Government of India

Ministry of Railways

(Railway Board)

INDIAN RAILWAY
STANDARD SPECIFICATION
FOR CAST MANGANESE STEEL (CMS) CROSSINGS AND WELDABLE CAST MANGANESE STEEL (WCMS) CROSSINGS

SERIAL NO. IRS: T-29 (REVISED-2024)

ISSUED
BY

RESEARCH DESIGNS AND STANDARDS ORGANISATION

(MINISTRY OF RAILWAYS)

MANAK NAGAR, LUCKNOW – 226 011

INDEX

0. FOREWORD

0.1 This specification is issued under the fixed serial number T - 29 : 2023, the final number indicates the year of original adoption as standard or in case of revision, the year of last revision.

ADOPTED	1974
REVISED	1997
REVISED	2000
REVISED	2016
REVISED	2022
REVISED	2023
REVISED	2024

0.2 This specification was revised in 2016 to incorporate the requirements of corrigenda issued so far, to include the latest practices & software adopted in testing, rationalization of inspection procedure by M&C and Engineering officials, to include the casting of integral test bars, for better traceability and to include latest version of IS codes relevant to manufacturing of CMS crossings.

0.3 This specification has been revised in 2022 to incorporate the latest version of IS/IRS codes and to incorporate a uniform & unique numbering system for marking on CMS Crossings including some minor corrections.

0.4 This specification has been revised again in 2023 to incorporate the provisions for Weldable Cast Manganese Steel (WCMS) Crossing and special test therefor and is incorporated as Part – B of this specification. For WCMS Crossing, Part – A of this specification wherever applicable has been referred to therein.

0.5 This specification has been revised again in May, 2024 to incorporate increased the number of cycles for fatigue testing & change in load for static bending test for Part-B of WCMS Crossing including some minor corrections.

PART – A

SPECIFICATION FOR CAST MANGANESE STEEL (CMS) CROSSINGS

1.0 SCOPE

1.1 This specification covers the requirement of Cast Manganese Steel (CMS) Crossings for use in Indian Railway Track.

1.2 Reference specifications

A) IS Specifications

1	IS: 2 – 2011 (reaffirmed 2016)	Rules for round off numerical values
2	IS: 210 – 2010 (reaffirmed 2020)	Specification for Grey Iron Castings
3	IS: 228 – 1987 (reaffirmed 1997)	Methods of chemical analysis of steels (plain carbon and low alloy)
4	IS: 12308 – 1991 (reaffirmed 2018)	Methods of chemical analysis of cast iron and pig iron
5	IS: 13607 – 1992 (reaffirmed 2019)	Ready mixed paint, Finishing, for general purposes, Synthetic smoke grey colour ISC No. 692 to IS: 5
6	IS: 104 -1979 (reaffirmed 2017)	Ready mixed paint, brushing, zinc chrome, priming
7	IS: 12117 -1996 (reaffirmed 2017)	Norms for classification of steel foundries for quality assurance
8	IS: 1500 -2005 (reaffirmed 2010)	Method for Brinell Hardness. Test for Metallic Materials
9	IS: 1599 -1985 (reaffirmed 2010) (reaffirmed 2019)	Method of bend test
10	IS: 2074 -1992 (reaffirmed 2014)	Ready mixed paint, Air Dying, Red Oxide Zinc Chrome, Priming

11	IS: 2062 – 2011 (reaffirmed 2016)	Hot Rolled Medium and High Tensile Structural Steel
12	IS: 3063-1994 (reaffirmed 2015)	Fasteners - Single coil rectangular section spring lock washers
13	IS: 7318-1974 (reaffirmed 2019)	Approval Test for Welders When Welding Procedure Approval is Not Required - Part I: Fusion welding of Steel.
14	IS: 7739 (Part-V) - 1976 (reaffirmed 2018)	Code of practice for preparation of metallographic specimen of iron and steel and their examination
15	IS:276-2000 (reaffirmed 2017)	Austenitic-Manganese Steel Castings
16	IS:4748:2009 (reaffirmed 2017)	Steels – Micrographic determination of the apparent grain size
17	IS:3658-1999 (reaffirmed 2020)	Code of practice for liquid penetrant flaw detection
18	IS:11732-1975 (reaffirmed 2017)	Acceptance standards for liquid penetrant inspection of steel casting
19	IS:6601 (reaffirmed 2017)	Permissible deviations in chemical composition for products analysis of steel castings

