of forms, the dimensions of the forms shall be

measured by the Engineer, and the Contractor, based on the measurement results, will prepare the measurement inspection report.

Note: The measurement inspection report is a reference that describes the measured results on the form, positions, shapes, and dimensions as well as the volume of concrete to be placed.

(6) **Placing Concrete**

(a) **Preparation for Placing**

Prior to placing concrete, its transport, placing, equipment, etc. shall be scheduled in advance, and the schedule shall be approved by the Engineer. Concrete shall not be placed before the placement of forms and reinforcement, the installation of embedded fixtures, and the surface treatment of earth, bedrock, and existing concrete are all inspected and approved by the Engineer. Before placing concrete, the hauling device, placing equipment, forms inside, and placing position shall be cleaned so as to prevent concrete from being mixed with foreign materials.

(b) **Transport**

The method of transporting concrete shall be selected so as to ensure quick concrete delivery to the placing position, minimizing the segregation of concrete materials and the change in concrete properties such as consistency and workability.

The transport route shall be planned to facilitate a quick and smooth concrete delivery operation through the shortest possible path.

(i) Buckets, hand carts, lorry, automobiles shall be ones that will not cause material segregation.

(ii) The bucket structure shall not cause material segregation when concrete is charged and discharged, and shall facilitate a quick concrete discharge from the bucket.

(iii) When hand carts or lorry are used, a flat transport path shall be provided to prevent material segregation during concrete transport.

(iv) Automobiles to transport concrete shall provide for easy unloading. If the transport distance is long, a device such as an agitator shall be installed in the automobile.

(v) When using a belt conveyor, concrete qualities shall be prevented from deterioration by properly arranging the position of the conveyor. Also, material segregation shall be prevented by installing baffle plates and funnel tubes at the end of the belt conveyor.

In the event of using a chute, a vertical chute shall be used in principle. A longitudinal chute should be made by connecting funnel tubes so that little material occurs.

Only when approved by the Engineer, an inclined chute may be used. An inclined chute shall have a constant slope all along its length, with the slope not causing material segregation.

The discharge outlet of a chute shall be provided with a proper fun-

nel tube.

(c) **Placing**

The method and sequence of concrete placing shall be approved by the Engineer and shall conform to the rules of this paragraph.

- o All concrete shall employ the previously approved type of machines and equipment and be thoroughly worked around reinforcement and embedded fixtures and into corners of forms without concrete is distributed to causing water prockets, air pockets, or honeycombs.
- o In the concrete placing operation, care should be taken not to disturb the placed reinforcement.
- o During rain, concrete shall not be placed unless otherwise instructed by the Engineer.
- o As provisions to prevent material segregation, the following items (i) through (vi) shall be carried out: (i) Place concrete so that it need not be moved after it is placed in the forms, (ii) Set the height from point of deposit to the discharge outlets of buckets, hoppers chutes, and funnel tubes to be less than 1.5 m, (iii) For a large form, install an input opening to the forms or use a vertical chute, and (iv) Apply proper means to prevent material segregation.

(d) **Compaction**

Unless otherwise specified, concrete shall be compacted with an internal vibrators approved by the Engineer. When instructed by the Engineer, the compaction shall be done with the vibrator attached with hand-spacing by using a proper tool capable of providing sufficient compaction.

Immediately after placing, concrete shall be sufficiently compacted and worked around the reinforcement and into corners of the forms.

The usage of the internal vibrator (including insertion intervals of the vibrator and vibration time for a place) shall follow the Engineer instruction.

(e) **Construction Joints**

The construction joints shall be provided at positions permitted or as instructed by the Engineer.

The construction joints shall be provided at positions where shearing force is minimum, and the joint surface shall face at right angles to the direction of compressive force applied to member. Care shall be taken that the lines of horizontal construction joints are as horizontal and straight lines, to the forms as possible.

Before placing fresh concrete, the construction joint surfaces shall be cleaned by sandblasting or wire-brushing, and immersed into water so that saturation condition is maintained until fresh concrete is placed. Immediately before placing fresh concrete, the forms shall be retightened, the existing concrete surface shall have a thin coat of cement paste applied (or mortar of the same type as mortar in the concrete).

At the execution of vertical construction joints, the surface of the existing concrete jointing surface shall be either removed or roughened, sufficiently wetted with water, and thinly coated with cement paste or mortar, then

it shall be jointed.

(f) **Contraction Joints and Expansion Joints**

The contraction joints and expansion joints shall be provided at positions as instructed by the Engineer. The Contractor shall submit the reference relating to such materials and method of execution and shall accept the approval from the Engineer.

(g) **Anchor Bolts**

To install anchor bolts as support of the superstructure of bridge abutments and bridge piers, either of the following shall be carried out in accordance with the Engineer's instruction:

(i) When concrete is placed, anchor bolts are correctly installed at the specified positions.

(ii) The anchor bolts shall be accurately embedded at the correct positions, and the space shall be filled completely with mortar. Unless otherwise specified, the mortar shall be dry mortar of cement and sand with 1:1 ratio by volume.

(h) **Removal of Forms, Timberings, and Scaffolds**

The forms, timberings and scaffolds shall not be removed without permission of the Engineer. The forms shall be removed carefully so as to prevent damage to the concrete. Any concrete damaged in the process of removing the forms shall be repaired in accordance with the rules of TS 5.05 (7) (j).

(i) **Curing**

Immediately after finishing flat-work or removal of formwork, all concrete shall be sufficiently cured so as to avoid harmful effects due to drying and rapid temperatures changes. The curing period shall follow the instructions of the Engineer. The concrete which is being cured shall be protected from vibrations shocks and loads.

(j) **Wet Curing**

After concrete is placed, it shall be protected from direct sunlight, wind and rain until it starts to harden.

The exposed surface of the concrete shall be maintained in a wet conditions for a period specified by the Engineer, by using either of the following methods as instructed by the Engineer.

o The concrete exposed surface is cured under wet conditions by using a curing materials specified in TS 5.04 (7).

o The concrete exposed surface is sprinkled with water to maintain the wet conditions.

Where shearing is likely to dry, this shall be also watered.

(k) **Concrete Surface Finish**

The surface of concrete structures shall be finished in accordance with the following items:

(i) **Surface contacting the forms**

- o After removing the forms, finish the form-fastening-metal fixture according to the TS 5.05 (5) (b) (iii).
- o Remove all projections from the concrete surface and make it smooth; fill at the remaining small holes, dents and voids with mortar of cement and sand in a ratio of 1:2 by volume. Finish the filled mortar surface with a wood trowel before it solidifies. Carefully finish it so that it appears nearly the same as the body of concrete.
- o When so instructed by the Engineer, a concrete surface with excessive honeycombs shall be removed and reexecuted by the Contractor at his own cost.
- o After the form is removed, if cracks have occurred to the concrete surface due to temperature stress of drying shrinkage, such cracks shall be repaired by the Contractor at his cost, according to the Engineer's instructions.

(ii) **Surface not Contacting the Forms**

The concrete surface completed with compaction and roughly finished to the height and shape required shall not be finished until bleeding water disappears or the surface water is treated. Finishing shall be done with a wood trowel or a proper finishing machine. Excessive finishing shall be carefully avoided; and when a smooth and dense surface is desirable, the surface should be finished with a metal trowel as late as practical.

(l) **Quality Control**

The Contractor shall be responsible for executing a quality control whereby the qualities of aggregates and cement are controlled. The equipment required for quality control tests shall be installed at the cost of the Contractor. The quality control shall be carried out in accordance with the Engineer's instructions.

(m) **Time for Back-filling and Structure Loading**

The time for back-filling is determined by the Engineer who judges it from the results of concrete test mixing and the situation of the field.

No load shall be applied to the concrete structure with the following period:

Ordinary portland cement: 21 days

TS 5.06 **Method of Measurement and Basis of Payment**

(1) **Method of Measurement**

Concrete shall be measured in units of m^3 according to the dimensions indicated on the design drawings or the dimensions ordered and accepted by the Engineer, and the measured result shall be approved by the Engineer. Except when the amount of structural steel embedded in the concrete is subtracted, subtraction should not be made for less than 20 cm diameter pipes, reinforcement, anchor bolts, or weep holes. The calculation shall not include the amount of concrete used for temporary cof-

ferdams and levee, scaffolds, and footing of scaffolds.

(2) **Basis of Payment**

The concrete for the structures is paid for according to the unit cost per cubic meter described in the Priced Bill of quantities. The unit cost described in the Priced Bill of quantities shall include all costs required for furnishing and placing all materials, including drainage, finishing, water-stopping, weep holes, and expansion joints, as well as scaffolds, timberings, forms, concrete surface finishing, curing, and other required to complete the work specified in this item.

<u>Pay Item No.</u>	<u>Description of Work Item</u>	<u>Unit</u>
20	Bridge abutment concrete	m ³
21	Bridge abutment foundation concrete	m ³
22	Bridge pier concrete	m ³
23	Bridge pier foundation concrete	m ³
24	Box culvert concrete	m ³
18	U-shaped retaining wall concrete	m ³
16	Drainage ditch concrete	m ³
15	Retaining wall concrete	m ³
17	Miscellaneous concrete	m ³
14	Leveling concrete	m ³

TS 5.07 **Reinforcement**

The materials, storage, fabrication, placing of reinforcement used for the concrete work shall comply with the following items:

(1) **Materials**

The reinforcement shall be deformed reinforcement conforming to ASTM A615, A616, A617, GRADE 60. The standard for the weight of reinforcement is shown in Table 5-7.

Table 5-7 Nominal Weight of Reinforcing Bar

Bar designation No.	#3	#4	#5	#6	#7	#8	#9	#10
Nominal weight (kg/m)	0.560	0.994	1.552	2.235	3.042	3.973	5.059	6.403

(2) **Storage**

The reinforcement shall be stored in separate groups according to type, diameter, and length. The reinforcement shall not be stored directly on the ground, but shall be stored either at position 30 cm or higher from the ground level in warehouses or outside on supports approved by the Engineer, covered with proper sheets (curing

sheets) so as to prevent rust.

(3) **Fabrication**

The reinforcement shall be accurately bent or cut to meet the dimensions and shapes shown on the design drawings. All reinforcement shall be bent cold unless otherwise permitted by the Engineer.

The minimum bend diameters measured on the inside of the bar shall conform to the codes of ACI 318 unless otherwise indicated on the design drawings.

(4) **Placing Reinforcement**

The reinforcement shall be accurately placed in accordance with the design drawings and firmly supported by approved supports so as to prevent displacement of reinforcement by concrete placing. To achieve this, a sufficient amount of erection bars shall be placed and the intersections of reinforcement shall be securely tied with black annealed wires or clips. Before placing concrete, only reinforcement that is free of oil, rust, dirt, mud, or other non-metallic coatings which do not affect bonding capacity shall be installed. After placing, the reinforcement shall be maintained in a clean condition until concrete is placed.

After the reinforcement is placed, it shall be subject to the inspection by measurement of the Engineer, and based on this result, the Contractor shall prepare the measurement inspection report.

Note: The measurement inspection report is a reference that describes the measured results as compared with the design drawings on the amount, diameter, bent position, splice position and length of reinforcement, mutual positions and spacing of reinforcement, concrete cover for reinforcement, and support conditions of reinforcement within the forms.

(5) **Splicing**

Splices of reinforcement shall follow the instructions indicated on the design drawings. Installing of splices not shown on the design drawings shall be approved by the Engineer for the method and position of splices.

(6) **Method of Measurement and Basis of Payment**

(a) **Method of Measurement**

The measurement for payment of reinforcement shall be conducted by the Engineer at two phases. The first measurement shall be made at time of delivery of the reinforcement at site, and be limited to 105% of total weight of reinforcement as shown on the design drawings and or reinforcement purchased under directions in writing by the Engineer. (reinforcement of work item.)

The second measurement shall be made at time of completion of placement of reinforcement in the locations as required, and be limited to 105% of total weight of either reinforcement as shown on the design drawings as measured and approved by the Engineer or reinforcement actually placed in accordance with the written directions by the Engineer. (fabrication and placement of reinforcement of work item.)

The weight of reinforcement is calculated from the length of reinforcement indicated on the drawing, or described in the written directions by the Engineer, or reinforcement actually placed, multiplied by the nominal weight of the reinforcement.

