

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)**

**INDIAN RAILWAY
STANDARD SPECIFICATION
FOR PRE-TENSIONED PRESTRESSED CONCRETE SLEEPERS
FOR
BROAD GAUGE, METRE GAUGE AND NARROW GAUGE**

**SERIAL NO. T-39
(SIXTH REVISION – MARCH 2021)**

**RESEARCH DESIGNS AND STANDARDS ORGANISATION
LUCKNOW – 226011**

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0. **FOREWORD**

- 0.1 This standard specification (First revision) was adopted by the Indian Railways in May 1985 after the draft was finalized by the Sub-committee of Track Standards Committee.
- 0.2 The last revision (Fifth Revision) was adopted by the Indian Railways in February 2016.
- 0.3 The present revision (Sixth Revision) has been taken up with a view to incorporate modifications found necessary as a result of use of the specification both by the manufacturer and user.
- 0.4 The significant modifications incorporated in this revision are as follows :-
- 0.4.1 All Correction slips /Corrigendum (Corrigendum no. 1 to 6) issued till date have been incorporated.
- 0.4.2 Guarantee Clause has been revised to make it applicable for all type of line sleepers plying on Indian Railways.
- 0.4.3 List of specifications (IS/IRS codes) needed for daily use and referred to in this specification has been updated in Annexure-VI.
- 0.4.4 Clause for acceptance of lot has been revised to make it applicable for all type of line sleepers plying on Indian Railways.
- 0.4.5 Annexure-I has been revised.
- 0.4.6 Annexure-IIB showing gauge to measure toe gap at rail seat with SGCI Insert to Drg. No. RT/6901 has been added.
- 0.4.7 Annexure-III has been revised to make it applicable for all type of line sleepers plying on Indian Railways.

1. SCOPE

- 1.0 This specification covers the manufacture and supply of pre-tensioned pre-stressed concrete sleepers for broad gauge, metre gauge and narrow gauge. For production of PSC sleepers through long line method, some of the provisions of this Specification may not be implementable. In such cases, manufacturer shall approach RDSO for specific dispensations, wherever required and these dispensations will be considered by Track and Quality Assurance Directorate of RDSO.

2. GENERAL

- 2.1 The manufacture of sleepers shall be to the Purchaser's drawing or to drawings approved by the Purchaser and the production shall commence with the prior approval of the Inspecting Officer. Any subsequent change in material or production technique shall require prior approval of Inspecting Officer.
- 2.2 The reference to IRS specifications and drawings in this specification relates to the latest version of these standards as amended from time to time. The provisions of this specification shall override the corresponding provisions of IS: Specifications. Any special requirements given in the drawings of the sleepers will override the relevant provisions of the specification. Annexure-VI shows the list of specifications required for manufacturing of sleepers.

3. MATERIALS

3.1 High Tensile Steel

- 3.1.1 High tensile steel in the form of plain wire or strand shall conform to IS: 1785 Part-I and IS: 6006. It shall be procured only from BIS approved manufacturers who shall furnish the proof of approval by BIS with the first consignment during the currency of approval and for each fresh approval. Each consignment of high tensile steel must be accompanied by a test certificate showing the serial no. of coils. Each coil shall carry a tag in accordance with the IS specifications mentioned above. In addition to the normal tests stipulated in the IS specifications for every consignment, results of "relaxation test" shall also be furnished once in six months. In case of change of source the first test certificate shall include "relaxation test" results also.

The steel shall be used for production only after ascertaining that it meets the provisions of relevant specifications.

- 3.1.2 Whenever directed by the Inspecting Officer, the manufacturer shall get the steel in stock tested at his own cost.

3.2 **Cement**

- 3.2.1 Cement shall be OPC 53-S conforming to IS: 269 (as amended upto date). However, upper limit of SO₃ and C₃A content in 53-S grade cement is revised as 3.3% & 9.0% respectively for improvement in quality of PSC sleepers on IR. Upper limit of initial setting time (IST) of 53-S grade cement is specified as 120 minutes preferably but not more than 150 minutes.
- 3.2.2 Each consignment of cement shall be covered by a test certificate. Each consignment shall be stocked separately, tested in the laboratory of the plant immediately for all relevant properties and shall be clearly identified. Cement more than 3 months old, if free from lumps, shall be tested for physical properties by an independent government approved laboratory or as directed by the Inspecting Officer and may be used after his approval.
- 3.2.2.1 The Inspecting Officer has the right to have the cement in stock tested at any time at the cost of manufacturer.
- 3.2.2.2 In case the source of supply of cement is changed, the mix design shall be reviewed and modified, if necessary, as per instructions given in para 3.6.3.1.
- 3.2.3 The cement content of the mix shall not be less than 350 kg/cu. m. and not more than 450 kg/cu.m.

3.3 **Admixture**

- 3.3.1 Super Plasticizer conforming to IS: 9103 may be used with the prior approval of RDSO. At this stage the revised concrete mix design shall also be submitted to RDSO for approval. However, following shall be observed:
- 3.3.2 Use of any admixture containing chloride in any form is prohibited.
- 3.3.3 Generally one admixture at a time should be used.
- 3.3.4 The admixture should be stored as per specified conditions by its manufacturer and its shelf life should be monitored continuously. Regular testing of admixture shall be done annually from NABL approved laboratory/NCCBM/IITs/NITs.
- 3.3.5 All containers should be correctly labeled. Reliable liquid dispenser for liquid admixtures should be used and calibrated.
- 3.3.6 The admixture containing Cl and SO₃ ions shall not be used. Admixtures containing nitrates shall also not be used. Admixture based on thiocynate shall be prohibited.

3.4 **Aggregates**

- 3.4.1 The aggregates shall conform to IS: 383 and shall, before use, be got tested through an approved testing institute, and results submitted in accordance with Annexure B of IS: 383 to the Inspecting Officer for approval. These tests shall be got done at the manufacturer's cost once in a year or at the time of approval/review of mix design or as desired by inspecting official. The aggregates shall have maximum 30% abrasion and maximum 30% impact value suitable for wearing surfaces when tested in accordance with IS:2386 (Part-IV). Flakiness & elongation shall be determined in accordance with IS 2386 (Part-I) on the same sample. The combined flakiness and elongation index so obtained shall not exceed 40 % when tested in accordance with IS: 2386 (Part-I).
- 3.4.2 Coarse and fine aggregates shall pass sodium or magnesium sulphate accelerated soundness test specified in IS: 2386 (part V).
- 3.4.3 Aggregates shall not contain harmful material such as pyrites, coal, lignite, mica shale or similar laminated material clay, alkali, free lime, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregate to be used for reinforced concrete shall not contain any material liable to attack steel reinforcement. Maximum limit of deleterious material in aggregates should conform IS: 383 when tested in accordance with IS: 2386 (Part-II).
- 3.4.4 Aggregates which are reactive with alkalies of cement are harmful as cracking of concrete may take place. Potential reactivity of aggregates shall be tested as per IS:2386 (part VII).
- 3.4.5 Coarse aggregates shall be crushed stone, angular in shape and gravel shall not be used.
- 3.4.6 Different sizes of aggregates shall be stacked in different storage bins or stock piles on proper hard floor surface. The bins near batching plant must be located under a covered shed to avoid any chance of raw material getting wet due to rains. Alternatively, auto sensors may be used to record the moisture content in the aggregate along with auto mechanism for adjusting water to be added to concrete in the weigh batcher.
- 3.4.7 If crushed stone sand is being used as fine aggregates then bond strength (pull out test) of concrete shall be tested as per IS: 2770 (Part I) during mix design approval and after production of every 5000 sleepers during regular production.

Crushed stone sand being used should not be by-product of any other manufacturing process.

3.5 **Water**

3.5.1 Water to be used in making and for curing concrete shall conform to IS: 456. However use of sea water is prohibited.

3.5.2 If water needs any treatment before use, adequate storage of treated water for daily requirement shall be made. Facilities for testing treated water shall be provided in the plant. Treated water shall be tested daily or as directed by the Inspecting Officer.

3.5.3 The total water content per batch shall be regulated with conform with the ratio by weight of free water to cement required for the particular design mix as established by preliminary tests. The total water content of a batch includes:

- (a) Absorbed water in the aggregates;
- (b) Free water in the aggregates; and
- (c) Free water added to the mix.

3.5.3.1 The water to be mixed at the mixer shall be free water content required per batch less the amount of free water in the aggregates, if wet, or plus the amount of water the aggregates will absorb, if dry. Free moisture content shall be determined at least once a day.