B) IRS Specifications

1	IRS: T-12-2009 or latest version	Flat bottom railway rails
2	IRS: T-23-1967 or latest version	Track bolts and nuts

1.3 All foundries manufacturing CMS Crossing shall be „A" class foundries only and they shall submit self-assessment report against every clause of IS:12117 to enable RDSO team to verify the correctness of self-assessment report at the time of inspection for assessment/periodical reassessment undertaken by RDSO.

1.4 Inspecting authority shall mean RDSO/RITES or any other agencydecided by Railway Board.

1.5 Inspecting official shall mean authorized representative of inspecting authority.

2.0 QUALITY ASSURANCE PROGRAMME

2.1 The manufacturer shall prepare quality assurance programme (QAP) and submit it for approval to the inspecting authority and shall obtain his approval before commencing the manufacture of CMS Crossing. Besides other aspects, the following salient points shall be taken into consideration for preparation of QAP to be submitted to Inspecting Authority.

a) Type of scrap to be used.

b) Internal specification of scraps to be used and charge-mix.

c) Moulding Practice

d) Selection of sands to be used

e) Sand binder additives

f) Preparation of sand and its testing

g) Design of mould box and core boxes

h) Pattern and core making

i) Preparation of moulds

j) Melting process

k) Gas purging technique if any

l) Grain refining technique

m) Stages of testing of molten metal before tapping and at the end of pouring

n) Shot blasting

o) Fettling i.e. knocks out and removal of risers, ingate, fins, etc.

p) Heat treatment process

q) Straightening after heat treatment and after rectification of defects by welding

r) Removal of protruded metal if any, with the help of air arc

s) Repair by welding

t) Marking for finishing

u) Machine finishing of bottom, fishing planes, top gauge face radius, end section etc. including drilling holes.

v) Bend test, hardness test, radiographic test, solidity test, non-magnetic test, D.P. test etc. at the various stages of manufacture in reference to relevant specification.

w) Maintenance of records of tests at various stages

x) Intensity of internal inspection at different stages by Works Inspector/Manager (QA)

y) Painting

z) Packing and dispatch

3.0 STEEL MAKING

3.1 The steel shall be made by electric arc process or such other process as approved by the Purchaser or his representative. Keeping the limitation of operational aspects in view, use of induction furnace for melting is not permitted.

4.0 CHEMICAL COMPOSITION

4.1 The steel used for crossings, when analyzed as per relevant parts of IS: 12308 or any other established instrumental method, shall have the following composition:

Constituent	Percent
Carbon	1.0 to 1.4%
Silicon (Max)	0.5%
Manganese	11.0 to 14.0%
Sulphur (Max)	0.03%
Phosphorus (Max)	0.06%

The ratio of Manganese to Carbon should be minimum 10:1. In case of any dispute, the procedure given in relevant part of IS: 12308 shall be the reference method.

4.2 The manufacturer shall make an analysis of the sample of steel from each melt heat batch and shall furnish the test results to the inspecting official.

The manufacturer shall also furnish the samples free of charge for analysis to the inspecting official, if required.

4.3 Calibration of Spectrometer

Spectrometer should be calibrated at pre-designated intervals based on recommendations of manufacturer/service agency. However, after standardization of spectrometer if wide variation between actual and certified value is obtained for some elements when a certified standard is run, the spectrometer should be calibrated more frequently for those elements.

Wide variation for CMS Crossings will mean:

For Mn	5% of certified value or 0.5 actual variation
For C and Si	5% of certified value or 0.05 actual variation
For P and S	5% of certified value or 0.005 actual variation

5.0 INTERNAL DEVELOPMENT

5.1 In view of the sophisticated nature of work involved in casting CMS Crossings, adequate internal development/internal exercises of the technique by the manufacturer is essential. Manufacturers are required to carry out their internal development with the aim of achieving soundness of casting and dimensional accuracy.