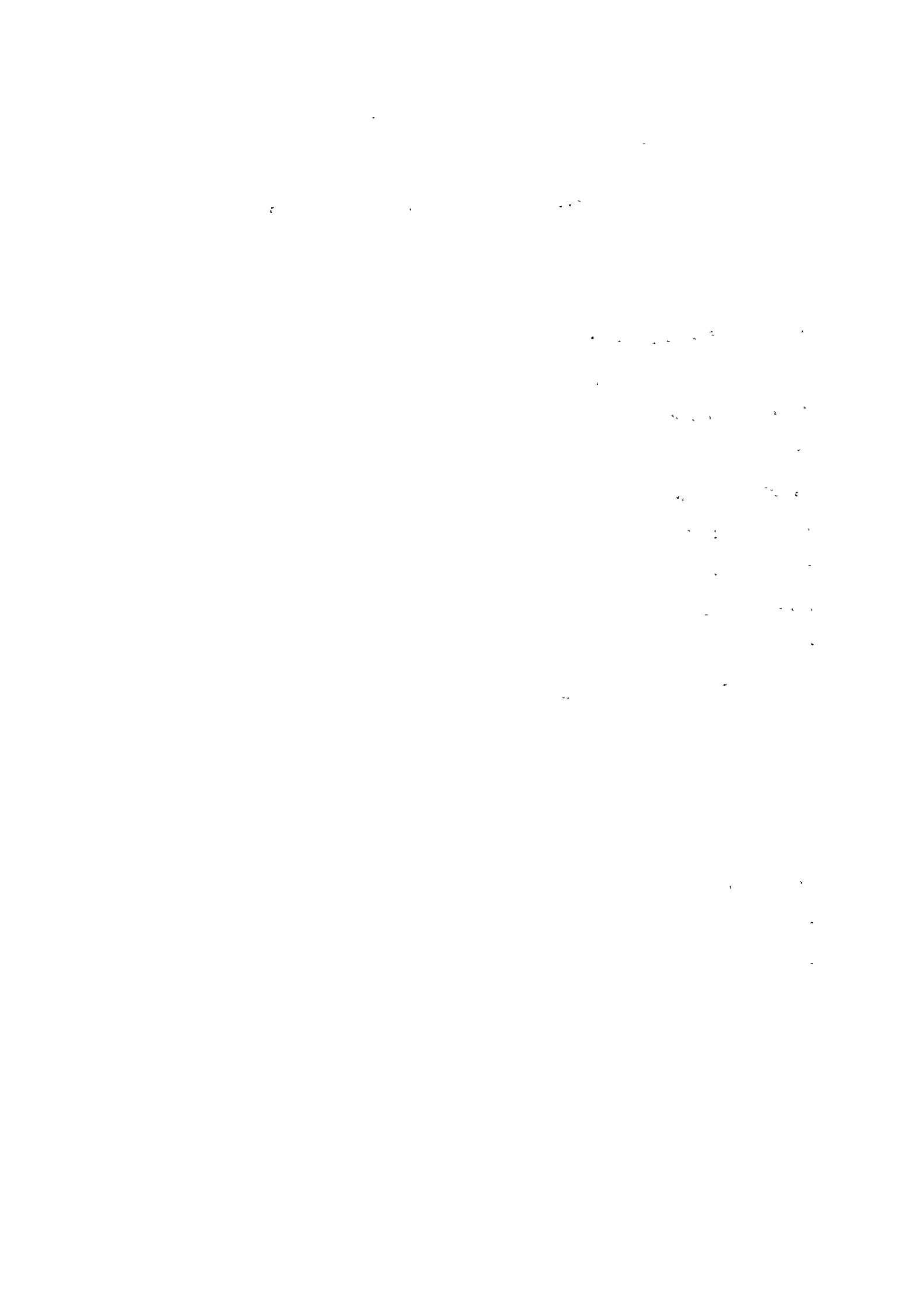
(b) **Basis of Payment**

Payment for the reinforcement shall be made on the unit cost per kilogram described in the Priced Bill of quantities.

<u>Pay Item No.</u>	<u>Description of Work Item</u>	<u>Unit</u>
25	Reinforcement	kg
26	Fabrication and Placement of Reinforcement	kg

SECTION 6 STEEL BRIDGES

	Page
TS 6.01	Scope of Application 6 – 1
TS 6.02	Construction Schedule (Fabrication, Delivery and Erection) 6 – 1
TS 6.03	Materials 6 – 1
TS 6.04	Cutting and Bending Process 6 – 7
TS 6.05	Welding 6 – 8
TS 6.06	Bolt Joints 6 – 13
TS 6.07	Working on Members 6 – 16
TS 6.08	Castings 6 – 17
TS 6.09	Structure, Shape and Dimensions 6 – 20
TS 6.10	Temporary (Provisional) Assembly 6 – 20
TS 6.11	Shop Painting 6 – 21
TS 6.12	Assembly Marks 6 – 22
TS 6.13	Shipping 6 – 22
TS 6.14	Test and Inspection 6 – 23
TS 6.15	Delivery 6 – 25
TS 6.16	Erection 6 – 26
TS 6.17	Method of Measurement and Basis of Payment 6 – 27



TS 6 STEEL BRIDGES

TS 6.01 Scope of Application

These specifications for steel bridges shall be applied to furnishing of all materials, execution of work and other related work necessary for steel railway bridges (plate girder, truss). The work shall be executed strictly in accordance with the contract documents.

TS 6.02 Construction Schedule (Fabrication, Delivery and Erection)

Immediately after the contract has been awarded, the Contractor shall submit for review and approve by the Engineer, the construction schedule summarizing the work into several phases and categories such as fabrication, delivery and erection.

TS 6.03 Materials

- (1) Materials to be used for fabrication of the steel girders shall conform to the standard requirements of JIS tabulated in the following, or equal and/or superior degree of quality as proposed and approved.

Table 6-1 Structural Steel

Materials	Items	Standards			
Steel plates Shape steel Flat steels Steel bars	Types of steels	JIS G 3106 (Rolled steel for welded structure)	Type 1	A B C	SM 41A SM 41B SM 41C
		JIS G 3101 (Rolled steel for general structure)	Type 2	SS 41	
	Shape, dimensions, weight and their tolerance of steel plates	JIS G 3193 (Shape, dimensions, weight and their tolerance of hot rolled steel plates, sheets and strips.)			
	Shape, dimensions, weight and their tolerance of shape steels	JIS G 3192 (Shape, dimensions, weight and their tolerance of hot rolled shape steels).			
	Shape, dimensions, weight and their tolerance of flat steels and steel bars	JIS G 3194 (Shape, dimensions, weight and their tolerance of hot rolled flat steels.) JIS G 3191 (Shape, dimensions, weight and their tolerance of hot rolled steel bar and bar-in-coil).			

Table 6-2 Materials for Connection

Items	Standards
High-Strength Bolts	JIS B 1186 (Sets of high-strength hexagon bolts, hexagon nuts and plain washers for friction grip Joints)
Friction Type High-Strength Bolts	Friction Type High-Strength Bolts shall comply with (2) as specified hereinafter.
Bolts	JIS B 1180 (Hexagon bolts)
Nuts	JIS B 1181 (Hexagon nuts)
Anchor Bolts	The quality shall conform to JIS B 1180, JIS B 1181 and the dimensions shall comply with design
Electrodes	JIS Z 3211 (Covered electrodes for mild steel)
Steel wire	JIS Z 3311 (Steel wires for submerged arc welding) or approved equal.
Flux	Of quality suited to the wire.

- Remarks:
- 1) With regard to brands of electrodes, combination of steel wires and fluxes and their brands, shall be used those indicated in the Implementation Schedule.
 - 2) With respect the steel wire and flux for submerged arc welding, the impact value of deposited metal shall be equal and/or than the value of the base metal.

Table 6-3 Bearing Materials

Cast Irons	FC15 and FC25 of JIS G 5501 (Gray Iron Casting)
Cast Steels	SC46 of JIS G 5101 (Carbon Steel Castings) SCW42 of JIS G 5102 (Steel Castings for Welded Structure)
Copper Alloy Bearing Plates	Shoes for Steel Railway Bridges Using Copper Alloy Bearing Plates shall comply with (3) as specified hereinafter.

(2) Friction Type High-strength Bolts

- (a) Bolt materials shall satisfy the following mechanical properties and shape shall be as shown in Figure 6-1, and mechanical properties test and measurement shall be performed in accordance with JIS B 1186.

Table 6-4 Mechanical Properties of Friction Type High-strength Bolts

Grade of friction type high-strength bolt according to mechanical properties	Mechanical properties of machined test piece				Mechanical properties of products
	Yield point (kg/mm ²)	Tensile strength (kg/mm ²)	Elongation (%)	Constriction of area (%)	Hardness according to method of brinell hardness test JIS Z 2244
B6T	not less than 40	60 to 80	not less than 16	not less than 45	H _R B 87-98

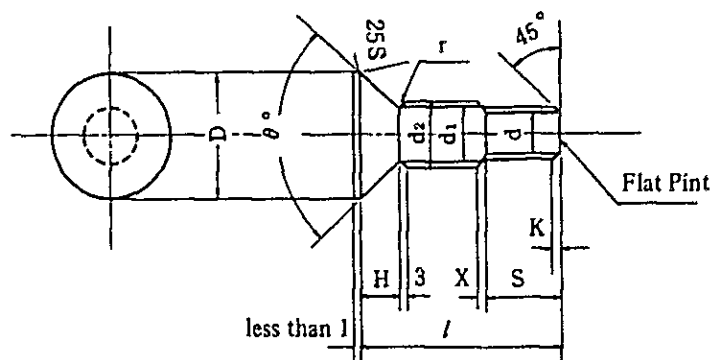


Fig. 6-1 Friction Type High Strength Bolt

Table 6-5 Basic Dimension and Tolerance of Friction Type High-Strength Bolts

Unit: mm

Designation of thread (d)	d ₁		d ₂	H		D		Q	S		K
	Basic dimension	Tolerance		Minimum dimension	Basic dimension	Tolerance	Basic dimension		Tolerance	Basic dimension		Tolerance
M16	17.3		16.3	8	± 0.35	25	+ 0.5 - 0.3		25	+ 5 0	2
M20	21.8	± 0.1	20.8	10	± 0.45	32	+ 0.6 - 0.3	60°	30		2.5
M22	23.8		22.8	11		35			35	+ 6 0	

- Remarks (1) Tolerance requirements for offset of bolt head, inclination of bearing surface and inclination of side surface of the bolt head shall be in accordance with requirements under JIS B 1186 Table 1.
- (2) Cylindrical part between the head and threaded part of the bolt shall have grille notches unless otherwise specified under applicable requirements of JIS B 1186.

(b) Combination of components parts to be applied shall be as follows:

Table 6-6 Combination of Components Parts

Components parts		
Friction type high-strength bolts	High strength hexagon nuts (JIS B 1186)	High strength plain washer (JIS B 1186)
B6T	F8	F35

(3) Copper Alloy Bearing Plates

Properties of materials to be used for copper alloy bearing plates shall be as follows:

Table 6-7 Chemical Components

(Unit: %)

Cu	Zn	Mn	Fe	Al	Sn	Foreign materials	
						Pb	Si
more than 60	remainders	2.5 to 5.0	2.0 to 4.0	3.0 to 7.5	less than 0.5	less than 0.2	less than 0.1

Table 6-8 Mechanical Properties

Tensile test	
Tensile strength (kg/mm ²)	Elongation (%)
not less than 65	not less than 15

Chemical analysis test and tensile test shall be performed by the world-wide reputable method which has been agreed upon with the Engineer.

- (4) The Contractor shall, prior to the use of the materials, submit a quality certificate prepared by his manufacturer to obtain approval of the Engineer.
- (a) Steel materials intended for use shall have all dirt cleaned and be straightened prior to processing.
- (b) Steel plates intended for use shall have no flaw of depth exceeding 100S specified by JIS B 0601 (surface roughness).
The said flaws are allowed to be repaired in the process shown in paragraph TS 7.05 (14) (c) "Types of defects and methods for repair."

TS 6.04 Cutting and Bending Process

- (1) The quality of cut face and beveled face of steel plates shall be better than those shown in the following table.

Table 6-9 Quality of cut face and beveled face of steel plates

Kind of members Items	Main Members	Secondary Members
Roughness of surface	The following value specified in JIS B 0601(surface roughness)	
	50S	100S
Notch	No notches allowed to exist	More than one notch shall not be allowed to exist in the range of 1 meter, and its depth shall not exceed 1 mm
Slug	Existence of slug shall be within the degree that it can be removed by the foundation for painting	
Melting-off of upper edge	Roundness with a radius of 0.5 mm or so is allowed to exist	

- (2) The corners of the cut edges of plates composing main members that will become free edge after completion shall be rounded with a radius of about 0.5 mm or chamfered at 0.5 mm or so.
- (3) Repair of notches shall be carried out in accordance with paragraph TS 6.05 (14) (c) "Types of defects and method of repair".
- (4) Fillers, tie plates, lacing bars, lateral bracings and other similar members may be shaped by shearing but burrs along the edge should be removed.
- (5) Strains due to flame cutting or shearing shall be corrected.
- (6) The corners of cut-in in steel pieces shall be as a rule rounded at a radius of 10 mm or larger with a drill or copying cutting machine.
- (7) The minimum distance from the center of a bolt holes to the cut edge shall conform to the following table unless particularly specified in the drawings:

Table 6-10 Minimum distance from center of a bolt holes to the cut edge

Nominal Thread	Distance from hole center to edge (mm)	
	Cut edge	Auto gas-cut edge, rolled edge and finished edge
M8	18	15
M10	20	17
M12	22	19
M16	27	23
M20	32	28
M22	37	32
M24	42	37

TS 6.05

Welding

(1) Welding Work in General

- (a) Shop welding shall in principle be performed indoors.
- (b) The surface to undergo welding and adjacent parts shall prior to welding be cleared of water, rust, paint, slug and dirt. When submerged arc welding, even mill-scale and pre-treatment paint (primer) shall not either be allowed to remain on the surface to be welded.
- (c) During the welding work, steel pieces shall be secured exactly at their proper relative position by means of assembling jigs and assembly welds in order to minimize distortion of the member due to welding. However, no excessive constraint shall be given to steel pieces in order to prevent cracks in welds.
- (d) Welding shall be performed in the flat position and horizontal position as far as practicable, by the aid of a turnign frame or an inclined stand.
- (e) In the selection of order and direction of welding due cares shall be taken to minimize both distortion and residual stress as much as possible. When welding is anticipated to bring about detrimental effect on high-strength bolt joint, the bolting shall be carried out after welding.
- (f) During welding and cooling, no detrimental shock or vibration shall be given to parts or members.

(2) Maintenance of Electrodes

- (a) Electrodes that have their coating peeled off or are soiled and damaged as well as those which have been left in wet condition shall not be used.
- (b) Electrodes and flux shall be kept in a drying furnace for a certain required length of time at an appropriate temperature prior to their use and they shall be used in a sufficiently dry condition.