3.6 **Concrete**

3.6.1 The concrete shall be of controlled quality with the nominal maximum size of aggregates limited to 20mm. Where wire spacing permits, aggregates upto 25mm may be used. The manufacturer shall get the concrete mix design along with the upper and lower limits of granulometric curves approved by the Inspecting Officer.

3.6.1.1 The granulometric curves shall be plotted on semilog graph once in a week and shall be between the approved limits.

3.6.1.2 Coarse and fine aggregates shall be batched separately.

3.6.2 The concrete shall satisfy the following design parameters:

- | | | |
|------|--|--|
| i) | Minimum release strength after steam curing | 40 N/sq.mm (For Mix M-55)
40N/sq.mm (For Mix M-60) |
| ii) | 15 days characteristic strength after water curing | 55 N/sq.mm (For Mix M-55)
60 N/sq.mm (For Mix M-60) |
| iii) | Percentage of cubes with strength less than the characteristic strength as per mix design/statistical analysis | Not more than
2.5% |
| iv) | Co-efficient of variation | Less than 7% |

3.6.3 Concrete mix shall be designed as per guidelines in IS: 10262 and complying design parameters as per para 3.6.2 by the sleeper plant, checked by zonal railways and got approved from RDSO before start of the sleeper production. RDSO will check and verify the new mix design at the sleeper plant by testing of trial cubes as per para 3.6.4 and complying design parameters as per para 3.6.2.

3.6.3.1 Zonal railways shall review the concrete mix design themselves whenever the source of cement or water or admixture is changed as per guidelines in IS: 10262 provided the quantity of cement is not reduced. All new ingredients must be got tested before hand from reputed laboratory to ascertain whether they are suitable to be used as per relevant standards/specifications. The copy of test report of all ingredients, mix design calculations, record of trial cube testing and records of modification should be communicated to RDSO for information and should be available with zonal railway as well as with CSP, so that the same can be inspected during oversight inspection by RDSO official. However, if the source of aggregate changes, RDSO should be approached by the zonal railways for approval of the source and also for reviewing/revising the mix design.

Zonal Railway or RDSO will check and verify the revised mix design at the sleeper plant by testing of trial cubes as per para 3.6.4 and complying design parameters as per para 3.6.2.

3.6.3.2 Workability of mix should be kept low i.e. compacting factor in range of 0.75-0.80 for stress bench method. For long line method, workability should be kept slightly higher with slump up to 25mm if required, for proper compaction of concrete, but not leading to segregation to constituents of concrete mix under vibrations.

3.6.4 At the time of approval/review of mix design, 80 cubes shall be cast, using materials proposed for regular manufacture, in 10 separate concrete batches of 8 cubes each, 4 for steam curing and 4 for water curing.

3.6.4.1 All the 40 cubes cured according to the proposed steam curing cycle shall attain the specified minimum release strength.

3.6.4.2 The statistical analysis of the compressive strength values of the 40 water cured cubes shall satisfy the design parameters of clause 3. 6.2 (ii), (iii) & (iv).

3.7 SGCI Inserts

3.7.1 SGCI inserts shall conform to IRS Specification No.T-46 as amended up-to-date and will be procured only from RDSO

approved manufacturers. Each consignment of SGCI inserts shall be accompanied by a test certificate from inspecting agency for inspection conducted prior to dispatch of consignment from supplier's premises.

- 3.7.2 Whenever directed by the inspecting official, the sleeper manufacturer shall get the SGCI inserts in stock tested at his own cost.

4. MANUFACTURE

4.1 Moulds

Moulds shall be of steel with minimum plate thickness of 10 mm in Rail seat area as well as for end plates. For other locations minimum plate thickness is to be 6 to 8 mm. Moulds shall be of rigid construction so as to prevent any in-service distortions. Moulds shall not allow any appreciable leakage of cement mortar in casting. The holes in the end plates shall be accurately drilled for correct placement of prestressing wires.

4.2 Stretching of wires

The prestressing wire shall be stretched either individually or collectively by an approved method. The tensioning force shall be as shown on the sleeper drawing. The final force to be adopted, duly considering the losses while stretching shall be approved by the Inspecting Officer. However, the stretching force shall in no case exceed 75% of the minimum specified UTS of the wire. The pre-tensioning force in the wire shall be applied by a tensioning device equipped with automatic load cut off unit along with measuring gauge. The final force shall also be verified by measuring the extension of the wire.

4.3 Mixing and consolidation of concrete

- 4.3.1 Manufacture of sleepers shall be done under a shed.

- 4.3.2 Batching of different ingredients shall be done by weight only. A modern, mechanized, or automatic weigh batcher shall be used for weighing aggregates and cement. The weigh batcher shall have an accuracy of +/- 3% for aggregate, admixtures & water and +/- 2% for cement.

- 4.3.3 Modern high speed mixer, pan, turbine or any other suitable type, approved by the Inspecting Officer shall be used for mixing concrete. Concreting shall commence within 2 hours of stressing of wires, failing which the HTS wires shall be checked and re-tensioned, if necessary.

- 4.3.4 Concrete shall be thoroughly mixed and consolidated by means of vibrators of at least 9000 \pm 4% revolutions/minute. The vibrator should normally be fixed at the bottom of the mould, at

least at two different locations for a sleeper. Any other vibration system should have prior approval of RDSO.

- 4.3.5 Freshly cast sleepers shall be protected during the first stage of hardening from adverse weather conditions.

4.4 De-tensioning of wires

Anchoring system shall provide a device for gradual de-tensioning of the wires. Back pulling of wires for releasing any wedge shall be strictly prohibited. De-tensioning of wires shall be undertaken only after the concrete has attained a compressive strength of 40 N/sq.mm.

4.5 Curing

- 4.5.1 Initial curing of concrete sleeper shall be done by steam at atmospheric pressure till the concrete attains a compressive strength of 40 N/sq.mm. Pre-steaming period shall not be less than the initial setting time of cement.

Total steam curing cycle duration can vary approximately from 10 to 12 hours depending on time taken in the steam curing stages e.g. presteaming, temperature rising (heating), constant temperature duration, cooling etc. Total cycle time depends on ambient temperature.

- i) Normal pre-steaming period is recommended as 2 hours or initial setting time (IST) of cement whichever is greater.
- ii) Temperature rising time is recommended as 2.0 to 2.5 hours keeping maximum rate of rise of temperature as 15°C per hour.
- iii) Maximum steam curing temperature shall be not more than 60°C keeping constant temperature in range of 55 – 60°C. Constant temperature duration can be kept between 3.5 to 5.0 hours.
- iv) Cooling of sleepers shall be gradual and cooling period is recommended in range of 2 to 3 hours with cooling rate not exceeding 15°C per hour.

Extra one hour cooling of sleepers after taking out from steam curing chamber at ambient temperature before demoulding is desirable/recommended to minimize difference in external and internal (inside) temperature of sleepers.

Mix design shall be revised, if minimum strength of 40 steam cured cubes is less than 40 N/mm² following the above mentioned stipulations on steam curing cycle. The steam

curing cycle which is proposed to be adopted shall have prior approval of the inspecting official.

4.5.2 After de-tensioning & de-moulding, the sleepers shall be cured for a further period of not less than 14 days (as per mix design) by submerging in water. Water used for curing should conform to the quality prescribed for water to be used for concrete mix.

4.5.3 Each steam chamber in stress bench method or production line in long line method shall be attached with a separate digital thermal sensor, temperature shall be recorded continuously and record shall be maintained.

4.6 Supervision

4.6.1 Suitably qualified persons as per Schedule of Technical Requirement shall be engaged by the manufacturer for supervising the following items at the works:

- i) Placing and stressing of prestressing wire;
- ii) Batching, mixing, placement and compaction of concrete. Checking of the steam curing arrangement for its adequacy.
- iii) De-moulding of sleepers, water curing, stacking/ loading etc.
- iv) Inserts shall be checked by suitable jigs before use by the manufacturer.
- v) Testing of cement, cement mortar cubes, concrete cubes, concrete beams;
- vi) Calibration of testing and measuring equipment and different gauges;
- vii) Checking electrical resistance of sleepers.

4.6.2 Supervisor so engaged shall maintain records as directed by the Inspecting Officer and shall present them for scrutiny when demanded.

- i) A site register shall be maintained in which inspecting officer shall record observations against which compliance will be recorded by the supervisor.
- ii) Suitable records as per Schedule of Technical Requirement shall be maintained in such a manner that it can be correlated at a later date to the sleeper laid in field.