5.2 As a part of internal development, the manufacturers should cast a few crossings and ensure internal soundness of such castings. Sections shall be cut by abrasive cutter at the critical locations i.e. 7 sections at a distance of 100mm apart starting from the nose of the crossing and covering 300 mm on either side as mentioned in Annexure-I. Non-destructive testing of areas such as flanges, which can be subjected to radiographic tests, should also be carried out and the manufacturer should satisfy himself that the standards of acceptance laid down for prototypes in Clause 6 of Part – A of this specification below are generally achieved during internal development. The manufacturers shall thereafter approach RDSO. Inspecting official will verify the report and satisfy himself on the basis of

soundness of the cut sections, dimensional accuracy, records of non-destructive testing and other tests like chemical composition, bend test etc. that adequate internal development has been carried out by the manufacturer. Results of detailed dimensional check shall be recorded in the format prescribed by the inspecting official. The report of internal development shall be recorded as per proforma at Annexure-I.

5.3 During internal development, inspection procedure detailed at Clause 6 and 10 of Part – A of this specification shall be followed by internal department of the manufacturer and relevant records shall be maintained for cross checks by the inspecting official.

5.4 After RDSO is satisfied with the internal development on scrutiny of the internal exercises made by the manufacturer, permission shall be given for casting prototype crossings. All the relevant papers/documents shall be retained in the office of the inspecting authority for future reference.

6.0 PROTOTYPES

6.1 Manufacturing of Prototype

6.1.1 On receipt of permission for casting of prototypes, the manufacturer shall then give 15 days‟ notice to RDSO for witnessing of melting and pouring for casting of prototypes.

6.1.2 Various stages of manufacture for bulk production as detailed in Clause 8 of Part – A of this specification shall be followed for manufacture of prototype crossings also.

6.2 Inspection

6.2.1 Surface inspection

All crossings shall be visually inspected for gross surface defects at various stages of inspection. Dye penetrant methods shall be employed for detection of finer surface defects. Castings thus inspected shall be free from cracks, shrinkage cavities, scabs, flakes, blisters, lack of metal, inclusion, porosities, hot tears, cold shuts and other harmful defects. Minor scattered porosities of less than 4 mm dia and 1.5 mm depth (provided they are not closer than 15mm from each other and not more than three nos. at a particular location) shall be considered acceptable.

However, all such defects have to be in a location which is at least 300 mm away from tip of the nose on its either side. Surface of the casting shall be reasonably smooth and free from extraneous matters.

6.2.2 Solidity Tests

10% of the prototype castings subject to a minimum of one casting of each type shall be selected for sectioning at seven locations by abrasive cutter as mentioned in Clause 5.2 of Part – A of this specification above. Each sectioned face on examination, shall not show a total defective area of more than 2% of the cross sectional area. The defect shall not be clustered at any particular location and shall be uniformly distributed throughout. Defects within 10mm from the surface and defects connected with the outside and presence of cracks/hot tears shall be cause for rejection. Hardness of the sectioned faces shall be taken at the center of the thick section. Dye-penetrant test shall be carried out on sectioned faces for detection of shrinkage and chequered cracks. These tests shall be carried out physically in the presence of RDSO representative.

In solidity test, the cross sections shall be plotted on graph sheet in 1:1 scale and location of defects, if any, shown. The dimensions of flange thickness, wall/web thickness, roof thickness, head thickness etc. shall also be mentioned to give guidance regarding major defects such as mould disturbance etc.

Subsequent to the clearance of prototype, this test shall be carried out once in the three years or completion of manufacturing of 1000 CMS Crossings satisfactorily whichever is earlier.

6.2.3 Radiographic Examination

Flange portion of the crossing shall be radiographically examined. Radiographs shall have sensitivity of minimum 2% and satisfy the requirement of ASTM designation E-446 – Reference Radiographs for Steel Casting – Level II in respect of blow holes, slag and sand inclusion and shrinkage. No cracks/hot tears shall be permitted. Radiographic examination shall be done at the rate of 1 in 20 for regular manufacture and 1 in 5 for prototype castings subject to a minimum of one casting of each type.

6.2.4 After solidity test and radiographic examination have been certified as satisfactory, the firm will prepare a document mentioning parameters (methoding size, shape and location of runners, risers and ingates, moulding practice, source and properties of prepared sand and metal tapping and pouring parameters) which gave satisfactory results. This document will be countersigned by inspecting official. Inspecting officials will be free to verify the parameters which were used during solidity test and which had been countersigned by inspecting official, so as to ensure the consistency of foundry practice. These parameters shall then be incorporated in the QAP.