(3) Classification of Electrodes According to Application

Classification of electrodes to be used for different types of steel shall conform to the following table:

Table 6-11 Classification of Electrodes for Types of Steel

Combination of Types of Steel	Electrodes
When SS41, SM41, are mutually welded together	Electrodes of JIS Z 3211 (Covered Electrode for Mild Steel) or 50 kg Class one of JIS Z 3212 (Covered Electrodes for High Tensile Strength Steel). When welded part undergoes strong constraint, those of low hydrogen type shall be used.

- (4) Beveling for weld joint shall be made by machining or automatic gas cutting in the shape as indicated in design drawing.
- (5) Any gap exceeding 1 mm shall not be allowed to be left at the root of fillet weld joint. When gap larger than 1 mm is feared to exist, the root face shall be beveled and groove welding shall be carried out.
- (6) In groove weld by both manual and submerged arc welding and fillet weld by submerged arc welding for main members, small steel pieces of SM41 or superior degree (hereinafter called "end tab") with the same bevel as the joint shall be fitted to the both ends of the weld to be carried out; after completion of the welding, end tabs shall be removed by gas cutting and the cut faces shall be finished. In fitting end tabs, the gap at the root shall be within 1 mm and the welding for end tabs shall conform to the requirements of Par. (8).
- (7) Start of welding arc shall be made on another steel piece or in the weld line.
- (8) Tack welding shall be performed as instructed below.
 - (a) The tack welding shall be performed in the same manner as final welding over a length not smaller than 40 mm and, as a rule, at the location finally incorporated in the welds for construction of the member. With regard to main members, the tack welding shall be made in a size larger than 4 mm at intervals not larger than 400 mm.
 - (b) Preheating shall be performed as specified in the following table.
 - (c) When cracks occur in tack welds, the defective parts shall be chipped off till the perfect welded parts are reached, or the tack welding shall be made all over again as the occasion demands.

Table 6-12 Preheating

Types of Steel	Tack Weld	
	Conditions	Preheating Temperature
SS41, SM41	(1) $0^{\circ}\text{C} < \text{shop temperature} \leq 5^{\circ}\text{C}$ (2) Under strong restraint (3) In case plate is 32 mm or thicker	Not less than 50°C

(9) It shall be a rule that strong backs (restraining plates for prevention of deformation) shall not be used in main members.

(10) Preheating

(a) In final welding or tack welding, when the work comes under any of the conditions shown in TS 6.05 (8) (c), the steel plates to be welded shall be preheated to the temperature shown in the Table over the range of 50 mm on each side from the weld line. This rule shall not apply to the case of submerged arc welding.

(b) When the carbon equivalent obtained from the standard certificate of steel is too high, a special consideration shall be taken with respect to welding materials and welding method. In the calculation of carbon equivalent in this case, the following formula shall be used.

$$C_{eq} = C + \frac{Mn}{6} + \frac{Si}{24} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{V}{14} \quad (\%)$$

(11) When the temperature of welding shop is below 0°C, no welding work shall be performed as a rule.

(12) Precautions for Welding Work

(a) Each pass of multiple-pass welds shall be cleaned by removing slugs and spatters from its surface prior to the start of the next pass. Similar cleaning shall be carried out at the change of electrode and also on completion of the last pass.

(b) The back welding in manual groove weld joint shall be carried out after the root of initial layer of the face weld has been chipped off from the back side till sound metal is reached.

(c) Groove weld joint shall be of complete joint penetration except as shown on the design drawings.

(d) Submerged arc welding shall be carried out within 24 hours as a rule after the assembly of parts by tack welding with particular cares to keep off the moisture.

(e) Fillet welding shall not be terminated at the corner of a steel piece but extended around the corner. The length of the extended weld around the corner shall be as a rule more than two times the size of the fillet welded.

(f) In the fillet welding, arc shall not, as a rule, be interrupted in the course of extending around the corner.

(g) At the end of bead of manual weld or at the point of electrode renewal, welding shall be carried out with an elaborate attention to fill up the crater.

(h) Submerged arc welding shall not as a rule have its arc interrupted on the midway of the member. In case the arc is unavoidably interrupted, a range of more than 50 mm from the bead end shall be chipped off and the welding shall be resumed.

(i) In case submerged arc welding is to be succeeded by manual welding, the bead end of the submerged arc weld shall be chipped off over a length of more than 50 mm, then manual welding shall be started therefrom.

(j) In a welding work, cares should be exercised as much as possible not to cause arc strikes. When an arc strike takes place, repair shall be made in accordance with paragraph TS 6.14 (1) (c).

- (13) When a groove weld is specified to have its surfaces finished, additional weld to a thickness of 10% the plate thickness shall be made there and surfaces shall be smoothly ground flush with the plate surfaces in the direction in which the stress acts. In this case care should be exercised not to scrape the base metal more than 0.5 mm in depth.
- (14) Defects of Weld
- (a) Weld shall not have such defects as cracks, incomplete fusion, harmful slag inclusions, detrimental blow holes, overlaps, craters, and pits larger than 0.3 mm in diameter. Judgement on the quality of groove weld shall be made in accordance with prescriptions in TS 6.14 (1) (c).
 - (b) When finishing is designated for a welded part, there shall be no undercut remaining.
 - (c) Types of defects occurring in welded parts and the methods of repairing such defects are given in the Table 6-13 "Types of Defects and Methods of Repair".
- (15) Correction of Distortion Caused by Welding:
- (a) Distortion caused by welding shall be corrected by mechanical processes or heating processes, provided that both the weld and base metal shall not be impaired by those process.
 - (b) When correction is conducted by heating, the preferable limit of heating temperature shall be 850°C.

Table 6-13 Types of Defects and Methods of Repair

Types of Defects	Method of Repair
Pits, Scratched flaws, etc. on plate surface	Flaws of a depth less than 1 mm shall be erased by grinding, but those deeper than 1 mm shall be welded and finished by grinding.
Lamellar cracks appearing on the surface of plate edge	The defective part shall be gouged to a depth about one fourth the thickness of the plate, welded and finished by grinding.
Notches on gas-cut edge	Notches less than 2 mm in depth shall be removed by grinding. Notches larger than 2 mm in depth shall be scraped over a length of more than 10 mm, welded and finished.
Arc strikes	Parts injured by arc strikes shall be erased by grinding.
Cracks due to welding and cracks due to bending process	Examine the cause of cracks; then completely remove the defective parts, and perform the welding with due care to prevent the recurrence of cracks.
Incomplete fusion, slug inclusions, blow holes, pits, etc., in weld	Remove such parts by arc air gouging or by other proper processes and weld again.
Unevenness of weld bead surface	Make it even by grinding.
Undercuts	Undercuts not deeper than 0.5 mm shall be removed by grinding. Those larger than 0.5 mm in depth shall be welded and finished by grinding.
Overlaps	Overlaps shall be removed by grinding or gouged and welded.
Holes drilled in an erroneous location and misshaped holes for bolts	Where any defect that would cause major detrimental effect to main members shall be replaced with the approved materials or repaired to acceptable conditions by welding and finished by grinding and radiographic inspection is conducted on the repaired parts (the criterion for the judgement of the inspection shall conform to the requirements given in Clause TS 6.14 (1) (c). With regard to secondary members, the holes are filled with weld, and finished by grinding and no radiographic inspection is required.

Remarks: 1) In several items in the above table, when welding is employed for repair, the size of based and preheating shall conform to the paragraph of tack welding specified in Par. TS 6.05 (8). Short bead shall be avoided.

TS 6.06 Bolt Joints

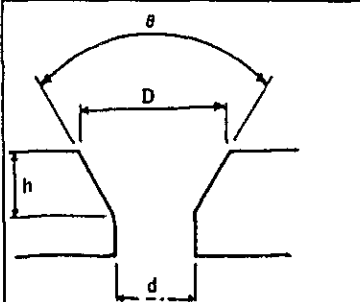
- (1) Bolt holes shall be made as specified in the following provisions.
- (a) The hole shall be cylindrical and its axis unless otherwise specified in the design drawings shall be perpendicular to the surface of the plate and the allowable amount of inclination shall be less than 1/20.
 - (b) The diameters of high strength bolts and ordinary bolt holes shall conform to the following, however, other bolt holes not indicated below shall conform to the design drawings.

Table 6-14 Bolt Hole Diameters

Nominal Thread	Diameter of high strength bolt & ordinary bolt holes (mm)
M 8	10.0
M10	12.0
M12	14.0
M16	18.0
M20	22.5
M22	24.0
M24	26.5

- (c) The hole shapes for countersunk High-strength bolts and ordinary countersunk bolts shall conform to the dimensions as shown in Table 6-15.

Table 6-15 Shapes and Dimensions of Holes for Countersunk Bolts

	Countersunk Friction Type High Strength Bolts				Ordinary Counter-Sunk Bolts			
	θ	h (mm)	D (mm)	d (mm)	θ	h (mm)	D (mm)	d (mm)
M12	60°	9.5	32.2	21.2	90°	5	24.0	14.0
M16						6	30.0	18.0
M20						7	36.5	22.5
M22	60°	11	35.9	23.2	60°	10	36.0	24.5

- (d) Holes in main members shall be made by drilling to the specified diameters. or preparatory holes shall be drilled at first, steel pieces assembled and enlarged to the specified diameter by reaming, or duplicating process for drilling shall be employed.
- (e) Holes in secondary members may be made by punching to the specified diameters, but holes in steel pieces more than 16 mm thick shall be made as specified by TS 6.06 (1) (d). Bolt holes for connection with main members shall also conform to TS 6.06 (1) (d).

- (f) Processing around bolt holes shall be done as specified in the following provisions.
- (i) Burrs around the hole edge formed in the course of drilling shall be scraped off.
 - (ii) Relief roll marks adjacent to strength bolt holes shall be removed, but this is not applicable in the case of ordinary bolts.
- (g) Passing drift pins through holes in assembly work shall be done just for drawing steel pieces up to each other without excessive force, and care shall be taken not to damage the holes.
- (h) The tolerance for bolt hole dimensions shall conform to the requirements in the following Tables except the case as specified on the design drawings. With respect to the tolerance when a gusset plate is fitted to a main member, the provisions for main members shall apply.
Testing of bolt holes after assembling of main members shall comply with the following rates for go gage and no-go gage:

Table 6-16 Tolerance for Diameter of Bolt Hole

Diameter of Holes for High-Strength Bolts and Ordinary Bolts (mm)		Diameter of Friction Type High Strength Bolt Holes (mm)
Main Members	Secondary Members	
+0.5 but +1.0 for 20% of a group	+1.0 but +2.0 for 20% of a group	± 0.3

Table 6-17 Rate of Gauges for Bolt Holes

Type	Nominal Diameter	Go-Gauge (mm)	Go-Rate (%)	No-Go Gauge (mm)	Stop-Rate (%)
High Strength Bolts and Ordinary Bolts	M12	13.0	100	15.0	80 or over
	M16	17.0		19.0	
	M20	21.0		23.0	
	M22	23.0		25.0	
	M24	25.0		27.0	
Friction Type High-Strength Bolts	M20	20.4	100	21.5	100
	M22	22.4		23.5	

(2) Fastening of high strength bolts shall be done as specified below.

- (a) The contacting surface and thereabout of the steel pieces to be connected with high strength bolts shall be subjected to the following treatment.
 - (i) Rust and mill scale shall be removed by sand blasting or other appropriate processes.
 - (ii) The standard surface roughness shall be 50S of the grade as specified in JIS B 0601 (Surface Roughness).

- (iii) In no event shall coatings be done with primer, and lead rust-preventing paint, etc.
 - (iv) Where primer applied to the plate before cutting, it shall be removed by the method with blasting, flame-cleaning, wire-brushing, and any other appropriate means.
- (b) Test for torque value of bolt shall be conducted as a rule immediately before starting work, and from the mean value of the test value for obtaining the required axial force of bolts shall be determined. The bolts which have been used for the test can be used for actual structural members except those utilized frequently for the calibration of the fastening tools.
- (c) The standard fastening axial force of the bolt shall conform to the values in the following Table. Excessively small or large fastening axial force shall be avoided.

Table 6-18 Fastening Axial Force of Bolts

Nominal Size	Axial Force of Bolt (Tons)	
	F10T	F11T
M24	26.2	27.6
M22	22.5	23.8
M20	18.2	19.2
M16	11.6	12.3

- (d) Washers shall be used as specified below.
- (i) Two washers shall be used for a high strength bolt. One washer shall be used at the bolt head and other one at the nut. A washer with lubricative surface treatment to decrease the torque value shall be used at the bolt head.
 - (ii) For friction type high strength bolts, only one washer shall be used under the nut.
- (e) Fastening of the bolts for joint or splices shall be made starting from the middle part of the connections toward the end of the section. In the first place, apply 80% of the torque as required then tighten the bolts with the maximum torque as required.
- (f) Fastening for secondary members with the use of high strength bolts and high strength bolts (friction type) may comply with the following methods regardless of the requirements under paragraph (b) and (c). High strength bolts and high strength bolts (friction type) shall be tightened manually to the full extent with the use of the spanner for general assembly use, then the bolts shall be further securely tightened with the use of longer spanner or any other most appropriate means, such that the nuts can be turned 180 degrees plus or minus 30 degrees for high strength bolts and 120 degrees plus or minus 30 degrees for high strength bolts (friction type).