4.7 **Finish**

4.7.1 All sleepers shall be free from surface defects such as water retaining pockets, air holes or honey combed formations. The underside of the sleeper coming in contact with ballast shall be left rough but the unevenness shall not exceed 5mm. The ends of the prestressing wires shall be cut close to the surface of the sleeper in such a way that there is minimum damage to end plate and the wire in no case shall project more than 3 mm from the concrete surface. Two coats of suitable ISI mark anti corrosive paint, approved by Inspecting Officer, shall be applied at the ends of the sleepers in the following manner:

- i) First coat of paint, sufficient thick to form impervious film of paint covering full surface of either ends of a sleeper shall be applied just after de-moulding from sleepers mould, and
- ii) Second coat after taking out the sleepers from submerged water curing tank in the above manner, ensuring that surface to be painted is completely dry and clean of dirt etc.

4.7.2 No touching up or finishing by cement mortar etc. shall be permitted on concrete sleeper, after it is de-moulded, except as provided in clause 4.7.3.

4.7.3 Such sleepers which are not found acceptable due to surface defects, shall be accepted up to a ceiling of 1% of the supplies made any time during the currency of the contract provided such sleepers are adequately treated with epoxy compounds to the satisfaction of the Inspecting Officer. However, epoxy treatment of rail seat area is not acceptable. These sleepers shall be marked as shown in Drawing No.RDSO/T-2466 before dispatch. The rectified sleepers shall be paid for at the rates fixed by the Purchaser.

4.8 **Stacking**

After the sleepers have been cured in terms of clause 4.5.2 and checked both dimensionally and visually they shall be stacked at convenient place in lots. The stacking of sleepers shall be done on leveled and consolidated ground, one over another up to 25 layers. Each layer shall be separated by wooden/concrete battens of 50mm x 50mm size for sleepers having Insert to drawing no.RT-381 and 60mm x 60mm for sleepers having Insert to drawing no.RT-6901, of suitable lengths to avoid any damage.

4.9 **Lots**

All sleepers cast in one shift shall form one lot.

5. INSPECTION AND TESTING

- 5.1 The manufacturer shall supply at his expense, all the sleepers required for tests and retests, samples of materials, labour, machine, tools, gauges, apparatus, forms of test reports etc. and any other item which may be necessary or required by the Inspecting Officer for carrying out any or all of the checks and tests mentioned in these specifications and shall render all reasonable assistance in conducting such checks and tests. All measuring and testing appliances shall be got checked and calibrated according to the schedule given in Annexure-I, through government approved agency or as directed by the Inspecting Officer. The calibration certificate shall be furnished to the Inspecting Officer. The cost of all such checks and calibrations shall be borne by the manufacturer.

The plant controlling Railway officer minimum JAG level have liberty to recalibrate the various gauges and testing equipments in the concrete sleeper plant or by engaging the external government approved agency who can bring their calibration equipments at the plant itself, whenever they consider necessary. The necessary arrangements will be facilitated by the manufactures and cost will be borne by the manufacturer.

- 5.2 Inspecting Officer and the Purchaser shall have free access at all reasonable times to the works in which the sleepers are manufactured. They shall be at liberty to inspect the manufacture of sleepers at any stage and to reject any material supplies not conforming to the terms of the specifications and to reject sleepers not manufactured according to approved manufacturing process. They shall be provided with necessary assistance for inspection by the manufacturer.

5.3 Checks and tests

- 5.3.1 In addition to the control checks exercised on the materials and manufacturing process specified above, the concrete and the finished sleepers shall be subjected to regular checks and tests, after 14 days submerged water curing, as detailed in clause 5.3.1.1.

5.3.1.1 Visual and Dimensional Check

Every sleeper shall be visually inspected for surface finish. No sleeper shall have surface defects except as provided in para 4.7.3.

Sleeper dimensions to be checked are listed below:

- (i) Critical dimensions are toe gap, location of inserts, distance between inserts at rail seat, distance between outer most inserts and slope at rail seat.

- (ii) General dimensions are depth of sleeper at centre, rail seat and end of sleeper; width of sleeper at top and bottom; length of sleeper, camber and wind at rail seat and position of high tensile steel wires at ends.

The sketch at Annexure-II shows the dimension checking arrangement. The dimensions, shown on the sleeper drawing, shall be checked by means of approved gauges, procured by the manufacturer. (Annexure II/A & II/B shows the gauges for measuring toe gap of rail seat).

- (iii) Scale of check
 - a) Prior to stabilization of production technique*:- Scale of check per lot for critical dimension is 100% (hundred percent) and for general dimensions 10% (ten percent) of sleepers produced.
 - b) After stabilization of production technique* :- Scale of check per lot for critical dimensions is 10% (ten per cent) and for general dimension 1% (one percent), but the dimensions between outer inserts shall be checked 100%.
 - c) Notwithstanding the provisions in (a) & (b) above the Inspecting Officer may decide to check the dimensions at scale higher than mentioned in para (a) & (b) above.

* Acceptance of minimum 10000 sleepers and achieving rejection rate less than 2% consistently, whichever is later, shall be one of the major criteria for deciding the stabilization of the manufacturing technique. After stabilization, the rejection rate shall be assessed after every 30000 numbers sleeper production and if it is found beyond 2%, then all the testing have to be done as per the frequency prescribed for pre-stabilized production. The additional cost of sleepers required for testing shall be borne by the firm.

5.3.2 Casting of cubes

15 cm size cubes shall be cast on a vibrating table conforming to IS: 2514 from random samples spread over the entire lot, out of concrete used for casting sleepers for testing prior to transfer of prestress and 15 days.

5.3.2 Method of testing

The cubes shall be surface dry at the time of testing. The rate of loading shall be about 400 KN/minute.

5.3.4 Compressive strength of concrete at transfer (release) of prestress

These cubes shall be steam cured along with sleepers in the same manner and tested for transfer of prestress to concrete (at least one cube for every steam chamber/3 for each long line but not less than a total of 3 in any case).

5.3.5 Test for 15 day compressive strength of concrete

These cubes shall not be steamed but shall be water cured for 14 days after de-moulding. Two number of samples per lot (one sample comprises of 3 cubes) shall be taken.

The samples should be spread over the entire period of concreting in a lot. Cubes of these samples shall be tested for 15 days compressive strength of concrete. The test result of a sample shall be the average of the strength of three cubes. Individual variation in cube strength in a sample should not be more than $\pm 15\%$ of the average. If variation is more than $\pm 15\%$, the test results of the sample is invalid and the lot shall be rejected.

Further, if mean of two test results of two samples is $< f_{ck}$ and / or minimum of the two test results of two samples is $< f_{ck} - 5$ N/mm², the lot shall also be rejected. Where, f_{ck} is characteristic strength of concrete i.e. 55 N/mm² for M55 and 60 N/mm² for M60 grade of concrete.

Otherwise, the concrete is accepted for further testing of sleeper/s as per para 5.3.7.2.2.

5.3.6 Test for 15 day modulus of rupture of concrete

The test for 15 day modulus of rupture of concrete shall be carried out on concrete beams of 10 x 10 x 50 cm size as specified in IS: 516. One specimen shall be tested daily prior to the stabilization of production technique, and once a week thereafter. If any value falls below 5.2 N/mm² for M55 and 5.5 N/mm² for M60, the mix design shall be reviewed.

5.3.7 Tests for static bending strength of sleepers

5.3.7.1 Method of testing

5.3.7.1.1 The tests shall be conducted in accordance with the arrangement shown in Annexure-III.

5.3.7.1.2 The sleepers shall be loaded gradually (30-40 KN/min) upto the specified load, which will be retained at this level for three

minutes for observing cracks, if any. For the purpose, a crack is defined as one which is barely visible to the naked eye and is at least 15mm long from the tension edge of the sleeper. However, if crack appears at a load smaller than the specified load, that value shall be recorded.

5.3.7.1.3 In case of 'Moment of Resistance' (MR) test, the sleeper shall be deemed to have passed the test if it sustains the loads specified in relevant sleeper drawing without cracking. While loading, load can be applied upto 5KN in excess of specified load.

5.3.7.1.4 In case of 'Moment of failure' (MF) test, the sleeper shall be deemed to have passed the test if it is able to take load beyond the specified test load. The initial cracking loads shall also be recorded for rail seat bottom, centre top and / or centre bottom (as the case be) for further statistical analysis of data during MF test.

5.3.7.1.5 Sleepers for test shall be selected randomly by the inspecting officer.

5.3.7.2 Acceptance tests

5.3.7.2.1 Moment of failure (MF) test (for rail seat bottom)

Prior to stabilization of production technique, one sleeper for every 250 sleepers manufactured shall be tested. After the production technique gets stabilized the testing scale shall be reduced to one sleeper for every 2500 sleepers produced.