6.2.5 The manufacturer will inform RDSO about any change in foundry inputs or practice. RDSO will then decide whether fresh solidity test and higher frequency of radiography test need to be carried out all over again after judging the impact of change in input/practice.

6.3 Approval of Prototypes

6.3.1 After RDSO is satisfied with the production of prototypes, approval shall be given to the firm for undertaking bulk production. All the relevant papers/documents shall be preserved in the office of the RDSO for future reference. Manufacturer is to get 10 prototype approved by the RDSO for each design/type of crossing. No prototype need be produced for repeat order, unless the existing design is modified considerably.

6.4 Before approaching RDSO for permission for bulk production, the manufacturer should make good the deficiencies of the plant and machinery, if any, as pointed out by the inspecting authority.

6.5 At the time of applying for approval of prototypes by new foundries, the firm shall submit QAP incorporating records of following aspects of methoding in duplicate after these parameters have given satisfactory results on solidity and radiographic tests:

1. **Source of**
   a) Moulding sand
   b) Core sand
   c) Facing sand

2. **Properties of above sand**

   a) Clay content

   b) Purity (major constituents %)

   c) AFS and grain fineness number

   d) Shape of grains (round, semi-angular, angular)

3. **Mould wash**

   a) Name

   b) Base

   c) Consistency

   d) Size of particles

4. **Properties of prepared sands (mould, core and facing)**

   a) System of sand (CO_2, resin bond etc.)

   b) Compression strength

   c) Shear Strength

   d) Collapsibility

5. **Feeding system (to be shown on sketch/drawing)**

   a) Size and position of ingate

   b) Size and position of runners

   c) Size and position of risers

   d) Yield percentage of good castings

6. **Pouring start temperature/method of measurement**

7. **Pouring end temperature/method of measurement.**

8. **Knock out time after pouring**

9. **Weight of casting**

These parameters shall be scrutinized by RDSO. These parameters shall then be incorporated in the QAP. One copy shall be retained by RDSO and the other shall be returned to the firm after duly signed by the representative of RDSO so as to enable verification from time to time. In case of any change in the methoding parameters mentioned above. RDSO shall be informed by the firm to decide whether the change is minor or major. If the change is expected to affect the quality of the casting, then it may require revalidation of solidity test.

7.0 INTEGRAL TEST BARS

7.1 Four number of test bars of size 200 mm X 30 mm X 30 mm (with tolerance of ± 1 mm in each dimension) shall be cast integral to crossing. These shall be located at toe end and heel end respectively (2 number each).

7.2 Pattern and mould shall be developed by manufacturer to accommodate the integral test bars.

7.3 Integral test bar shall be so cast that it should not get detached during knock out, fettling, shot blasting or heat treatment.

7.4 These integral bars shall be used for chemical composition, microstructure/grain size determination, hardness and for impact bend test.

7.5 Integral test bar shall be detached from crossing by suitable method to avoid any damage to crossing. The detachment shall only be done in the presence of inspecting official.

7.6 While detaching the integral test bar at various stages, inspecting official shall transfer suitable marking on particular test bar so that the same may be identified in terms of crossing number and location. A record must be maintained for integral test bars indicating crossing number, location & date of detachment.

7.7 The manufacturer shall preserve at least one integral test bar of each crossing for minimum 6 months from the date of issue of inspection certificate of particular crossing and shall present to inspecting official on demand. In case all integral test bars are used during test/retest, one integral test bar used in Impact Bend Test may be preserved.

8. VARIOUS STAGES OF MANUFACTURE FOR BULK PRODUCTION

8.1 Moulding

8.1.1 The crossing shall be accurately moulded and finished to the form and dimensions shown on the drawings to be supplied by the purchaser or RDSO/Lucknow.

8.1.2 Unless otherwise permitted by the purchaser or the inspecting official in writing the dimensions/tolerances shown on the drawing (s) shall be adhered to.

8.1.3 Manufacturer should have adequate in-house facility for sand preparation, testing and recycling as per moulding practice specified in QAP.