- (g) In the case of (f), bolts shall be marked for identification to ensure the rotation angle.
 - (h) High strength bolting shall be driven into by a hammer to the extent such that the end of bolt thread can be entered the nut, then the bolt shall be pulled in by turning the nut.
- (3) Inspection of high strength bolting shall be performed as specified under the following provisions:
- (a) Where the bolt tightening is controlled by the torque value, the tightening torque shall be checked immediately after tightening with the use of a torque wrench or other appropriate means. The number of bolts to be checked at joints or splices shall be, as a rule, 10% of the total number of bolts in each group. Tolerance for the torque value shall be $\pm 10\%$ of the torque value as determined in (2) (c).
 - (b) Where the tightening of high strength bolts is controlled by rotation angle of the nut, change in angle indicated by the mark from the initial position shall be closely checked for identification.
 - (c) Where the bolts are tightened in excess of or insufficient to the requirements, remedial actions shall be made to the extent as required.
 - (d) Tolerance for projection of the head of friction type high strength bolts shall be within the limits between 0 and 2 mm.

TS 6.07 Working on Members

- (1) The accuracy of splice connections and overlapped flange plates shall be as specified in the following provisions unless otherwise shown the drawings. (Ref.: Fig. 6-2)
 - (i) Unevenness of steel members at the edge of a splice connection shall not exceed 2 mm.
 - (ii) The gap between butt ends of steel pieces at a splice connection shall not exceed 4 mm.
 - (iii) Cares shall be exercised to ensure close contact between the member plate and the splice plate. There shall be no step larger than 3 mm. With regard to a step larger than 1 mm on a member surface, it shall be graded into a slope of less than 1/10 by a grinder or some other appropriate means.
- (2) In regard to the two ends of an intermediate stiffener or an intermediate diaphragm, the one that isn't to be welded with the flange plate shall be so arranged as to touch the inside the flange plate, provided that a gap not larger than 1 mm is tolerated there. The end to be welded with the flange shall conform to the requirements of Clause TS 6.05 (5).

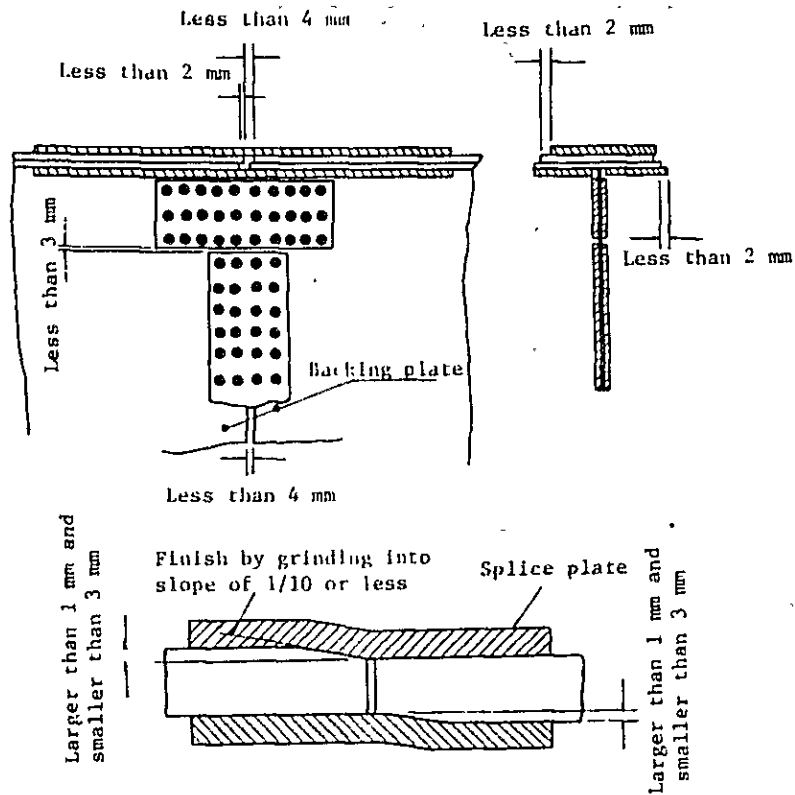


Table 6-2 Measurement Tolerance in Member Processing

- (3) When a sole plate is fitted to the flange, great care shall be exercised to minimize the gap with the flange and not to make a camber larger than 0.5 mm. The inclination of the sole plate shall be less than 1/200.

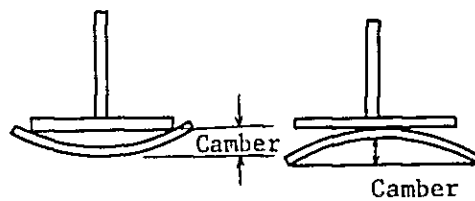
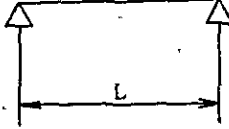
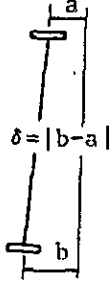
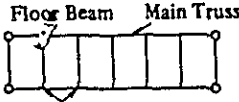
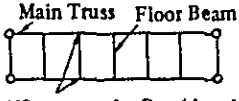
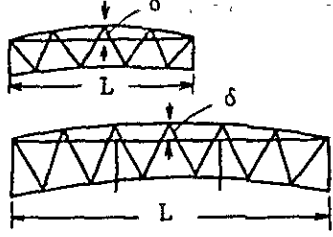


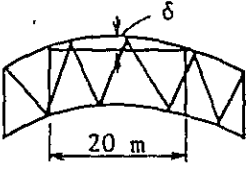
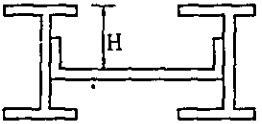
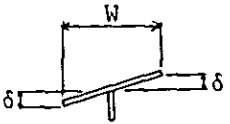
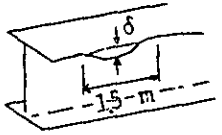
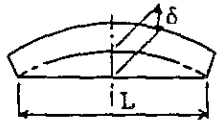
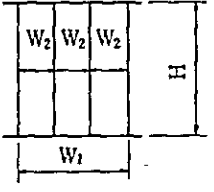
Fig. 6-3 Camber of Sole Plate

TS 6.08 Castings

- (1) Pieces shall be cast as a rule under a pressure of feeder head, homogeneous in quality with no such harmful defects as blowholes, cracks, deformation, etc.
- (2) Dry sand mold shall be used as a rule for the production of cast pieces.

Table 6-19 Tolerances for Dimensions of Bridge Members (mm)

Items		Tolerance	Remarks
1	Span	$\pm (5 + 0.15L)$ L = Span in meters	
2	Distance between centers of main girders or main trusses	$\pm (3 + 0.5B)$ B = Distance between centers of main girders or main trusses in meters	
3	Difference between upper center distance and lower center distance	$2 + 2B$ B = Distance between centers of main girders or main trusses but maximum is 10 mm	With regard to plate girders, the distance between the centers of upper flanges as compared with that of lower flanges. With regard to trusses, the distance between the centers of upper chord members as compared with that of lower chord members.
4	Height of main girders or main trusses	$\pm (4 + 0.5H)$ H = Height of main girders or main trusses in meters	
5	Inclination of main girders or main trusses	$\delta = 3 + H$ H = Height of main girders or main trusses in meters	
6	Difference of elevation of supports	5 mm	
7	Camber at span center in shop		| (measured camber) - (specified camber) | Where no dead load is applied.
	Amount of excess	$3 + 0.15L$ Maximum is 12 mm L = Span in meters	
	Amount of lack	$3 + 0.05L$ Maximum is 6 mm L = Span in meters	
8	Difference of elevation of truss panel points		
	In bridge axial direction	5 mm	 Difference to be Considered
	Between right and left trusses	5 mm	 Difference to be Considered
9	Horizontal alignment of bridge between supports	Deflection at span center $\delta = 3 + 0.1L$ Maximum is 12 mm L = Span in meters	

Items		Tolerance	Remarks
10	Horizontal alignment of bridge in intermediate portion	Deflection at center of any portion of 20 m in length $\delta = 5$	
11	Difference of elevation of sleeper bearing faces	1/400 of distance between centers of sleeper bearing faces on right and left sides	
	Elevation of upper faces of adjacent sleeper bearers in a trough girder	2	
	Distance between the upper face of flange and top face of sleeper bearer in a trough girder	± 2	
12	Width of flange	Amount of lack $1 + \frac{W}{1000}$	W = Width of flange in meters
		Amount of excess $2 + \frac{1.5W}{1000}$	
13	Tolerance for angle between web plate and flange plate in welded I shape structure	$\delta = \frac{W}{200}$	
14	Deviation from straightness of flange edge.	At center of any portion of 1.5 m in length $\delta = 2$	
15	Deviation from straightness of main members, measured at center of any portion.	$\delta = \frac{L}{1000}$ Maximum is 8 mm L = Any arbitrary length in meters	
16	Deviation from flatness of web plate of plate girder	H/250 or 2/3t Whichever is smaller. t = Thickness of web plate	
17	Deviation from flatness of flange plate of box girder	Between web plates $W_1/150$ or t Whichever is smaller. t = Thickness of flange plate	
		Between web plate and rib or between ribs $\frac{W_2}{150}$	

- (3) The tolerance in thickness of a cast piece in the unfinished state shall be 5%.
- (4) Cast pieces shall as a rule be annealed in order to remove casting stresses.

TS 6.09 Structures, Shapes and Dimensions

- (1) The structures, shapes and dimensions of bridge shall conform to the relevant design drawings.
- (2) The tolerance in measurement error of bridge shall conform to the values given in Table 6-19, unless otherwise shown on the drawings.

TS 6.10 Temporary (Provisional) Assembly

- (1) Upon temporary assembly of the steel bridge, the entire structure shall be assembled at a time in principle.
In this case, supporting blocks of 70 cm in height above the ground shall be placed on firm foundation, and the structure shall be erected on the blocks in normal position as specified except special cases as specified. In no event shall the assembly be performed in an inclined position.
- (2) The sequence of order of the assembly work shall be determined in consideration of field conditions which might adversely affect the process of erection work at job site.
- (3) For connection of main members in temporary assembly, both drift pins and bolts shall be used for each group of high strength bolts to be used for connections. The minimum number of drift pins and bolts to be applied to each group shall be 10% and 20% respectively.
- (4) In principle, the Engineer shall be present at trial assembly inspection at manufacturer's plant to verify the accuracy of the finished items based on the dimensional permissible tolerance as shown in TS 6.09 (2).

TS 6.11 Painting

- (1) Members of the bridge shall be painted in accordance with "Process of Painting and Standard Quantity of Paint to be Used" as shown in the following Table 6.20 with the exception of cases under (6).
- (2) The surface to be painted shall be cleared of dust, oil white powder used for marking-off and moisture prior to coating.
- (3) When a steel plate which was coated with "primer coat for a long period" before the cutting process has got rusty or the coating has deteriorated, the rusty parts shall be cleaned and painted for repair. The scale formed on the weld bead surface, high-tension bolt heads shall be removed by blasting and other appropriate means and the part shall be subjected to primers coating.
- (4) In under-coating, the members shall not be exposed to rain or dew before 24 hours has elapsed after each time of finish of the first and second layer paintings.

Table 6-20 Process of Painting and Standard Quantity of Paint to be used

Remarks	Kinds of Process	Paint	Standard Amount to be Used (g/m ²)		Time for Curing
			By Brush	By Airless Spray	
Shop Painting	Surface Preparation	Remove rust and mill-scale by blasting or pickling. The maximum surface roughness shall be 50S of JIS B 0601 (Surface Roughness)			not more than 3 hours
	Primer Coat	(Primer Coat for Long Period)	not less than 100	not less than 130	
	1st Shop Coat (under-coating)	(Red Lead Rust-Preventing Paint) Grade 1	not less than 200	not less than 250	12 hours to 3 months
	2nd Shop Coat (under-coating)	(Red Lead Rust-Preventing Paint) Grade 2 Color shall be changed slightly from 1st coat.	not less than 180	not less than 230	48 hours to 7 days. 2nd coat shall not be applied while 1st coat is felt wet by finger touch.
Painting at site	Intermediate 1st coat	Fatal acid resin paint	not less than 110	—	48 hours to 10 days
	Finish coat 2nd coat	ditto	not less than 95	—	

Note: If the paint is found still wet even after 48 hours passed, the time shall be extended until the paint has thoroughly dried.

- (5) The painted surface shall be of the following conditions.
 - (a) The painted surface shall be smooth.
 - (b) There shall be no conspicuous brush marks, no irregular flaws, nor striking unevenness.
 - (c) There shall be no such defects as remarkable swelling discolorment, blurs, chalking, etc.
 - (d) There shall be no cracks, pits and pin holes on the paint coating.

- (6) Contact surfaces shall be painted in conformity to the following provisions.
 - (a) In case steel pieces are connected together with high-tension bolts, the treatment of their surfaces to be brought to contact shall conform to Clause TS 6.06 (2) (a).
 - (b) Side walks, filler plates and drainage facilities shall be cleared of rust and dirt and painted with one layer of (Red Lead Rust-Preventing Paint) Grade 1. In this respect, the basic surface adjustment and the preparatory coating prescribed in Par. (1) can be omitted.
 - (c) The bevel edges of main members for field welding shall be coated with a paint of rust preventing effect and as little detrimental effect on weld as possible. No under-coating shall be performed.
 - (d) Shoes, washers and anchor bolts, unless otherwise specified in the design drawing, shall be treated and painted in the same way as prescribed in Par. (b). No paint shall be applied to the bottom of the shoe and the part of an anchor bolt, lower than a point of 50 mm below the top face of the concrete pier or abutment.
 - (e) Rollers and bearing faces in contact with them in a roller shoe shall be coated with Primer Coat for Long Period and, thereafter, the under-coating prescribed in TS 6.11 (1) shall be applied.
 - (f) In the case of a shoe with copper alloy bearing plate, the bearing plate and the slide face in contact with the bearing plate shall not be painted.
 - (g) Rust-preventing grease shall be applied to a pin, the finished surface of a pin hole, and the threaded portion of an anchor bolt.