5.3.7.2.2 Moment of resistance (MR) test (Rail seat bottom, centre top, centre bottom)

Depending on 15th day test results of samples of the lot as mentioned in para 5.3.5, the scale of testing of sleepers for the lot shall be as follows (as explained in Table -1):

- i) Wherever mean of the two test results of two samples is $\geq f_{ck} + 3 \text{ N/mm}^2$ or $f_{ck} + 0.825 \times$ established standard deviation whichever is greater and minimum of the two test results of two samples is $\geq f_{ck} - 3 \text{ N/mm}^2$ and the lot is not rejected as per the criteria given in para 5.3.5– one sleeper per lot
- ii) Wherever mean of two test results of two samples is $< f_{ck} + 3 \text{ N/mm}^2$ or $f_{ck} + 0.825 \times$ established standard deviation whichever is greater but $\geq f_{ck}$ or minimum of the of the two test results is $< f_{ck} - 3 \text{ N/mm}^2$ but $\geq f_{ck} -$

5 N/mm² or both and the lot is not rejected as per the criteria given in para 5.3.5 – two sleeper per lot

- iii) In case, mean of two test results of two samples is < f_{ck} and /or minimum of the two test results of two samples is < $f_{ck} - 5$ N/mm², the lot shall be rejected and no testing for moment of resistance or moment of failure will be conducted.

Note:

- a. Prior to stabilization of production technique: Sleeper to be tested shall be subjected to rail seat bottom, centre top and centre bottom tests.
- b. After stabilization of production technique: Sleeper to be tested shall be subjected to rail seat bottom and centre top tests only.

Table -1: Acceptance / Rejection Criteria of Concrete and No. of Sleepers for SBT Test per Lot

SN	First condition	Second Condition	Conditions to be complied	No. of sleeper per lot for test
Case 1	If average of test results of two samples is $\geq f_{ck} + 3$ N/mm ² or $\geq f_{ck} + 0.825$ x established standard deviation, N/mm ² whichever is greater	If minimum of test results of two samples is $\geq f_{ck} - 3$ N/mm ²	Both conditions are to be fulfilled and the lot is not rejected as per the criteria given in para 5.3.5.	Concrete is accepted and one sleeper will be tested for SBT from the lot.
Case 2	If average of test results of two samples is < $f_{ck} + 3$ N/mm ² or < $f_{ck} + 0.825$ x established standard deviation, N/mm ² whichever is greater but $\geq f_{ck}$ N/mm ²	If minimum of test results of two samples is < $f_{ck} - 3$ N/mm ² but $\geq f_{ck} - 5$ N/mm ²	Any one of them or both conditions are fulfilled and the lot is not rejected as per the criteria given in para 5.3.5	Concrete is accepted but two sleepers will be tested for SBT from the lot.
Case 3	If average of test results of the two samples is < f_{ck} N/mm ²	If minimum of test results of two samples is < $f_{ck} - 5$ N/mm ²	Any one of them or both condition are fulfilled.	Lot rejected without any further testing on sleepers of the lot.

5.3.7.3 Acceptance of 'lots'

5.3.7.3.1 All sleepers tested in accordance with clause 5.3.7.1 should pass all the acceptance tests provided in clause 5.3.7.2 for the lot to be accepted. The specified values of Load for Centre Top, Centre bottom, Rails Seat cracking and MF test shall be as per relevant RDSO's drawings of various PSC sleepers.

5.3.7.3.2 If the sleeper fail in any of the tests conducted as per clause 5.3.7.2.2 (i), the lot shall be subjected to 'retest' as per clause 5.3.7.4.

5.3.7.4 RETEST

5.3.7.4.1 Moment of resistance (MR) test

For every sleeper failed in acceptance tests as per clause 5.3.7.2.2 (i), two more sleepers from the same lot shall be retested as per clause 5.3.7.2.2.

However, in case of testing of two sleepers as per clause 5.3.7.2.2(ii), if any of the sleepers fail, the lot shall be rejected.

5.3.7.4.2 Moment of failure (MF) test

In case of failure of the sleeper in MF test as per clause 5.3.7.2.1, 2 more sleepers from the same lot shall be selected for testing in MF as per clause 5.3.7.2.1 and 5.3.7.2.2 and subjected to all relevant tests. However, if the sleeper has passed MF test and failed in some other test MF test need not be repeated on subsequent sleepers subjected to testing.

5.3.7.4.3 For acceptance of the lot, all the sleepers tested in 'retest' must pass all the tests conducted. However, sleepers failing in any static bending tests shall not be paid for.

Also final passing of the lot is a prerequisite condition for payment for any sleeper having passed all the relevant tests conducted on that sleepers.

Sleeper/sleepers tested for rail seat bottom failure test and passes the test, shall be paid by the purchaser, if that particular lot passes all the relevant retests.

NOTE:

In case where more than one test value is obtained in retests. The lowest value obtained will be taken as strength of the lot for deciding the result of the lot.

5.3.7.5 Testing of PSC sleeper in Zonal Railways testing facility or at RDSO

Three/Four sleepers due for testing selected randomly at the level of minimum JAG will be sent for Static Bend Test (SBT) and Moment of Failure (MF) test to RDSO or at testing facilities available with Zonal Railways such as 'Bridge Workshops/'Soil Testing Lab' or any other Lab of Open line / Construction Unit of Zonal Railways for a frequency not less than once in a year. Zonal Railways should choose testing agency either RDSO or Railways who can perform the testing within 7 to 14 days including transportation time. Out of which one sleeper selected randomly will be tested. If sleeper fails in any of the test as per clause 5.3.7.1, the other two sleepers shall be subjected to retest as per clause 5.3.7.4. The testing cost including transportation etc. for above testing will be borne by the Railway.

If the sleeper fails in above testing:

- (i) All sleepers manufactured in that batch will be rejected and re-calibration of the all gauges and various testing equipments in the sleeper plant is to be carried out at manufacturers cost.
- (ii) Three/four sleepers from next one batch will also be got tested for Static Bend Test (SBT) and Moment of Failure (MF) test as above from RDSO or at testing facilities available with Zonal Railways such as 'Bridge Workshops/'Soil Testing Lab' or any other Lab of Open line / Construction Unit of Zonal Railways. In case of failure of sleeper in any of the test as per clause 5.3.7.1, two sleepers from the same batch shall be subjected to retest as per clause 5.3.7.4. In case failure of sleepers from next one batch, the concerned batch shall be rejected and further production shall be suspended. The detailed enquiry of the concerned sleeper plant is to be ordered by PCE of Zonal Railway. In addition, the quality audit is to be ordered by an Officer not below the rank of JAG.

All precautions should be taken during handling & transportation of sleepers for outside testing so that these are not received in cracked Condition for testing. The condition of the sleepers received before testing shall also be mentioned in the test report.

- (iii) The sleeper plant representative can be permitted to witness the transportation of sleepers and the testing in RDSO/Railways Lab.

5.3.8 Measurement of electrical resistance

- 5.3.8.1 All sleepers shall be tested as per Annexure-V for electrical resistance for their fitness for use in track circuited area.

5.3.8.2 **Competency Certificate**

For inspection of concrete sleepers, officials having competency certificate issued after due test by RDSO/Chief Track Engineer only shall be posted.

6. STAMPING AND MARKING

6.1 All the sleepers shall have legible permanently inscribed and painted markings on the top as per drawing No.RDSO/T-2466.

6.2 The accepted sleepers shall bear the passing marks of the Inspecting Officer in indelible paints. Sleepers which have been subjected to static bending strength test up to cracking and accepted, shall in addition be marked on the top in indelible paint with the letter 'T'. MF tested and accepted sleepers shall bear the marking 'MF' in paint with yellow bands at ends.

6.3 All sleepers fit for use in track circuited area shall bear the mark 'FTC' at the center of the sleeper.

6.4 Rejected sleepers shall be stacked separately by the manufacturer so as to avoid their mixing with the accepted sleepers. Such rejected sleepers shall be marked in the way specified in drawing No.RDSO/T-2466.

The rejected sleepers shall be permanently damaged so as to render them un-useable and a certification that all rejected sleepers of previous batches have been permanently damaged will be given by manufacturer before offering next batch for inspection. The same shall be verified and ensured by inspecting officials/ SSE's and AIE before issuing the IC.

6.5 All markings mentioned in para 6.1 to 6.3 shall be done with enamel paint of ISI mark and shall be such as to last for at least 3 years under normal weather conditions. Colour and quality of the paint used shall be got approved by the Inspecting Officer. All such markings shall be done by the manufacturer at his cost.