8.1.4 Sand selection, moulding and core practice, mould and core paint selection shall be such that there is no metal mould reaction, which shall cause defects with bad/rough surface finish.

8.1.5 Internal/external metallic chills or chaplets shall be avoided to ensure the consistent internal quality requirement.

8.2 Marking 'Unique Identification (UID) Number' on CMS Crossing

8.2.1 Following scheme for allotting UID number to each CMS Crossing shall be followed: The UID Number shall comprise of 11 characters. However, for easy handling of core in order to control it from breakage, the UID number can be cast in two separate parts comprising of 6 & 5 characters in close proximity such that no break should appear in the UID Number.

e.g. the UID Number shall therefore be e.g. XXYYMMαZZZZ,

where:

XX - First & Second character will denote „Firm‟s Plant ID‟

YY - Third & Fourth character will denote „Year of casting‟

MM - Fifth & Sixth character will denote „Month of casting‟ (the date of completion of casting to be considered)

α - Seventh character will denote " Type of crossing" (either 'C' or 'W' will be used, C for CMS crossing and W for Weldable CMS crossing)

ZZZZ - Eighth, Ninth, Tenth & Eleventh character will denote "Serial number of crossing"

i) All characters in the UID number shall be numerals except the Seventh character which shall be an alphabet.

ii) The UID number of CMS crossing shall encompass all the designs manufactured by an approved vendor in a particular year.

iii) The "Firm's Plant ID" i.e. "XX" shall be allotted by RDSO to all the approved vendors of CMS crossing.

iv) The "Serial Number of Crossing" i.e. "ZZZZ" will be given by the firm themselves starting from 0001 as the first crossing. Series will start from 1st of January ending on 31st of December every year.

v) The UID number of CMS crossing, as indicated above, drawing no of crossing, Rail section designation shall be cast in raised letters 40mm high and 3mm deep. All these markings shall be sharp clear and distinct.

vi) On one of the outer faces of web of the crossing unit, UID number of CMS Crossing shall be provided and other outer face of web of the crossing unit shall have the "Rail Section Designation" & "Drawing Number" as per the existing scheme given in the respective drawing of CMS Crossings.

Marking for "Angle of crossing" shall be done on CMS Crossings as per respective drawings.

8.3 Melting

8.3.1 Suitable efforts shall be made for selection of proper scrap and use of correct melting process with proper refining operation shall be ensured so as to control the detrimental tramp elements in steel. Moreover, the sulphur and phosphorus contents in the steel shall be achieved as mentioned in Clause 4.1 of Part – A of this specification.

8.4 Pouring

8.4.1 Metal should be poured by bottom pouring ladle and mould filling time shall be recorded. Further, each manufacturer will indicate pouring start and pouring end temperatures in his QAP after ensuring that all castings from first to last are sound and no adverse effect are noticed due to high or low temperature of pouring. Pouring start and pouring end temperatures will be measured and records kept.

8.4.2 Any casting for which witnessing of melting & pouring is mandatory, the manufacturer shall give prior notice to the inspecting authority. Inspecting official shall witness melting & pouring as per Clause 10.2.1 of Part – A of this specification. Casting for which witnessing of melting & pouring is not mandatory, the manufacturer may cast the same keeping records as indicated in Clause 10.2.2 of Part – A of this specification.

8.5 Knock Out

8.5.1 During knock out, casting should be handled very carefully to avoid development of cracks in the castings. Any impact shall be avoided.

8.6 Fettling and shot blasting

8.6.1 The crossing shall be free from embedded sand particles and risers, flow off shall be knocked off, ingate at ends and other thick fins, if any, shall be removed by Arc Air or oxy-cut. If oxy-cut, then the cut should be at least 25mm away from the crossing body. The casting shall be suitably shot blasted thereafter, so that they are free from sand etc. and surface inspection can be done visually by the inspecting official without any difficulty. In no case, crossing shall be placed on shaker for removal of sands. Fettling & shot blasting shall be done in such a way so as to avoid any impact to the crossing.

8.6.2 When ingate riser etc. are removed by thermal operation, care shall be taken to make the cut with sufficient allowance (at least 25mm away from the crossing body) to prevent any defect being introduced into the main body of the crossing due to local heating.