- (7) No painting work shall be performed in the following conditions.
- (a) When the temperature in the shop is lower than 5°C.
 - (b) In rainy weather except for indoor work.
 - (c) At a relative humidity of 85% or higher.
 - (d) When dusty wind blows.
 - (e) As a rule, within 3 hours from the sunrise and within 3 hours to the sunset. This is not applicable to indoor work, and the above rule shall be adjusted by taking into consideration drying and dew formation.

TS 6.12 Assembly Marks

- (1) Bridge members to be assembled on site shall have assemble marks painted at prominent places. With respect to members which are prohibited to be painted, tags or some suitable means shall be used for marking.
- (2) Members weighing more than two tons per piece shall have their weight and position of gravity center indicated with paint at prominent places.
- (3) The paint used to indicate the assembly marks and the position of gravity center shall not be of such a type as to cause detrimental effect for the paint to be applied thereon later.

TS 6.13 Shipping

- (1) Appropriate safeguarding measures shall be taken to protect the parts of members liable to damages during the course of transportation.
- (2) As to gusset plates, splice paltles, connection angles, lateral angles, anchor bolts, shoe washers and other smaller parts, pieces of similar shape shall be gathered together and fastened with bolts or bound with SWM-A (Annealed Steel Wire) of JIS G 3532 (Steel Wire) into handy packages.
- (3) Prior to packing, ordinary bolts, nuts and washers shall be soaked into machine oil. These parts and feled rivets shall be classified by both sets of bridge and types of parts and put into jute bags separately, each of which shall have a tag fixed to it. These bags shall be put into designated boxes which respectively show list of names, types, sizes and quantities of contents. The total weight of what are contained in one box shall as a rule not exceed 50 kg.
- (4) High strength bolts shall be paired with nuts, coated with rust-preventing oil and thereafter put into moisture-proof bags. Then they shall be necased in sturdy wooden boxes or cardboard boxes so as to be protected from injury. Washers, after being coated with rust-preventing oil, shall be grouped by types and sizes and put into bags, which shall as a rule be placed into the same boxes with the bolts. In case washers have undergone the surface lubrication treatment, no rust-preventing oil shall be given to them.
On each of these boxes the following items shall be clearly indicated.
 - (a) Name of standards of the bolts sets.
 - (b) Types classified by their mechanical properties.
 - (c) Types classified by the values of torque coefficients.
 - (d) Nominal diameter size and length of bolt.
 - (e) Quantity

- (f) Other designated affairs.
 - (g) Manufacturer's name or trade mark.
 - (h) Production lot number of the bolt sets.
 - (i) Date of inspection of the bolt sets.
- (5) The Contractor shall prepare 5% supplement pieces for the number of pieces of high strength bolt sets and friction type High strength bolt sets for erection required in the design drawings.
- (6) The Contractor shall prepare the following number of drift pins and ordinary bolts for erection of structural members.
- | | |
|-----------------------|---------------------|
| Drift pin for flange: | 1% ordinary bolt 5% |
| Drift pin for Web: | 1% ordinary bolt 3% |

TS 6.14 Test and Inspection

(1) Radiographic Test and Inspection

- (a) Groove welded joints shall be subjected to radiographic test and inspection in accordance with JIS Z 3104 (Methods of Radiographic Test and Classification of Radiographs for Steel Welds) except for cases specified on drawings and Par. (1) (b).
- (b) Radiographic test and inspection may as a rule be omitted with regard to groove weld joint of below-listed members.
 - (i) Groove weld joint of a quasi-connection chord member of truss.
 - (ii) Groove weld joint of gusset plates of the main girder flanges to connect the lateral bracings or the lower flanges of floor beam (except the gusset plates for the floor beams which compose a grid structure with the main girders).
 - (iii) Groove weld joints of secondary members.
- (c) Radiographic test and inspection shall be conducted as specified below.
 - (i) Radiographic test shall be carried out for the location as shown in Table 6-21, and the test results shall conform to the grades as required. When the test results do not conform to the grades as required, repair shall be made as specified below:
 - o When parts other than the end parts in the sampling inspection do not conform to the grades as required, the inspection shall be carried out over the entire weld line and the defective parts shall be repaired.
 - o When only the radiographs sampled from the end parts of weld line do not conform to the grade as required, those parts only may be repaired.
 - o The method of repair shall conform to the requirements in Table 6-13 and reinspection shall be made for the parts repaired.
 - (ii) The length of the film for the radiograph shall be as a rule longer than 30 cm.
 - (iii) In case two or more radiographs are taken in continuation, films

shall be partly overlapped.

- (iv) The range of radiographing shall include the part of the end tab distanced 20 mm at least from the touching edge of the base metal with the end tab. However, only the weld of base metal shall be examined, and the weld on the end tab shall be examined.
- (v) In the case of radiographing after cut-down of the end tab, due care shall be exercised not to let the scattered-ray-preventing lead plate cover the base metal more than 1 mm from the edge.

- (d) Engineers to take radiographs and those to judge the result in radiographic tests shall be respectively qualified as approved by the Engineer.

Table 6-21 Location for Radiographic Test and Grades for Acceptance

Location for Test		Ranges to be Tested	Grades
Members principally subject to bending moment such as plate girders	Joints of tension flange	About 50% of entire width including one for each of both edges	Grade 1
	Joints of compression flange	Take one radiograph for each of both edges and center	Grade 2 or higher
	Vertical joint of web plate	Take one for each of both edges and center	Grade 1 for one at tension end and Grade 2 or higher for others
	Horizontal joint of web plate	Take one for each of both edges and for every interval not longer than 3 meters (note 3)	Grade 2 or higher
Members principally subject to axial force such as main truss members	Joints of tension members	Entire width	Grade 1
	Joints of compression member	Entire width	
Provisional connection chord members for cantilever erection of truss bridge		Entire width	
Transverse beams composing a grid structure together with main girders	Joints between flanges of main girders and gusset plates. Joints of flange plates of the beams.	Entire width	Grade 2 or higher
	Vertical and horizontal joints of web plates	Take one for each of both edges and center.	

- (e) When the design drawings prescribes removal of reinforcement weld metal and surface finish, radiographs of the special grade in quality as specified by JIS Z 3104 (Methods of Radiographic Test and Classification of Radiographs for Steel Welds) shall be taken after the surface finish. In other cases, radiographs of the regular grade in quality of the same Standard shall be taken.

- (f) The method to show the positions of radiographing shall be as provided for by the following paragraphs.
- (i) Marking plates made of lead on which the symbols for radiographed position and the company's inspection mark are stamped shall be fitted on steel members at the position shown in Fig. 4, and the radiographs shall be taken in that state. The stamped marks must be clearly discernible on the radiographed films.
 - (ii) When two or more radiographs are taken in continuation, a marking plate shall be placed on the overlapped part of the films as shown in Fig. 3 (b); or a set sign shall be put on every overlapped part as shown in Fig. 3 (c) and a marking plate shall be placed on each film.

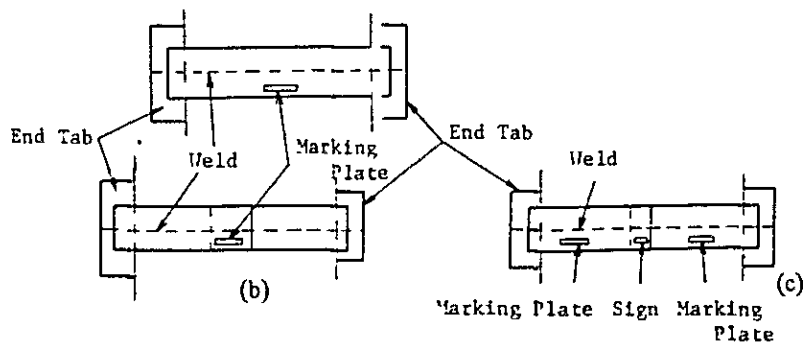


Fig. 6-4 Films and Method of Marking

TS 6.15 Delivery

- (1) Delivery Schedule

The Contractor shall submit to the Engineer a Delivery Schedule in accordance with the construction schedule. In case of making any change in the delivery schedule, he shall also obtain the approval of the Engineer for the following.

 - (i) Method of delivery and route;
 - (ii) Transportation schedule;
 - (iii) Crating, method of loading and protection for damages;
 - (iv) Loading and unloading the structural members; and
 - (v) Temporary storage.
- (a) Safety

The structural members while in delivery shall be rigidly fixed with appropriate method and shall be thoroughly protected from damages or deformation caused by moving and the contractor shall deliver the members to the site for erection, with a complete method of transportation.
- (b) Damages while delivery

Should any damages be made while in delivery, the Contractor shall repair or remedy the defects as directed by the Engineer.
- (c) With regard to the delivery of the bridge girder, attention shall be paid to the type of the track flat trolleys together with the holding method of the track flat trolleys as well as the bridge girder so that the freight may not be destroyed.

Erection

- (1) The Contractor shall collate the measuring steel tapes to be used at construction site and for erection. The tape shall be compensated according to the temperature by establishing the standard temperature.
- (2) Erection schedule
The Contractor shall submit to the Engineer an erection design and implementation schedule consisting of the following, based on the construction schedule.
In the event of making a change thereof, the same procedure should be followed.
 - (a) General
 - (i) Site organization (responsible engineer, engineer in charge, site geological map, site facilities, etc.) and the erection site conditions;
 - (ii) Method of erection and erection sequence erection preparatory works;
 - (iii) Materials for erection, erection equipment, erection work, structures for erection, power facilities;
 - (iv) Erection works; (Delivery, custody, assembling, connections at site and survey.)
 - (v) Safety; and
 - (vi) Schedule.
 - (b) Inspection
Prior to the commencement of the erection, the Contractor shall prepare the records of internal inspection and other necessary documents so that they may be reviewed by the Engineer, however, the Contractor may omit a part thereof, provided that the Engineer's consent is obtained.
 - (i) Erection inspection;
 - (ii) Inspection for connections;
 - (iii) Inspection for completed erection (including the partial completion of the erection)
- (3) Temporary storage of the structural members
Should the structural members be stored at site temporarily, care shall be exercised so that no members are directly contact the ground surface.
Careful protective action should be taken so as not impair by contacting other structural members and/or falling down from the supporting platform while in temporary storage.
A long piece of member, such as chord member, skew member, etc. should be fully supported so as not to be damaged while they are stockpiled temporarily.
Should the period of the temporary storage be prolonged, an adequate protective method shall be made to protect the members from stain or erosion.
The Contractor shall ensure that the temporary facilities and erection equipment to be used in erecting the members are rigid and extent to ensure the safety while the work is under-way.
- (4) Should the erection be carried out by using a crane, the equipment having the capacity appropriate to the working conditions shall be used and the equipment shall be carefully operated.
- (5) The erection of the bridge shall accurately be carried out in accordance with the erection symbol, specified sequence of erection, etc. and the members while in as-

sembling shall be carefully handled so as not to cause any damages. The contacting surfaces between the members shall be cleaned prior to the erection.

The total number of the temporary fastening bolts, drift pins, etc. shall be as specified in TS 6.10 (3) and the number of the drift pins shall be limited to such extent needed to meet the number of pin holes so that the total number of the bolts may be maximized.

The Contractor shall examine whether the shape of bridge meets the design or not, prior to the final fastening.

- (6) The bearing shall be provided accurately at the specified location. The fixing between the lower structure and the bearing, and the embedding the anchor bolts shall be carefully made with hard mix of cement mortar.
 Upon installing the bearing, consideration shall be paid to the temperature when the work is carried out and the final location shall be decided based on the standard temperature by compensating the temperature so that the relative positions between the bridge and the bearing may become the standard position.
 After the erection work has been completed, the Contractor shall confirm that the bearing is equipped with a capacity specified in terms of the moving, rotation, etc.
- (7) The painting work for welded portion shall be as specified in TS 6.11.

TS 6.17 Method of Measurement and Basis of Payment

(1) Method of Measurement

The measurement for payment of the steel bridges shall be conducted by the Engineer at three phases. The first measurement shall be made at time of delivery of all members of each steel bridges at site (fabrication and delivery of work item).
 The second measurement shall be at time of completing the erection of each steel bridges (erection of work item).
 The third measurement shall be made at time of completion of the filed painting, removal of scaffolds, and the work of steel bridge (painting of work item).

(2) Basis of Payment

The payment for the steel bridges shall be made on the basis of unit cost indicated in Priced Bill of Quantities according to completed amount in the month when the certificate of completion is issued with respect to the following item;
 The unit cost of the steel bridges shall include all expenses required for fabrication and test of materials, inspection, temporary (provisional) assembly, delivery, erection, and other related work necessary for completion of the steel bridges work.