7. LOADING AND DESPATCH

7.1 Only those sleepers which have been passed, properly marked and accepted by the Inspecting Officer shall be loaded for despatch.

7.2 The loading of the passed sleepers in wagon shall be done by the manufacturer at his cost as per the loading arrangement

approved by the purchaser. The sleepers shall be properly secured to avoid movement and displacement during transit. The manufacturer shall be responsible to replace, free of cost, all the sleepers which are found damaged in transit on account of defective loading.

8. GUARANTEE

- 8.1 The sleepers shall be guaranteed by the manufacturer for a period of five years from the date of manufacturing / 3 years from the date of placement in service (whichever is earlier). If during the guarantee period, sleepers in general are found to develop defects attributable to bad material and workmanship as established during investigation, leading to large scale withdrawal from service, the cost of sleepers and their replacement shall be borne by the manufacturer. The defective sleepers withdrawn from service can be taken over at site by the manufacturer for their disposal. The manufacturer shall make good the cost due within 60 days of advice of defects. The sleeper manufacturer will also be involved during inspection / investigation and his view will be considered by the Purchaser before taking decision. The decision of the purchaser shall be final and binding in this regard.

ANNEXURE-I**SCHEDULE FOR CALIBRATION OF VARIOUS GAUGES AND TESTING EQUIPMENTS IN THE CONCRETE SLEEPER PLANT**

S.No.	Equipment	Frequency
1	15 cm concrete cube testing machine (2000 KN capacity)	Once in 3 months
2	Cement mortar cube testing machine (500 KN capacity)	Once in 6 months
3	Sleeper Static Bend Test Machine (1000 KN capacity)	Once in 3 months or after testing 250 sleepers, whichever is earlier.
4	Pre tensioning Jacks (500 KN capacity for single mould bench) & (1000 KN Capacity for twin mould bench)	Once a month or after casting 5000 sleepers for single mould and once a month or after casting 10,000 sleepers for twin mould, whichever is earlier.
5	Pre-tensioning load cell	Once a month or after casting 5000 sleepers for single mould and once a month or after casting 10,000 sleepers for twin mould, whichever is earlier.
6	Concrete Beam Testing Machine (100 KN capacity)	Once in 6 months
7	Aggregate weight batcher	Once every week or after casting 4000 sleepers, whichever is earlier.
8	Cement weighing equipment	Once every week or after casting 4000 sleepers, whichever is earlier.
9	Water Meter	Once every week or after casting 4000 sleepers, whichever is earlier.
10	Admixture dispenser	Once every week or after casting 4000 sleepers, whichever is earlier.
11	Master gauges for checking correctness of dimension measuring gauges	Once in 6 months
12	Dimension checking gauges	Once every 15 days or after inspecting 5000 sleepers, whichever is earlier.
13	Proving rings (2000 KN, 500 KN, 1000 KN and 100 KN capacity)	Once in 24 months or within the validity period of last calibration, whichever is earlier.
14	Weights & Measures	By Weights & Measures Department as per extant rules.
15	Tachometer	Once a year

Note:

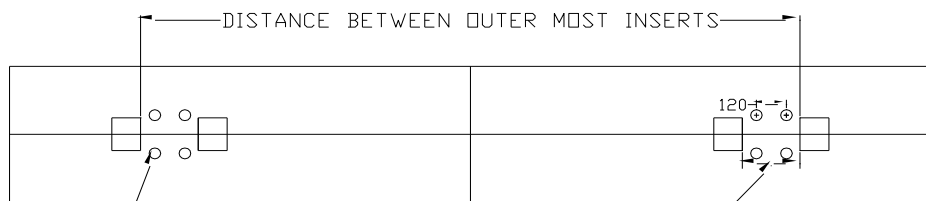
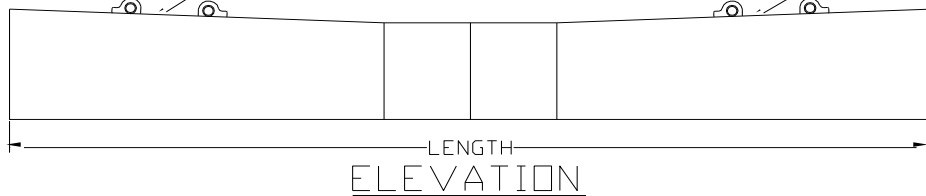
1. The items referred at S.No.1 to 6 above should be calibrated by proving rings in the sleeper plant itself.
2. The items referred at S.No.7, 8, 9 & 10 should be calibrated by dead weights.
3. The proving rings should be got calibrated from NABL approved laboratory / NCCBM/IITs/NITs.

4. The record of calibration of all the above equipments should be maintained in a manner that previous records can be easily connected.
5. The calibration can be done more frequently at the discretion of the Inspecting Official.

DIMENSIONS CHECKING ON PSC SLEEPER

CONVEX OR CONCAVE CAMBER
IN ANY DIRECTION ON RAIL
SEAT SHALL NOT EXCEED 0.8mm.

RAIL SEAT SLOPE 1 IN 20±0.25

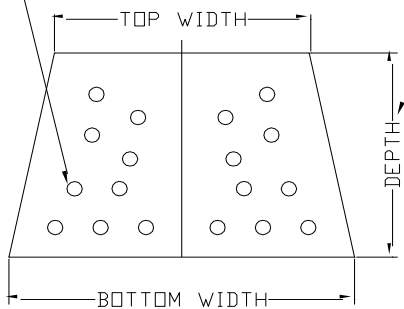


PLAN

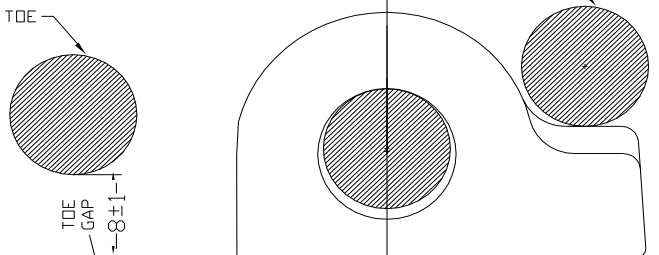
DISTANCE BETWEEN INSERTS AT RAIL SEAT.

GAUGING POINTS FOR MEASURING INCLINATION AND WIND AT RAIL SEATS. WIND SHALL NOT EXCEED 1.2mm ON WIDTH OF 120mm.

POSITION OF HTS WIRES AS PER RESPECTIVE DRAWING.