8.6.3 Enlargement of bolt-holes and making of any new holes by thermal operation shall not be permitted.

8.6.4 All crossings shall be free from gas pockets, sand holes, cracks, cold shuts and other injurious defects. Lumps and sharp fins, if any, on the edges of the casting shall be suitably removed.

8.6.5 Repair of defects by welding that will not ultimately impair the strength or utility of the crossing, may be carried out with the consent of the inspecting officer, as per approved process as mentioned in Annexure-III.

8.6.6 During fettling for removing risers, runners and ingates from castings, no excessive heat should be generated to avoid any thermal shock to the casting.

8.7 Heat treatment of crossings

8.7.1 All crossings along with integral test bars shall suitably be heat treated to render them tough. It shall be ensured that integral test bars meant for further testing is not detached from the crossing even after heat treatment and shot blasting to facilitate inspecting officials in carrying out the test related to particular crossing. This treatment shall consist of uniform heating of the crossing to a suitable temperature holding it at that temperature till uniformly heated throughout and quenching in water within 60 seconds from a minimum temperature of 1050°C. The crossing should be kept in the quenching tank in head down manner. The initial temperature of water in the quenching tank shall be less than or equal to 30°C and should not rise by more than 10°C during and immediately after quenching of crossings. Water in quenching tank shall be agitated and circulated properly and a continuous temperature measuring system should be installed to record before and after quenching temperature of tank for each heat treated batches of crossings. The recording of temperature should be kept preserved for checking of inspecting officials.

8.7.2 The heat treatment shall be done in a furnace fitted with recorder type pyrometer. The number of castings for each heat treatment batch indicating melt heat number shall be recorded on the heat treatment chart and it shall be signed by the manufacturer's representative and produced to the inspecting official on demand.

8.7.3 On completion of heat treatment, the crossing again shall be shot blasted.

8.7.4 A record of the heat treatment of the crossing shall be maintained by the manufacturer, details of which shall be supplied to the inspecting official.

8.8 Surface Preparation and defects removal

8.8.1 The castings shall be suitably prepared for the removal/rectification of castings defects as permitted by the inspecting official without resorting to any thermal operation.

8.8.2 Continuous grinding at one location shall not be done to avoid rising of temperature of the surface during grinding beyond 250°C.

8.9 Straightening

8.9.1 The casting after complete repair work and certification to that effect by the manufacturer shall only be straightened by application of gradual load under a suitable heavy duty hydraulic press. Casting shall be summarily rejected, if end-to- end straightening is beyond 40mm.

8.9.2 After the pressing operation is done, the casting shall be offered to the Inspecting official for inspection by dye-penetration test and records shall be maintained. In no case, straightening operation will be allowed before undertaking repair welding.

8.10 Finishing

8.10.1 Surface finish shall be ensured to minimize machining on any part of crossing. Ideal finish shall be taken as smooth finish.

8.10.2 The bottom of crossing shall be machined by milling machine so that the bottom surface of crossing which rests on PSC sleepers shall be straight without twists and shall be free from such imperfections which may prevent a good and even bearing of the crossing on PSC sleepers.

8.10.3 End section faces (both toe and heel end) shall be machine-finished by milling machine to provide machined joints in turnout as mentioned in the drawing.

8.10.4 Fishing plane shall be finished by milling for achieving required surface contact between fish plate and casting to have sturdy joint for proper transfer of dynamic load.

8.10.5 Fish bolt holes shall be drilled and have a 1mm chamfer at each end to achieve tolerances mentioned in the drawing. Bond holes in fish plate area for DC traction shall also be drilled for getting bond wires force fitted.

8.10.6 The top edge contour (gauge face) up to tangent points shall be machine-finished by planer/miller in order to achieve uniform radius all through running faces and to eliminate local misalignment.

8.10.7 Other locations shall be finished either by machining or by hand grinding operation depending upon the facilities available. While grinding, Clause 8.8.2 of Part – A of this specification shall be adhered to.

8.10.8 Machining facility shall be generally available in the same premises to have dedicated flow line for manufacture of this sophisticated safety related item.