Pay Item No.	Description of Work Item	Unit of Measurement
27	Fabrication and delivery of steel deck bridge (span 15 m) for tangent track	Per each steel bridge
28	Erection of steel deck bridge (span 15 m) for tangent track	Per each steel bridge
29	Painting of steel deck bridge (span 15 m) for tangent track	Per each steel bridge

Pay Item No.	Description of Work Item	Unit of measurement
30	Fabrication and delivery of steel deck bridge (span 15 m) for curved track	Per each steel bridge
31	Erection of steel deck bridge (span 15 m) for curved track	Per each steel bridge
32	Painting of steel deck bridge (span 15 m) for curved track	Per each steel bridge
33	Fabrication and delivery of steel through bridge (span 15 m) for tangent track	Per each steel bridge
34	Erection of steel through bridge (span 15 m) for tangent track	Per each steel bridge
35	Painting of steel through bridge (span 15 m) for tangent track	Per each steel bridge
36	Fabrication and delivery of steel through bridge (span 20 m) for tangent track	Per each steel bridge
37	Erection of steel through bridge (span 20 m) for tangent track	Per each steel bridge
38	Painting of steel through bridge (span 20 m) for tangent track	Per each steel bridge
39	Fabrication and delivery of steel deck bridge (span 40 m) for curved track	Per each steel bridge
40	Erection of steel deck bridge (span 40 m) for curved track	Per each steel bridge
41	Painting of steel deck bridge (span 40 m) for curved track	Per each steel bridge
42	Fabrication and delivery of steel deck truss bridge (span 40 m) for curved track	Per each steel bridge
43	Erection of steel deck truss bridge (span 40 m) for curved track	Per each steel bridge
44	Painting of steel deck truss bridge (span 40 m) for curved track	Per each steel bridge
45	Fabrication and delivery of steel through truss bridge (span 65 m) for tangent track	Per each steel bridge
46	Erection of steel through truss bridge (span 65 m) for tangent track	Per each steel bridge

47

Painting of steel through truss bridge
(span 65 m) for tangent track

Per each steel bridge

TS 7 TRACK MATERIALS

	Page
TS 7.01	Scope of Application 7 - 1
TS 7.02	Furnishing and Delivery Schedule 7 - 1
TS 7.03	Materials 7 - 1
	(1) Rail 7 - 1
	(2) Joint Bar 7 - 1
	(3) Bolt, Nut and Washer 7 - 1
	(4) Screw Spike 7 - 4
TS 7.04	Handling of Track materials 7 - 4
	(1) Handling at Port 7 - 4
	(2) Handling on Shore 7 - 4
TS 7.05	Storage of Track Materials 7 - 5
TS 7.06	Method of Measurement 7 - 5
TS 7.07	Basis of Payment 7 - 5

TS 7 TRACK MATERIALS

TS 7.01 Scope of Application

The technical specifications for track materials applies to rail (37.2 kg/m with 18 m length per each), joint bars (for 37.2 kg/m rail), bolts and nuts (for 37.2 kg/m rail, including washers), and screw spikes (for 37.2 kg/m rail) which are to be furnished and delivered to the site.

TS 7.02 Furnished and Delivery Schedule

The contractor shall prepare the track materials furnish and delivery schedule the describes the manufacturing Company, manufacturing place, transport method, period and process of delivering to the site, storage method, and other items relating to the above track materials. Such schedule shall be submitted to, and approved by, the Engineer.

TS 7.03 Materials

(1) Rail

The rail standard shall conform to the ordinary rail 37A (with bolt holes at both ends) of JIS-E-1101-1980 (37.2 kg/m) or equivalent.

Before ordering such rails, the Contractor shall prepare the following references relating to the rails and such references shall be submitted to, and approved by, the Engineer.

- (a) Chemical composition
- (b) Mechanical properties
- (c) Manufacturing process
- (d) Rolling method
- (e) Conditioning and cooling method
- (f) Test and inspection method and type
- (g) Rail marking type and method

(2) Joint bar

The joint bar shall conform to the ordinary rail for 37A of JIS-E-1102-1978 or equivalent.

Before ordering such joint bars, the Contractor shall prepare the following references relating the joint bars and such references shall be submitted to, and approved by, the Engineer.

- (a) Chemical composition
- (b) Mechanical properties
- (c) Joint bar standard dimensions and weight
- (d) Manufacturing method
- (e) Cutting and drilling method
- (f) Test and inspection method and type
- (g) Marking type and method

(3) Bolts and nuts for joint bars

(a) Bolt

The bolts shall be hexagonal nut type, conforming to the quality shown below, or equivalent.

- (i) Standard: SS50 of JIS-G-3101 (rolled steel for general structure)
- (ii) The standard dimensions are as shown below.

Table 7-1 Standard Dimensions and Dimensional Tolerance

Symbol (see Fig. 8-4)	Standard dimensions (mm)	Dimensional tolerance (mm)
d	19.05	
D	34	+0.5 ~ -0.5
d1	27	+0.5 ~ -0.5
d2	19.0	+1.0 ~ -0.5
C	26	
H	14	+0.5 ~ -0.5
h	12	
h1	3	
S	50	+8 ~ 0
K (about)	2.5	
a - b (maximum)		1.5
E (maximum)		2 degrees
L	115	+2.0 ~ -2.0

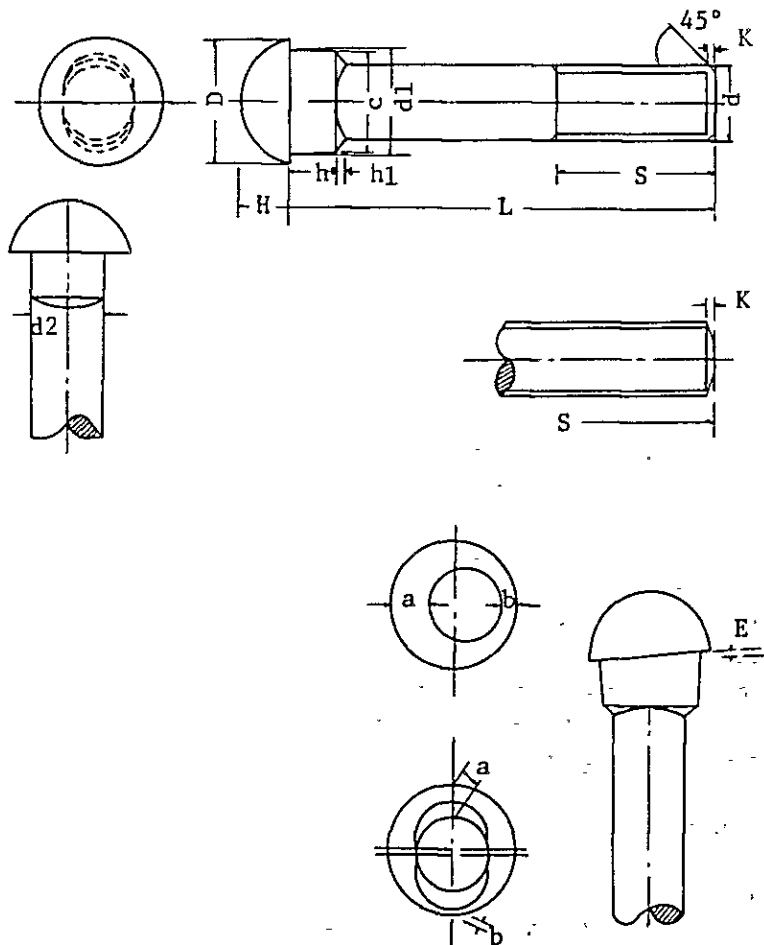


Fig. 7-1 Bolt for 37A Rail

(b) Nut

The nuts shall have the following or equivalent qualities.

- (i) Standard: JIS-G-3101 (rolled steel for general structure), SS50
- (ii) The standard dimensions are as follows:

Table 7-2 Standard Dimensions and Dimensional Tolerance

Symbol (see Fig. 7-2)	Standard dimensions (mm)	Dimensional tolerance (mm)
H	16	± 0.9
m (about)	1.2	
B	32	$0 \sim -1$
C (about)	37	
D (about)	31	
a - b (maximum)	1.5	
E & F (maximum)	2 degrees	

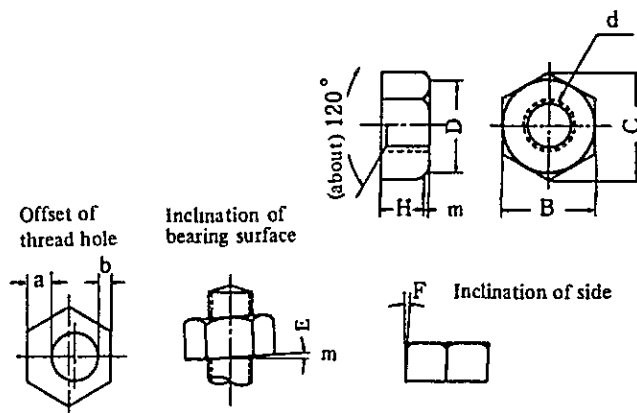


Fig. 7-2 Hexagonal Nut

(c) Washer

The spring washers shall have the following or equivalent qualities.

- (i) Standard: JIS-G-3506 (High carbon steel wire Rads), SWRH 62A, 62B, 67A, 67B, 72A, 72B, 77A, 77B, 82A, and 82B.
- (ii) Standard dimensions are as follows:
Thickness: 11 mm, inner diameter: 20 mm (tolerance +1.0 to 0.0 mm)

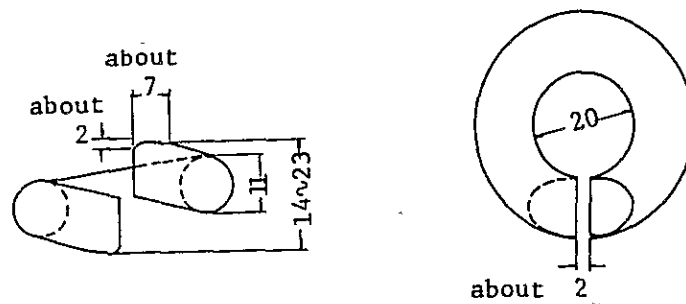


Fig. 7-3 Washer Standard Dimension (unit: mm)

- (d) Before ordering bolts, nuts, and washers, the Contractor shall prepare the following references for the respective items and such references shall be submitted to, and approved by the Engineer.
- (i) Chemical composition
 - (ii) Mechanical properties
 - (iii) Manufacturing method
 - (iv) Test and inspection type and method
 - (v) Marking and method used
- (4) **Screw spike**
 The screw spike shall conform to the standards for screw spike of 3M-63-AREA wooden tie or equivalent.
 Before ordering screw spikes, the Contractor shall prepare the following references relating to the screw spikes and such references shall be submitted to, and approved by, the Engineer.
- (a) Chemical composition
 - (b) Mechanical properties
 - (c) Manufacturing method
 - (d) Test and inspection type and methods

TS 7.04 Handling of Rails

- (1) **Handling rails at ports**
 When importing rails from foreign countries, at the port the rails shall be handled under the following conditions:
- (a) At ports of lading and discharge, packed rails shall be handled with a 18-m long receive-beam with wire rope so as to prevent rail deformation.
 - (b) The opening of the ship used for loading shall be longer than the standard rail.
 - (c) A 3-cm thick support plate shall be attached to the rail pack and a means shall be provided to facilitate passing of a rope under the packed rails.
- (2) **Handling of rails on shore**
- (a) Loading and unloading of rails into freight cars shall be done by the use of derrick crane. In the site, a crane and a rail carrier together shall be used for rail loading and transportation. When handling rails manually with a rail tongs, the rails should not be thrown.

TS 7.05 **Storage of Track Materials**

- (1) Rails shall be placed on adequate supports to protect them from damage or bending. In station yards, rails shall be stacked at a location where the trains operation is not hampered and the rail distribution is convenient.
- (2) Joint bars, bolts, nuts, and screw spikes shall be stored in a warehouse or building. Should they be stored outdoors, an adequate means shall be provided to protect them from rain water.
- (3) The contractor shall be responsible for keeping the materials stored in the contractor's base safe from damage and loss.

TS 7.06 **Method of Measurement**

When the contractor has delivered the full quantity of the contract to the contractor's base in the site, he shall prepare the references for test and inspection, and submit it to the Engineer.

The engineer inspects the references submitted by the contractor and the delivered materials, and if they are accepted, the engineer issues the completion certificate to the contractor.

TS 7.07 **Basis of Payment**

The price for track materials includes all costs needed to transport them from the manufacturer place to the Contractor's base in the site, all costs needed for tests and inspections performed by the manufacture, all costs needed for storage after delivery to the Employer, and all other costs needed to comply with the rules of these technical specifications.

The payment for track materials will be made on the basis of work pieces for the month in which the Engineer issued the completion certificate.

Pay Item Number	Description of work item	Unit of Measurement
48	Rail Furnishing and delivery (37.2 kg/m 18 m/rail)	Each
49	Joint bar furnishing and delivery (for 37.2 kg/m rail)	Each
50	Furnishing and delivery of bolts and nuts for joint bar (for 37.2 kg/m rail)	Each
51	Screw spike furnishing and delivery (for 37.2 kg/m rail)	Each

TS 8 TRACK MOTOR TROLLEY

	Page
TS 8.01	Scope of Application 8 - 1
TS 8.02	General 8 - 1
TS 8.03	Principal Specifications 8 - 1
	(1) Track motor trolley: 110 PS 8 - 1
	(2) Track motor trolley: 30 PS 8 - 1
	(3) Track flat trolley: 40-t 8 - 1
	(4) Track flat trolley: 20-t 8 - 2
	(5) Track flat trolley: 10-t 8 - 2
	(6) Track flat trolley 5-t 8 - 2
TS 8.04	Basis of Payment 8 - 2

TS 8 TRACK MOTOR TROLLEY

TS 8.01 Scope of Application

These technical specifications for track motor trolley shall apply to the work of furnishing and delivering the track motor trolley and track flat trolleys to the construction site. After delivery these track motor trolley and track flat trolleys to the construction site, the Contractor shall hand them over to the Employer in satisfactory.

TS 8.02 General

The Contractor shall submit all specifications, information on manufacturer and external views of track motor trolleys and track flat trolleys to the Engineer and obtain approval from the Engineer prior to the furnishing of these vehicles. All vehicles to be furnishing shall have a track gauge of 1,000 mm, a minimum vehicle operation curve radius of 100 m, and a continuous brake.