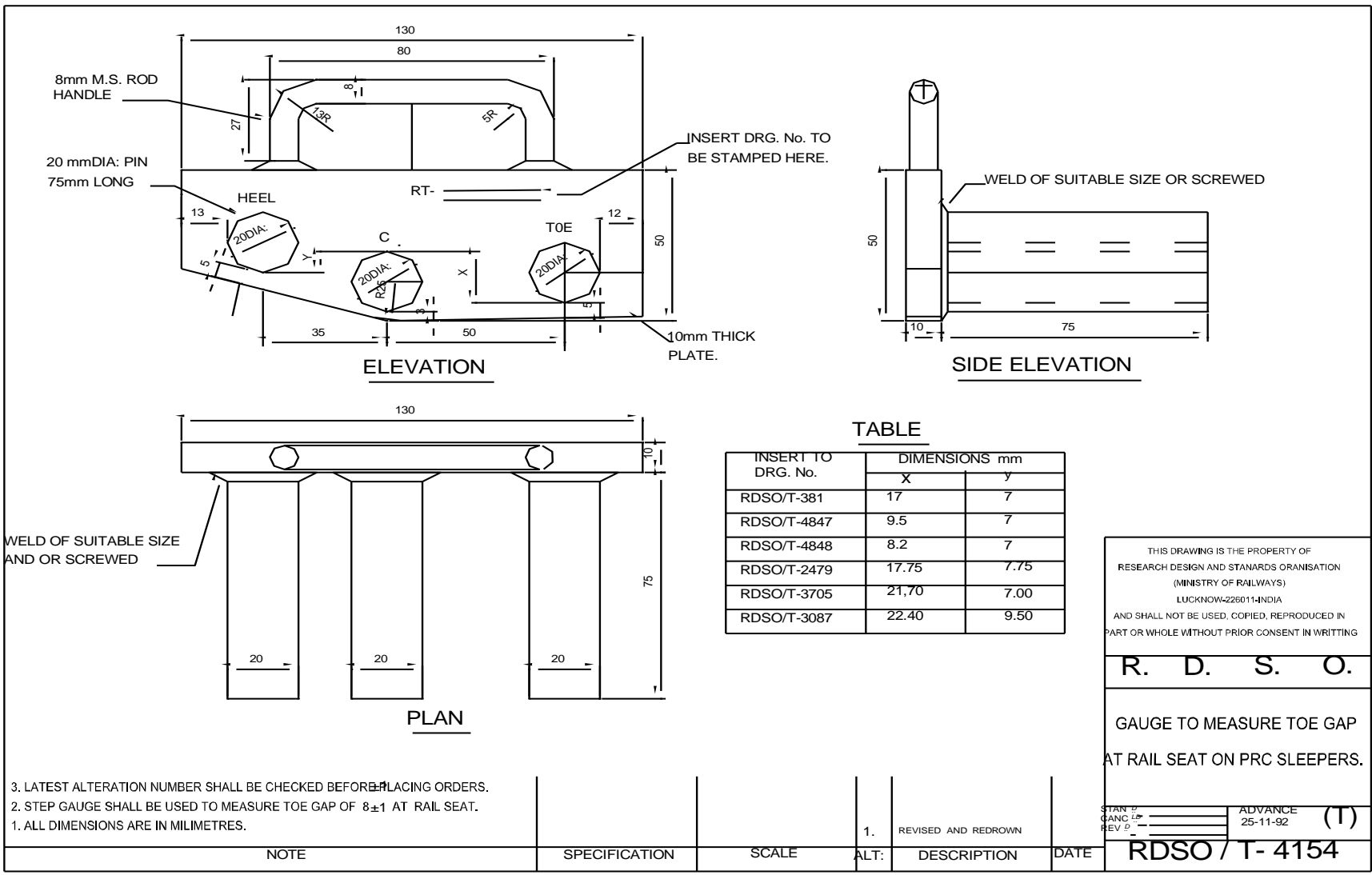


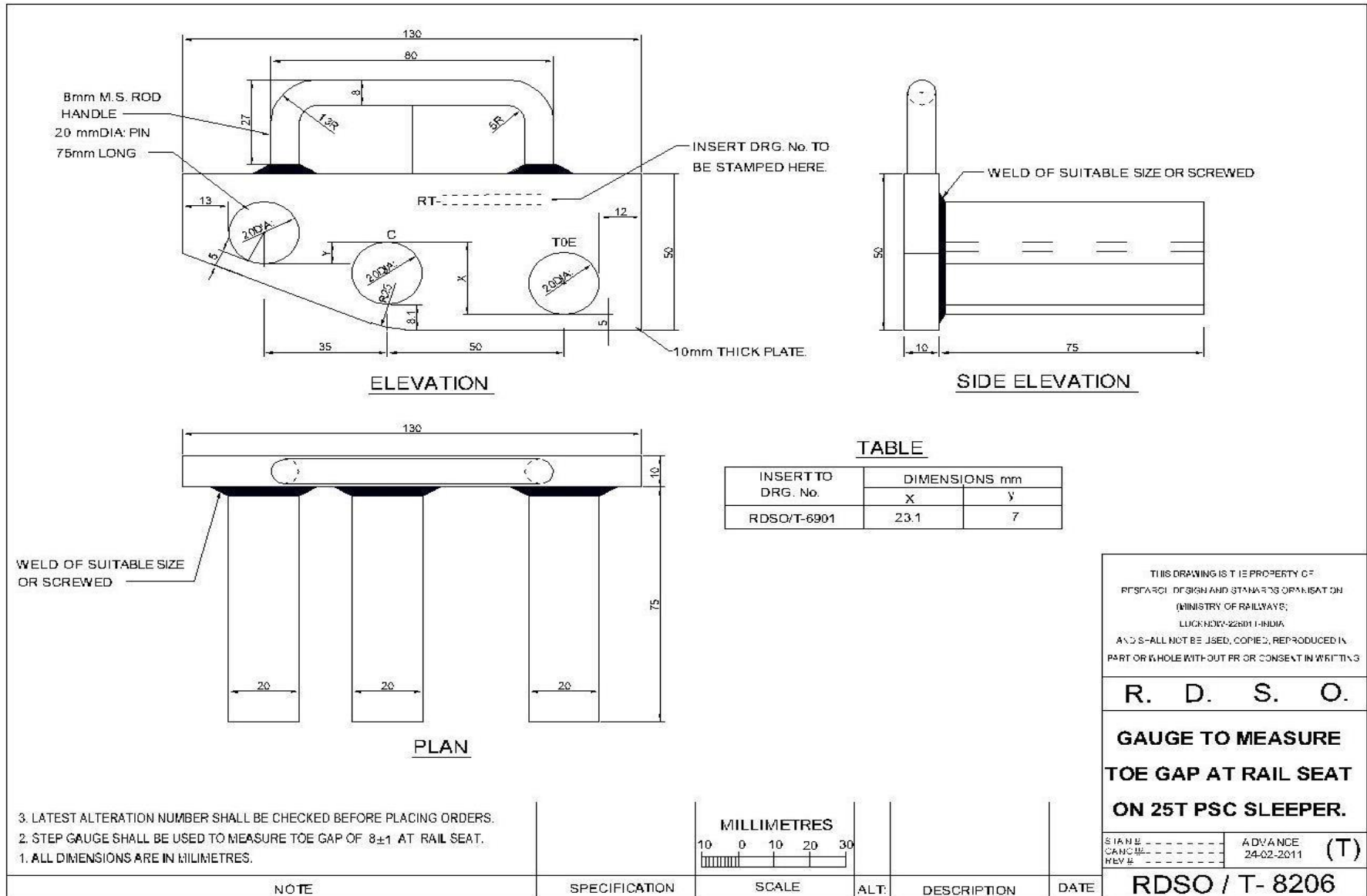
AT CENTRE, RAIL SEAT AND END OF SLEEPERS AS PER DRAWING.

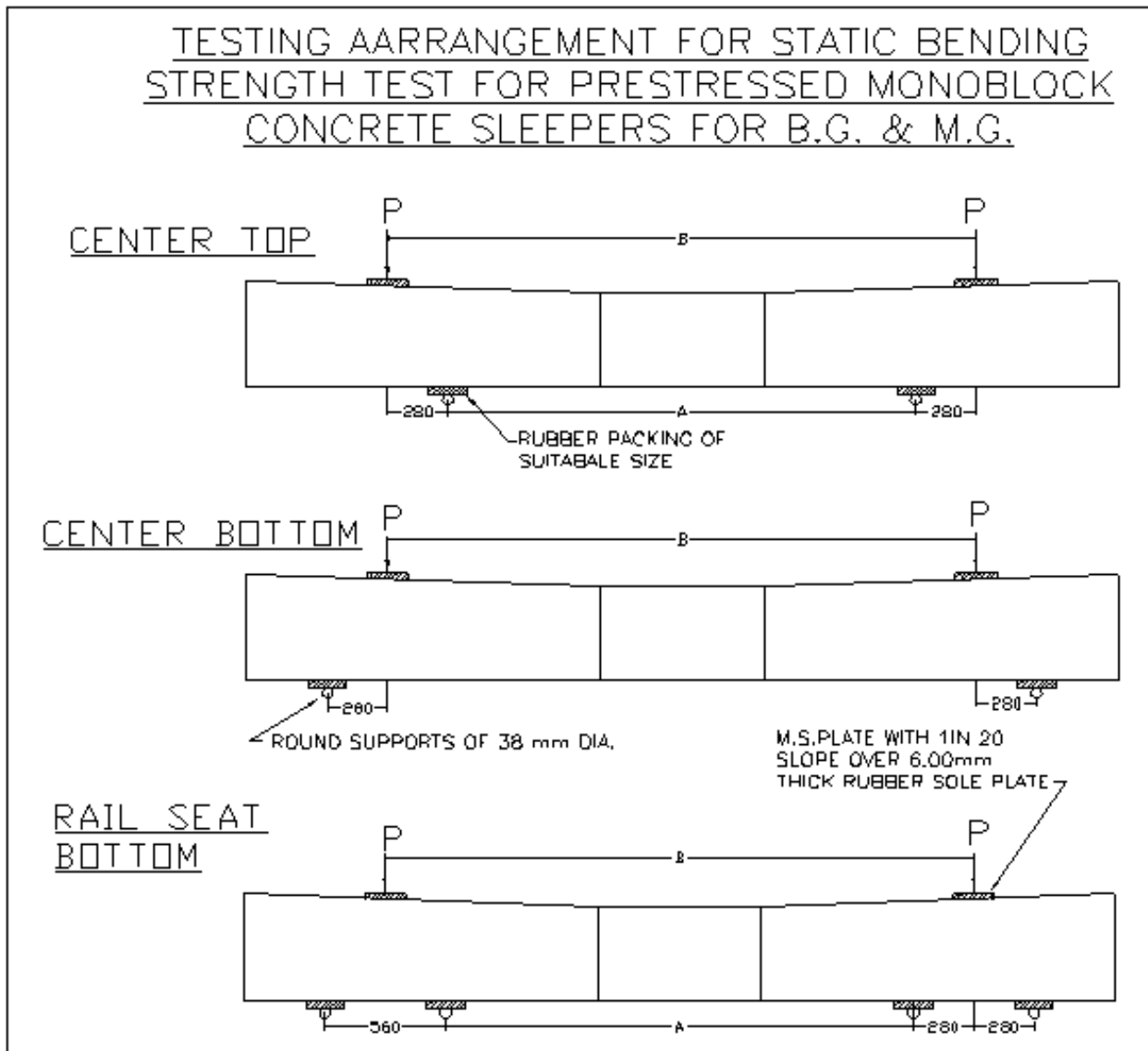


TOE GAP TO BE MEASURED WITH GAUGE TO DRG: No. RDSO/T-4154.

NOT TO SCALE





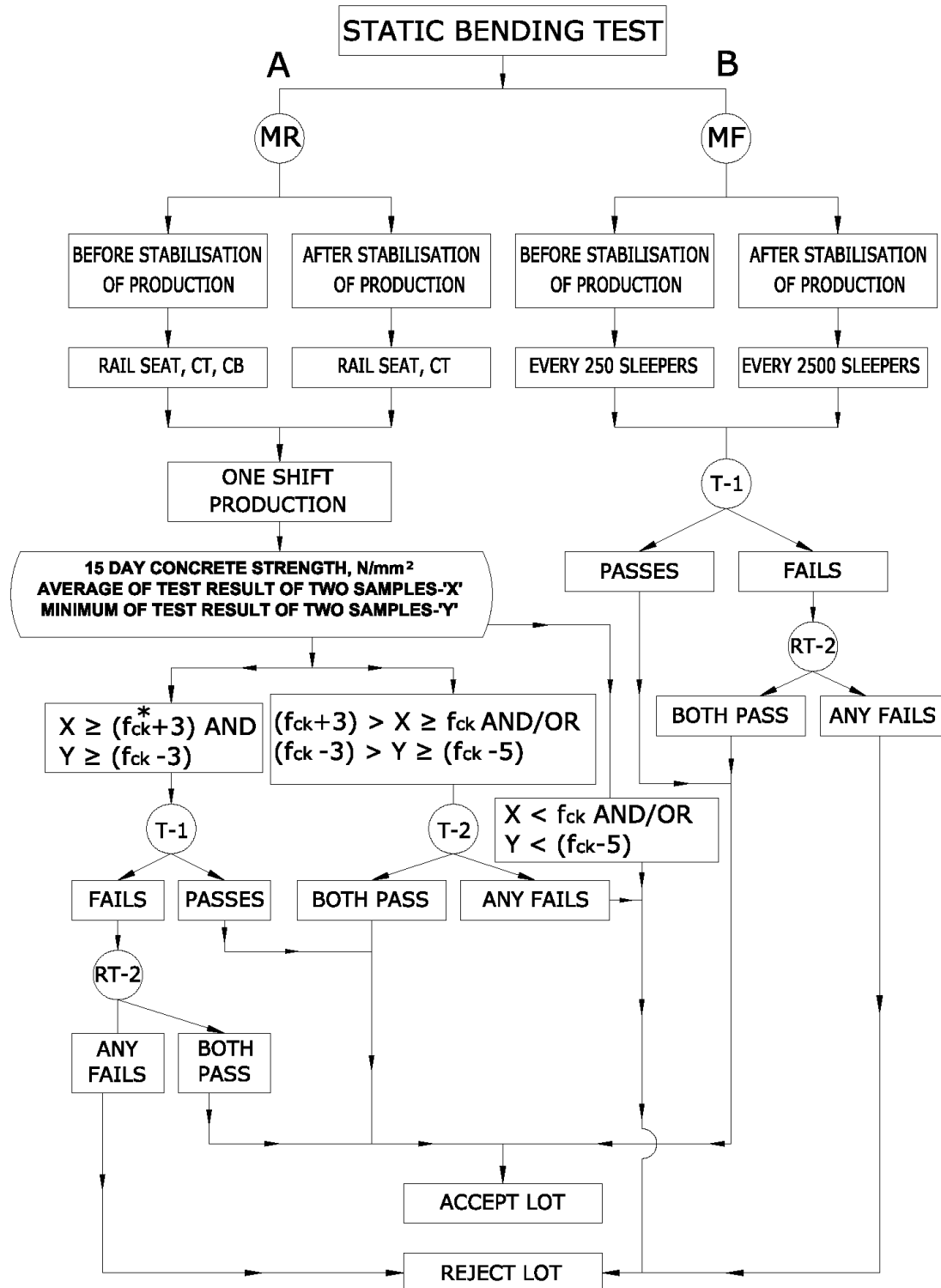


Note:- The testing arrangement is for guidance purpose only. Testing shall be conducted as per test loads mentioned in the relevant RDSO's drawings of PSC sleepers. The dimensions A & B mentioned in above testing arrangement shall be referred from relevant RDSO's drawing of PSC sleepers.

1. All dimensions are in millimeters.
2. The load 'P' will be applied at centre line of Rail Seat through pressure distributing M.S. Plate with 1 in 20 slope and size 145X25mm, covering the full width of sleeper.

3. One rail seat bottom shall be tested at a time. It shall be ensured that the other end is not restrained in upward direction. The rate of loading is 30-40KN per minute.
4. Cracks shall not appear up to the load mentioned in relevant drawings, when retained for three minute.
5. A coat of lime wash shall be applied on the sleeper surface before testing.

FLOW CHART FOR TESTING OF SLEEPER



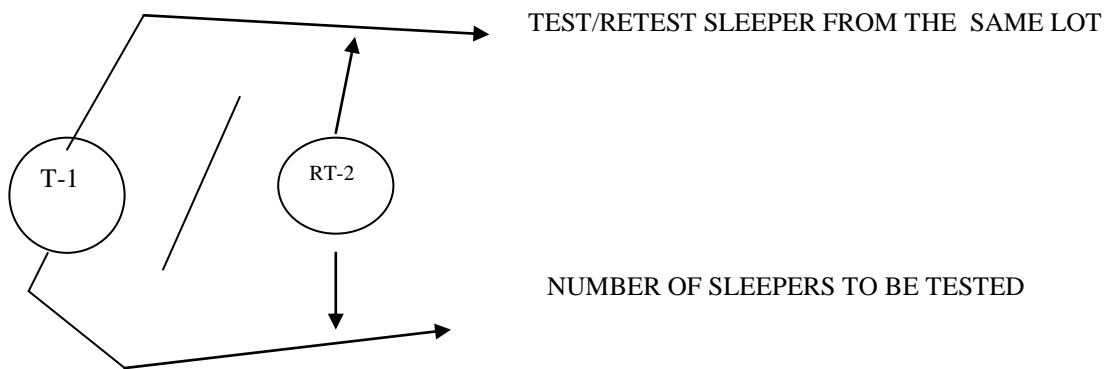
ANNEXURE-IV (Contd.)