TS8.03 Principal Specifications

Trolleys furnished shall meet the following specifications:

- | | | |
|-----|------------------------------------|---|
| (1) | 110 PS Track motor trolley: | 2 units |
| | (a) Horsepower | 110 PS |
| | (b) Tractive force (on horizontal) | Not less than 50 tons |
| | (c) Number of axles | 2 |
| | (d) Rigid wheel base | Approx. 3 meters |
| | (e) Length over couplers | Approx. 6.5 meters |
| | (f) Fuel | Gasoline |
| | (g) Coupler height | |
| | (h) Passenger capacity | 2 or more |
| (2) | 30 PS Track motor trolley: | 5 units |
| | (a) Horsepower | 30 PS |
| | (b) Tractive force (on horizontal) | Not less than 2.5 tons |
| | (c) Number of axles | 2 |
| | (d) Rigid wheel base | Approx. 1.3 meters |
| | (e) Length over couplers | Approx. 2.6 meters |
| | (f) Fuel | Gasoline |
| | (g) Coupler height | |
| | (h) Version | Closed cab with 2 doors each sides
of cab: 3 units
Gang version (semi-open with front
and rear windscreens and steel
roof): 2 units |
| | (i) Passenger capacity | 8 or more |
| (3) | 40 t Track Flat Trolley: | 2 units |
| | (a) Principal purpose of use | Transporting construction machine
(heavy machines) |

- (b) Loading capacity Not less than 40 tons
 - (c) Coupler height
 - (d) Number of axles 4
 - (e) Bogie center distance Approx. 9.4 meters
 - (f) Length over couplers Approx. 13.4 meters
 - (g) Brake Handbrake for parking
- (4) 20 t Track Flat Trolley: 5 units
- (a) Principal purpose of use Transporting bridge girders
 - (b) Loading capacity Not less than 20 tons
 - (c) Coupler height
 - (d) Number of axles 2
 - (e) Rigid wheel base Approx. 4.3 meters
 - (f) Length over couplers Approx. 7.3 meters
 - (g) Brake Handbrake for parking
- (5) 10 t Track Flat Trolley: 2 units
- (a) Principal purpose of use Transporting concrete materials
 - (b) Loading capacity Not less than 10 tons
 - (c) Coupler height
 - (d) Number of axles 2
 - (e) Rigid wheel base Approx. 4.3 meters
 - (f) Length over couplers Approx. 7.3 meters
 - (g) Brake Handbrake for parking
- (6) 5 t Track Flat Trolley: 2 units
- (a) Principal purpose of use Transporting laborers and small equipment
 - (b) Loading capacity Not less than 5 tons
 - (c) Coupler height
 - (d) Number of axles 2
 - (e) Rigid wheel base Approx. 3.5 meters
 - (f) Length over couplers Approx. 6.5 meters
 - (g) Brake Handbrake for parking

TS 8.04 Payment

The Contractor shall notify the Engineer when the track motor trolleys and track flat trolleys have been delivered to the Contractor's base on the site, inspected and prepared for use. The Engineer will inspect the condition of track motor trolleys and track flat trolleys and will issue a certificate of completion to the Contractor on approval.

The payment for the track motor trolleys and track flat trolleys will be made on the basis of the completed amount in the month when the certificate of completion is issued with respect to the following items:

Pay Item No.	Description of Work Item	Unit of Measurement
52	Furnishing and delivering 110 PS track motor trolleys	units

Pay Item No.	Description of Work Item	Unit of Measurement
53	Furnishing and delivering 30 PS track motor trolleies	units
54	Furnishing and delivering 40 t track flat trolleies	units
55	Furnishing and delivery 20 to track flat trolleies	units
56	Furnishing and delivering 10 t track flat trolleies	units
57	Furnishing and delivering 5 t track flat trolleies	units

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent and reliable data collection processes to support informed decision-making.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and reporting, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that data is used responsibly and ethically.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It stresses the importance of ongoing monitoring and evaluation to ensure that data management practices remain effective and aligned with the organization's goals.

TS 9 ADMINISTRATION BUILDING

	Page
TS 9.01 <i>Scope of Application</i>	9 – 1
TS 9.02 <i>General</i>	9 – 1
TS 9.03 <i>Main Facilities</i>	9 – 1
TS 9.04 <i>Method of Measurement</i>	9 – 11
TS 9.04 <i>Basis of Payment</i>	9 – 11

TS 9 ADMINISTRATION BUILDING

TS 9.01 Scope of Application

The technical specifications for Administration building shall apply to the furnishing of all materials and equipment necessary for the completion of the work and to execution of the Engineer's field office, lodgings, and other buildings as required including the grading and leveling of the areas designated by the Engineer near Chochis station.

The Contractor shall fully examine the site and design the field office and lodgings, using structures and building materials fully suited to the weather and climate at the site in accordance with these specifications, and shall submit the drawings to the Engineer for approval.

TS 9.02 General

The work shall be executed strictly in accordance with the contract and the buildings, when completed, shall be properly arranged and handed over the Employer. The work shall be carried out in accordance with each paragraph described below.

(1) Sites

A site with an area of 700 m² for the Engineers' field office and a site with an area of 6,300 m² for the Engineers' lodgings at locations designated by the Engineer shall be graded and finished level.

(2) Buildings

- (a) All buildings shall be constructed with materials suited to permanent construction and capable of fully withstanding the weather.
- (b) Eaves shall extend more than 50 cm from wall line, and ceiling shall be finished with proper materials.
- (c) Floor shall be constructed at a level at least 50 cm above the finished ground and be made of concrete slab thicker than 30 mm and of moisture-proof and insect-proof construction.
- (d) Walls shall be at least 20 mm in thickness and shall be of sound-proof and moisture-proof construction. Ceilings and walls shall all be finished with oil paint in colors designated by the Engineer.
- (e) Each room shall have appropriate windows, doors, and ventilating fan, with insect-proof construction for windows and fans, and all doors and windows shall have locks. All windows shall be glazed and be equipped with a curtain rail and curtain of a color designated by the Engineer.
- (f) Each room shall have electrical appliances satisfactory to the Engineer and wiring of size rating.
- (g) Water supply facilities shall be provided, and sinks, lavatories, and water closets shall be provided together with proper faucets and drain facilities. Also, all required water supply and drain pipes shall be provided. Hot water at a temperature higher than 50°C shall be always available in the showers.
- (h) Sidewalks between the buildings for Engineers' lodgings shall be paved with concrete slab wider than 1.5 m capable of fully withstanding rain water.

TS 9.03 Main Facilities

(1) Office

The Contractor shall construct the Engineers' field office equipped with facilities and equipment listed below. The location of the field office shall be determined by

the Engineer.

(a) Chief Engineer's office

Minimum floor area:	25 m ²
Lighting:	Not less than 500 lux
Convenience outlets:	2
Chief's desk and chair:	1 set
Side table:	1
Table lamp (30W):	1
A set of furniture for guests (5 units):	1 set
Sideboard:	1
Safe with double lock & combination lock:	1
Metal filing cabinet with 2 door & 5 shelves:	1
Filing cabinets with 4 drawers (metal):	2
Ventilating fan:	1
Air conditioner (heating and cooling):	1 set

(b) Reception room

Minimum floor area:	15 m ²
Lighting:	Not less than 500 lux
Convenience outlets:	2
A set of 5-unit furniture for guests:	1 set
Ventilating fan:	1
Air conditioner (heating and cooling):	1 set

(c) General office

Minimum floor area:	100 m ²
Lighting:	Not less than 500 lux
Convenience outlets:	6
Desks (drawers on both sides) & chairs:	6 sets
Desks (drawers on one side only) & chairs:	9 sets
Typing desks and chairs:	2 sets
Table lamps:	6
Olivetti standard typewriter, manual type (70 cm):	1
Standard typewriter, manual type:	1
Copying machine (Size A4; Fuji Xerox or equal):	1
Metal filing cabinets (0.95 x 0.50 x 1.8 m, with 2 doors, 5 shelves & locks)	6
Metal filing cabinets (with 4 drawers and locks):	6
Folding chairs:	10
Ventilating fans:	2
Chalkboards (60 x 90 cm):	2
Cameras (35 mm) with dating mechanism:	2
Air conditioner (cooling and heating):	1 set

(d) Conference room

Minimum floor area:	28 m ²
Lighting:	Not less than 500 lux

	Convenience outlets:	2
	Conference table and chairs (20 persons):	1 set
	Chalkboard (120 x 240 cm):	1
	Ventilating fan:	1
	Air conditioner (cooling & heating):	1 set
(e)	Rest room	
	Minimum floor area:	16 m ²
	Lighting:	Not less than 200 lux
	Air conditioner (heating & cooling):	1 set
(f)	Hot-water service room	
	Minimum floor area:	8 m ²
	Lighting:	Not less than 200 lux
	Sink (with draining board at one side):	1
	Cooking gas stove (with 2 burners):	1
	Crockery cabinet:	1
	Refrigerator (180 liters):	1
	Glasses, coffee cups, spoons, forks, plates, etc.:	For 20 persons
	Kettles and pans:	2 each
	Convenience outlets:	2
	Ventilating fan:	1
	Gas bottles (10 kg):	2
	Buckets:	2
(g)	Radio room	
	Minimum floor area:	8 m ²
	Lighting:	Not less than 500 lux
	Convenience outlets:	2
	Operator's desk and chair:	2 sets
	Radio equipment:	1 set
	Air conditioner (heating & cooling):	1 set
(h)	Dressing room	
	Minimum floor area:	12 m ²
	Lighting:	Not less than 200 lux
	Convenience outlets:	1
	Locker (metal, with lock):	20
(i)	Toilet	
	Minimum floor area:	8 m ²
	Lighting:	Not less than 200 lux
	Toilet sink (with mirror & glass shelf):	2
	Water closets:	2
	Urinals:	2

- (j) **Storage**
- | | |
|---------------------------------------|-----------------------|
| Minimum floor area: | 12 m ² |
| Lighting: | Not less than 200 lux |
| Built-in shelf (1.0 m wide, 1 level): | 4 m ² |
- (k) **Material storage**
- | | |
|---------------------------------------|-----------------------|
| Minimum floor area: | 16 m ² |
| Lighting: | Not less than 100 lux |
| Built-in shelf (1.0 m wide, 1 level): | 10 m ² |
- (l) **Entrance**
- | | |
|--------------------------------|------------------|
| Minimum floor area: | 8 m ² |
| Built-in shelf for 15 helmets: | 1 |
| Sink (for washing shoes): | 1 |
| Door mats: | 2 |
- (m) **Fence, gate and outdoor lights**
 The Contractor shall install a fence around the site and a front gate. Install outdoor lights; one at the front gate and at least at two other places.

(2) **Engineers' lodgings**

The Contractor shall construct Engineers' lodgings equipped with facilities and equipment listed below. The location of each site shall be determined by the Engineer.

(a) **Chief Engineer's lodging**

Minimum floor area:	121 m ²
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(i) **Hall (used also as dining room)**

Minimum floor area:	53 m ²
Lighting:	Not less than 200 lux
Dining tables & chairs (for 10 persons):	1 set
Sideboard:	1
Convenience outlets:	2
A set of 5-unit furniture for guests:	1 set
Cupboard:	1
Cups, bowls, plates, knives, forks, spoons, etc:	For 12 persons
Toilet sink (with mirror and glass shelf):	1
Air conditioner (heating & cooling):	1 set

(ii) **Living room**

Minimum floor area:	26 m ²
Lighting:	Not less than 200 lux
Single bed (with mattress):	1
Convenience outlets:	2
Dressing table with mirror & chair:	1 set
Chest (drawer type):	1

Table lamp:	1
Beside table (with lamp):	1
Blankets:	4
Bed sheets:	2
Pillow:	1
Pillow covers:	2
Bookshelf:	1
Telephone set:	1
Air conditioner (heating & cooling):	1 set

(iii) Shower room (used also as toilet)

Minimum floor area:	8 m ²
Lighting:	Not less than 200 lux
Wooden floor drainboard, screened (1.0 x 1.0 m):	1
Convenience outlets (for electric shaver & washing machine):	2
Toilet sink (with mirror, glass shelf, lamp):	1
Shower (with adjustable faucets for cold and hot water):	1
Water closet:	1
Ventilating fan:	1
Electric washing machine (with drier):	1
Faucet (for washing machine):	1
Ceiling finished with oil paint, and walls & floor finished with white tiles.	

(iv) Kitchen

Minimum floor area:	24 m ²
Lighting:	Not less than 500 lux
Large sink (with draining boards at both sides):	1
Convenience outlets:	2
Ventilating fan (large):	1
Gas cooking stove (with 4 burners and 1 oven, Philips or equal):	1
Gas bottles (50 kg):	2
Refrigerator (with freezer, 340 liters):	1
Cabinet with shelves:	1
Kettle, pan, frying pan, etc.:	1 set
Cooking knives, chopping board, wash bowl, etc.:	1 set
Cooking table (for 10 persons):	1
Kitchen floor must be well drained.	