NOTATIONS & EXPLANATORY NOTES:

MR: MOMENT OF RESISTANCE TEST:

- RAIL SEAT BOTTOM, CENTRE TOP & CENTRE BOTTOM (PRIOR TO STABILISATION)
- RAIL SEAT BOTTOM & CENTRE TOP (AFTER STABILIZATION)

MF: MOMENT OF FAILURE TEST FOR RAIL SEAT BOTTOM



PASSES : SLEEPER PASSES RELEVANT TEST SUCCESSFULLY

FAILS : SLEEPER FAILS IN ANY OF THE RELEVANT TEST

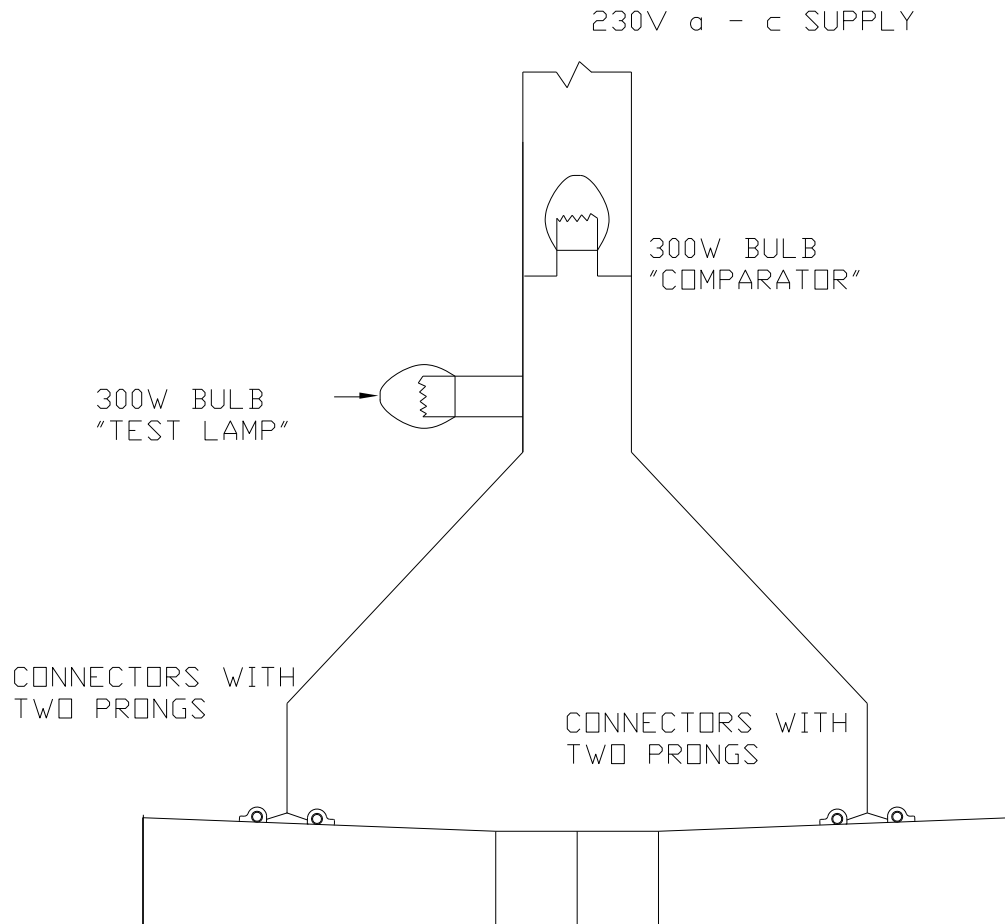
- NOTE :
- (1) WHEN DUE, MF TEST SHALL BE CONDUCTED ON THE FIRST SLEEPER SELECTED FOR TESTING UNDER MR
 - (2) WHENEVER MF IS DONE, PASSING THIS TEST IS A PREREQUISITE FOR ACCEPTANCE OF THAT LOT UNDER 'A' OF FLOW CHART.
 - (3) IF THE FIRST SLEEPER HAS PASSED MF TEST BUT FAILED IN ANY OTHER TEST, MF TEST NEED NOT BE REPEATED ON SUBSEQUENT SLEEPERS SUBJECTED TO RE-TESTING.

ANNEXURE-V

PROCEDURE FOR CHECKING FITNESS OF CONCRETE SLEEPERS ON TRACK CIRCUITED STRETCH (AT THE TIME OF INSPECTION IN THE CONCRETE SLEEPER MANUFACTURER'S PREMISES)

1. All the sleepers shall be tested.
2. The sleeper shall be checked for electrical resistance at 230 volts AC supply. The circuitry to be followed will be shown in sketch at Annexure-V (Contd.).
3. The 230 volts AC supply will be passed through a not less than 300 W test lamp in series with the pairs of inserts being tested. For the sake of comparison, another comparator bulb of the same wattage directly connected to the 230 volts AC supply will be fitted along side.
4. Since the testing is being done at a higher voltage, removal of the rust layer by grinding shall not be necessary.
5. Resistance will be checked against 2 rail seats.
6. If the test lamp emits light dimmer than the comparator lamp in the sleeper, the sleeper shall be accepted and marked 'FTC' (Fit for Track circuit). If it emits light with the same brightness as the comparator lamp, the sleeper will be rejected and marked 'NFTC' (Not fit for track circuit). In case the test lamp does not emit light at all, it indicates that the circuitry is defective and should be rechecked.
7. In the event of doubts regarding comparison of brightness, such sleepers will not be marked. They will be retested with 1.5 V Avometer and marked for fitness, if found fit with 200 ohms resistance.
8. The 'NFTC' marked sleepers should be stacked separately. The FTC/NFTC marking shall be done on top of sleepers in middle portion, as shown on Drawing No.RDSO/T-2466.
9. As the testing is done at higher voltage, all precautions such as use of gloves in the hands, insulated boots and insulated chairs for operator and other necessary precautions shall be taken for the safety purpose.

ELECTRICAL CIRCUIT FOR TESTING
CONCRETE SLEEPER IN PLANT



NOTE:

1. THE CONNECTORS SHALL HAVE TWO PRONGS EACH SO THAT BOTH INSERTS AT A RAILSEAT ARE TESTED AT A TIME.
2. NECESSARY PRECAUTIONS FOR WORKERS SAFETY SHALL BE TAKEN.

LIST OF IRS & BIS CODES REFERRED TO

(Up-to-date version of Codes/Specifications with latest amendments/correction slips shall be followed)

S.N o.	IRS/IS No. & Year	Description
1	IS:269-2015	Ordinary Portland Cement- Specification (Sixth Revision)
2	IS:1343 – 2012 (Reaffirmed-2017)	Prestressed Concrete-Code of Practice (Second revision)
3	IS:383 – 2016	Coarse and fine aggregates for concrete-specification (third Revision)
4	IS:456-2000 (Reaffirmed-2016)	Plain and reinforced concrete- code for practice (Fourth Revision)
5	IS:516 – 1959 (Reaffirmed-2018)	Method of test for strength of concrete
6	IS:650 – 1991 (Reaffirmed-2018)	Standard sand for testing of cement (Second Revision)
7	IS:1785 Pt.I - 1983 (Reaffirmed-2018)	Specification for plain hard drawn steel wire for prestressed concrete Part.I Cold drawn stress relieved wire (Second Revision)
8	IS: 2386 - 1963 Pt. I – VIII (Reaffirmed-2016)	Methods of tests for aggregate for concrete
9	IS:2430 –1986 (Reaffirmed-2019)	Methods for sampling of aggregate for concrete(First Revision)
10	IS:2514 – 1963 (Reaffirmed-2017)	Specification for concrete vibrating table
11	IS:3536 - 2016	Ready mix paint, Brushing, Wood primer-Specification (second revision)
12	IS:4031 –(Part-1)- 1996 (Reaffirmed- 2019)	Methods of physical tests for hydraulic cement Part -1 Determination of fineness by dry sieving (Second Revision)
13	IS:4031 (Part 2) - 1999 (Reaffirmed- 2019)	Part-2 Determination of fineness by specific surface by blaine air permeability method (First Revision)
14	IS:4031 (Part 3) - 1988 (Reaffirmed- 2019)	Part-3 Determination of soundness (First Revision)
15	IS:4031 (Part 4) - 1988 (Reaffirmed- 2019)	Part-4 Determination of consistency of standard cement paste (First Revision)
16	IS:4031(Part 5) - 1988 (Reaffirmed- 2019)	Part-5 Determination of initial and final setting times (First Revision)
17	IS:4031 (Part 6) – 1988 (Reaffirmed- 2019)	Part-6 Determination of compressive strength of hydraulic cement (other than masonry cement) (First Revision)

18	IS:4031(Part 14) - 1989 (Reaffirmed-2019)	Part-14 Determination of false set
19	IS:4032 – 1985 (Reaffirmed-2019)	Methods of chemical analysis of hydraulic cement
20	IS:6006 - 2014 (Reaffirmed-2019)	Uncoated stress relieved strand for pre-stressed concrete-Specification (Second Revision)
21	IS:9103 – 1999 (Reaffirmed-2018)	Specification for concrete Admixture
22	IS:10262 – 2019	Concrete Mix Proportioning – Guidelines (Second Revision)
23	IS:2770 (Pt.1)-1967 (Reaffirmed-2017)	Methods of testing bond in reinforced concrete Part 1: Pull-out test
24	IRS/T-46	Specification for Spheroidal Graphite Cast Iron inserts
25	Schedule of Technical Requirement (STR)	Schedule of Technical Requirement for manufacture of PSC Sleepers as applicable from time to time.