(v) Servant's toilet

Minimum floor area:	2 m ²
Water closet:	1
Toilet sink:	1
Lighting:	Not less than 100 lux

(vi) Entry

Minimum floor area:	8 m ²
---------------------	------------------

Lighting:	Not less than 100 lux
Door mat:	1
(vii) Terrace	
Minimum floor area:	25 m ²
Table and chairs for terrace (5 units):	1 set
(b) Engineers' lodging (6 engineers & 4 guests)	450 m² with 80 m² terrace.
(i) Private rooms (6)	
Following items are needed for each room:	
Minimum floor area:	20 m ² each
Lighting:	Not less than 200 lux
Convenience outlets:	2
Single bed (with mattress):	1
Bed sheets:	2
Pillow:	1
Pillow covers:	2
Dressing table with mirror & chair:	1 set
Built-in wardrobe (drawer type):	1
Built-in bookshelf:	1
Blankets:	4
Beside table (with shelf, drawers & lamp):	1
Table lamp:	1
Hooks for hammock:	1 set
Air conditioner (heating & cooling):	1 set
(ii) Dining room	
Minimum floor area:	30 m ²
Lighting:	Not less than 200 lux
Convenience outlets:	2
Dining tables and armchairs:	For ten persons
Folding chairs:	4
Cupboard:	1
Cups, bowls, plates, knives, forks, spoons, etc.:	For 12 persons
Toilet sink (with mirror & glass shelf):	1
Telephone set:	1
Air conditioner (heating & cooling):	1 set
(iii) Recreation room	
Minimum floor area:	40 m ²
Lighting:	Not less than 200 lux
Billiards table (pocket type):	1 set
Furniture set (5 pieces):	1 set
Stereo system (with cassette deck):	1 set
Coffee table:	1

Folding chairs:	4
Toilet sink (with mirror):	1
Air conditioner (heating & cooling):	1 set

(iv) Guest rooms (4)

The following items are required in each room:

Minimum floor area:	20 m ² each
<u>Bedroom</u>	15.5 m ²
Lighting:	Not less than 200 lux
Convenience outlets:	2
Single bed (with mattress):	1
Bed sheets:	2
Pillow:	1
Pillow covers:	2
Blankets:	4
Beside table (with lamp):	1
Built-in wardrobe (drawer type):	1
Built-in bookshelf:	1
Dressing table with mirror & chair:	1 set
Table lamp:	1
Hooks for hammock:	1 set
Air conditioner (heating & cooling):	1 set
<u>Bathroom</u> (also used as toilet)	4.5 m ²
Lighting:	Not less than 100 lux
Convenience outlets (for shaving):	1
Toilet sink (with mirror, glass shelf & lamp):	1
Bath tub:	1
Shower (adjustable hot & cold water):	1
Water closet:	1
Wooden floor drainboard for shower (1.0 x 1.0 m):	1
Ventilating fan:	1

(v) Corridor

Minimum floor area:	91 m ²
Lighting:	Not less than 100 lux

(vi) Entry

Minimum floor area:	6 m ²
Lighting:	Not less than 100 lux
Door mats:	2

(vii) Terrace

Minimum floor area:	120 m ²
Tables & chairs for terrace (5 pieces per set):	2 sets

(viii) Toilets (2)

The following items are needed for each room:

Minimum floor area:	6 m ²
Lighting:	Not less than 100 lux
Water closets:	2
Toilet sink (with mirror & glass shelf):	1
Ventilating fan:	1

(ix) Shower rooms (2)

The following items are needed for each room:

Minimum floor area:	14 m ² each
Lighting:	Not less than 200 lux
Bath tub:	1
Showers (adjustable hot & cold water):	2
Toilet sinks (with mirror, glass shelf & lamp):	2
Wooden floor drainboards (1.0 x 1.0 m):	2
Electric washing machine (with dryer):	1
Convenience outlets (for washing machine & shaver):	2
Faucet (for washing machine):	1

(x) Storage

Minimum floor area:	16 m ²
Lighting:	Not less than 100 lux
Built-in shelf (1.0 m wide, 1 level):	10 m ²

(xi) Kitchen

Minimum floor area:	25 m ²
Lighting:	Not less than 500 lux
Large-size kitchen sink (with draining boards at both sides):	1
Convenience outlets:	2
Ventilating fan (large):	1
Gas cooking stoves (with 4 burners & 1 oven, Philips or equal):	2
Gas bottles (50 kg each):	4
Cabinet with shelves:	1
Kettle, pan, frying pan, etc.:	1 set
Cooking knives, chopping board, bowls, etc.:	1 set
Cooking table (for 10 persons):	1
Refrigerators (with freezer, 280 liters):	2

(xii) Servant's toilet

Minimum floor area:	2 m ²
Lighting:	Not less than 100 lux
Water closet:	1

Toilet sink:	1
(c) Servant lodging (for 5 persons)	
(i) Bedroom	
Minimum floor area:	50 m ²
Lighting:	Not less than 200 lux
Single beds (with mattress):	5
Bed sheets:	10
Pillows:	5
Pillow covers:	10
Blankets:	20
Convenience outlets:	5
(ii) Toilet	
Minimum floor area:	10 m ²
Lighting:	Not less than 100 lux
Water closets:	2
Showers (adjustable hot & cold water):	2
Toilet sinks (with mirrors):	2
(d) Tennis court	
Minimum court area:	836 m ²
Wire mesh fence (2 m high):	60 m
Doors (small):	At 2 places
Tennis nets:	2
Roller for compaction:	1
Cleaning brushes (20 cm wide, 1500 cm long):	2
Court (with line tape & poles for net):	1 set
Umpire's chair (1.52 m high):	1
Benches (for 4 persons each):	2
Cock for sprinkler:	At one place
Rubber hose for sprinkler:	20 m
(e) Fence, gate and exterior lights	
Wire mesh fence (2 m high):	250 m
Gate (large):	At 2 places
Exterior lights:	At 6 places
(f) Engineer staff's lodging	210 m ²
The following facilities and equipment are required for the Engineer staff's lodging:	
(i) Dining room	
Minimum floor area:	50 m ²
Lighting:	Not less than 200 lux
Convenience outlets:	2
Dining tables and chairs:	For 10 persons

Folding chairs:	4
Cupboard:	1
Cups, bowls, plates, knives, forks, spoons, etc.:	For 12 persons
Toilet sink (with mirror and glass shelf):	1
A set of furniture (5-piece set):	1 set
Telephone set:	1

(ii) Bedrooms (6 persons)

The following items are required for each room:

Minimum floor area:	12 m ² each
Lighting:	Not less than 200 lux
Convenience outlets:	2
Single beds (with mattress):	2
Bed sheets:	4
Blankets:	8
Pillows:	2
Pillow covers:	4
Side table (with shelf and drawers):	2

(iii) Toilet

Minimum floor area:	15 m ²
Lighting:	Not less than 100 lux
Water closets:	3
Showers (adjustable hot & cold water):	3
Convenience outlets:	2
Toilet sinks (with mirror, glass shelf & light for each):	3
Ventilating fan:	1

(iv) Kitchen

Minimum floor area:	25 m ²
Lighting:	Not less than 500 lux
Large-size kitchen sink (with draining boards at both sides):	1
Convenience outlets:	2
Ventilating fan (large):	1
Gas cooking stoves (with 4 burners & 1 oven for each, Philips or equal):	2
Gas bottles (50 kg each):	4
Cabinet with shelves:	1
Kettle, pan, frying pan, etc.:	1 set
Cooking knives, chopping board, bowls, etc.:	1 set
Cooking table (for 10 persons):	1
Refrigerator (with freezer, 340 liters):	1

(v) Storage

Minimum floor area:	8 m ²
Lighting:	Not less than 100 lux

Built-in shelf (1.0 m wide, 1 level):	4 m ²
(vi) Entry	
Minimum floor area:	8 m ²
Lighting:	Not less than 100 lux
(vii) Corridor	
Minimum floor area:	30 m ²
Lighting:	Not less than 100 lux
(viii) Servant's toilet:	
Minimum floor area:	2 m ²
Lighting:	Not less than 100 lux
Water closet:	1
Toilet sink (with mirror):	1

TS 9.04 Method of Measurement

The Contractor shall notify the Engineer when the Engineers' office, lodgings and related work is completed and ready for use.

Measurement for payment shall be made of the total floor area of Engineers' office and lodgings.

The Engineer will inspect the conditions and equipment of each building and issue a certificate of completion to the Contractor if approved.

TS 9.05 Basis of Payment

Payment for Engineers' office, lodgings and related work will be made for the completed amount in a month for which a certificate of completion has been issued by the Engineer with respect to the items of payment listed below.

Pay Item	Description of Work Item	Unit of measurement
5B.	Construction of engineers' field office:	m ²
59.	Construction of engineers' lodgings:	m ²

TS 10 COMMUNICATION FACILITIES

	Page
TS 10.01	Scope of Application 10 – 1
TS 10.02	General 10 – 1
TS 10.03	Communication Facilities between Chochis and Santa Curz 10 – 1
TS 10.04	Communication Facilities on the Site 10 – 1
TS 10.05	Communication Facilities between Engineers' Office and Contractor's Office 10 – 1
TS 10.06	Communication Facilities between Engineers' Field Office and Engineers' Lodgings 10 – 2
TS 10.07	Basis of Payment 10 – 2

TS 10 COMMUNICATION FACILITIES

TS 10.01 Scope of Application

These technical specifications for the communication facilities shall apply to wired and wireless facilities for effective communications on the construction site between Santa Cruz and Chochis for the purpose of carrying out the work smoothly. These communication facilities shall be installed by the Contractor, tested and inspected by the Engineer, adjusted to good operating conditions, and handed over to the Employer.

TS 10.02 General

The Contractor shall prepare the scheme of execution in accordance with the laws relating to communication facilities in the Republic of Bolivia prior to the commencement of the work on communication facilities prescribed in the provisions shown below, and submit the scheme to the Engineer for approval. Specifications for the communication equipment, information concerning the manufacturers and communication system diagrams shall be submitted with this scheme of execution.

TS 10.03 Communication Facilities between Chochis and Santa Cruz

Communication between Santa Cruz and Chochis shall be by means of a HF radio system, and the Contractor shall install SSB fixed station in each of the contractor's offices. In addition, the Contractor shall install a teleprinter and a wired communication device to the radio system at each place of communication between Santa Cruz office and Eastern Station and between Chochis office and engineers's field office.

The Contractor shall always make these communication facilities available for use by the Engineer and his representative whenever they require to use them.

TS 10.04 Communication Facilities on the Construction Site

The Contractor shall install a VHF radio system for communication between the engineers' field office and the contractor's office and FM mobile stations after preparing a scheme referring to the communication facilities shown in Fig. 10-1. The base stations shall be located at Ipias Station, El Porton Station, Limoncito Station, Robore Station, engineers' field office, and contractor's office, and mobile stations shall be installed on each of seven track motor trolleys and four places on the construction site.

Principal specification for the communication equipment are shown below.

- (1) Power source: Batteries or AC power
- (2) Number of channels: 6 minimum
- (3) Operation: Simultaneous talk (Confidential talk must be possible.)

The Contractor shall provide channels for use by engineers at all times.

TS 10.05 Communication Facilities between Engineers' Office and Contractor's Office

The Contractor shall install at least two wired communication circuits between the engineers' field office and the contractor's office to assure quick communication with Engineers.

TS 10.06 **Communication Facilities between Engineers' Field Office and Engineers' Lodgings**

The Contractor shall install one wired communication circuit between the engineers' field office and each of the engineers' lodgings.

TS 10.07 **Basis of Payment**

The Contractor shall notify the Engineer when the installations of communication facilities are completed and ready for use. The Engineer will inspect the condition and function of the communication facilities and will issue a certificate of completion to the Contractor on approved.

Payment for the communication facilities will be made on the basis of completed amount in the month when the certificate of completion is issued with respect to the following item:

Pay Item No.	Description of Work Item	Unit of Measurement
60	Communication facilities:	Lump Sum

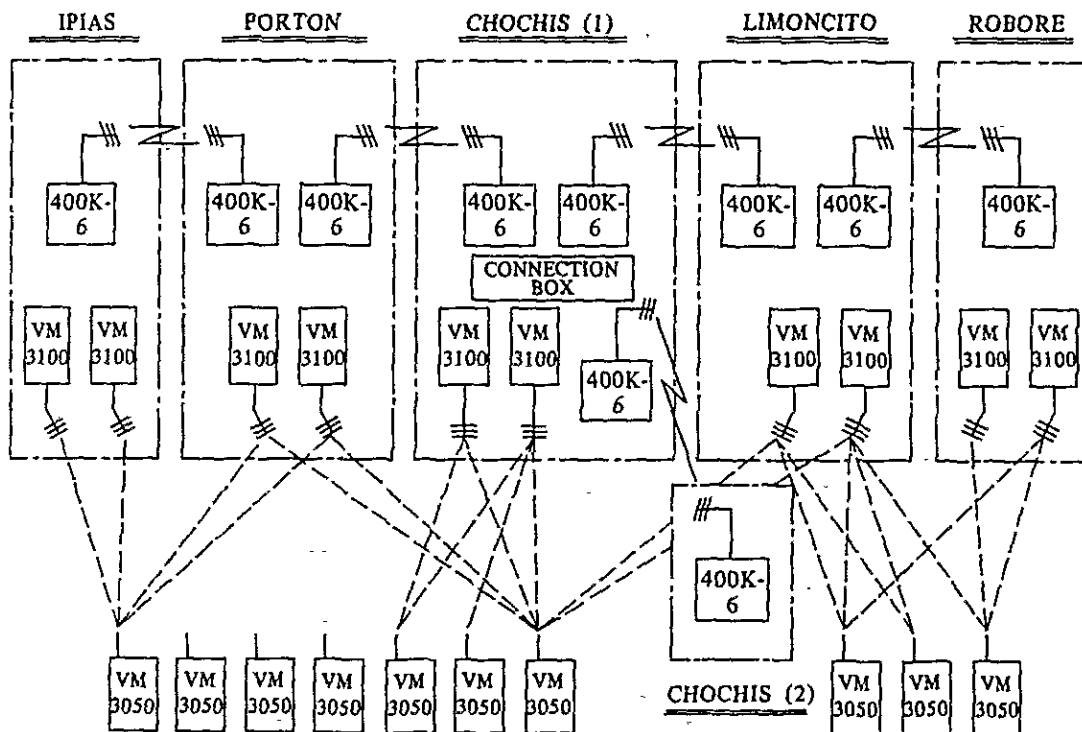


Fig. 10-1

- EX. 400K-6 : VHF/UHF-band 6-channel radio and multiplex equipment.
- VM-3100: Radio equipment, for master station, AC power operation.
- VM-3050: Mobile radio equipment, type for mobile station, with antenna and battery.

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