9.0 INSPECTION GAUGES/TEMPLATES & OTHER EQUIPMENT

9.1 Manufacture of inspection gauges

The manufacturer shall prepare two sets of inspection gauges/templates as per drawings to be supplied/ approved by the purchaser/Inspecting authority for each type of CMS crossings ordered and shall submit them for approval to the purchaser or the inspecting official and shall obtain his approval before commencing manufacture of prototype CMS Crossing. The crossings shall be checked with the help of approved inspection gauges/templates at different locations as mentioned in the gauge drawing. Out of the two sets of gauges/templates approved, one set is to be kept as MASTER GAUGE for use in case of any discrepancy and the other set is to be used for finishing of crossings in shop floor and by Inspecting Officials during inspection. Extra sets of gauges shall also be made depending upon the rate of production and got approved by the Inspecting Authority. The inspection gauges shall be verified during Quality Audit. These gauges may also be checked as and when considered necessary during inspection.

9.2 Other inspection equipment/accessories

The following materials shall be made available before approval of internal development for checking end fitments of each CMS Crossing.

9.2.1 Rail pieces of standard section 750 mm long (approx.) having standard fish bolt holes at one end matching with the section of CMS Crossing to be inspected. Four such rail pieces shall be made available for checking one crossing. Number of rail pieces required shall depend upon the number of crossings to be put up at a time for inspection. End face of rail pieces shall be machined to have frozen/machined joint as mentioned in the respective assembly drawing of CMS Crossing. Bolt holes in the back of rails shall register with reference to the base of the rail within ± 0.8 mm provided that fish bolt holes shall register within ± 0.6 mm in location and + 0.8 mm & - 0.0 mm in diameter for the purpose of machined joint.

9.2.2 Bolts of sizes as per drawing.

9.2.3 Fish plates of standard section with six bolt holes matching with the CMS crossings. Four fish plates will be required per crossing. Second quality/second hand fish plate shall not be used.

9.2.4 Distance blocks for ends as mentioned in drawings. These web and fishing fit blocks shall be finished by machining before use.

9.2.5 Adequate number of spherical washers, packing pieces and tapered washers as mentioned in the relevant drawings.

9.2.6 Other standard equipment such as tape (steel 10 m), straight edge (steel 1 m long), scale steel (305 mm – 610 mm), Nylon cord (10 m), filler gauge having strips of 0.5mm to 1.0mm and scale Vernier of 600 mm long.

9.2.7 Any other equipment specified by purchaser/inspecting authority.

9.2.8 These accessories/other equipment shall be maintained for regular inspection also.

10.0 INSPECTION

10.1 The CMS crossing is related to the public safety in the railway transit. The process of manufacture is most intricate both from the foundry and metallurgical point of view. Considering the basic characteristic of the steel i.e. the thermal sensitivity, low diathermic character, mould metal reactivity of the steel, and the work hardening and high shrinkage characteristics of the steel, rigorous inspection (both metallurgical and

dimensional) at different stages of manufacture shall be carried out as detailed herein.

10.2 Chemical composition

10.2.1 For casting of prototypes, the manufacturers shall intimate the inspecting authority well in advance (at least 15 days) so as to enable him to witness sampling of molten steel at different stages for chemical analysis and shall furnish details of charge, pouring temperature etc. Inspecting official shall witness such pouring and ensure that temperature and chemical composition as mentioned in QAP has been met with. The bath samples shall be taken at different stages and chemical composition shall be carried out. The same shall be recorded with other parameters in inspection memo-I as given in Annexure-II.

10.2.2 For casting that does not require pouring witness, the manufacturer may go ahead with the casting and record the parameters in inspection memo-I as given in Annexure-II The records shall be presented to the inspecting officials for cross check during subsequent stages of inspection. Chemical composition of such crossings at any stage shall be determined as per Clause 10.4.2.2 of Part – A of this specification.

10.3 Identification of cast and correlation of heat numbers

10.3.1 The castings shall bear manufacturer's identification marks, drawing number, serial number and date of cast. A register shall be maintained by the manufacturer correlating the casting serial number and heat number and register shall be produced to the Inspecting Authority for their verification on demand.

10.4 STAGES OF INSPECTION

10.4.1 Inspection shall be carried out in four stages i.e. Stage-I, Stage-II and Stage-III and Stage IV (final stage). Sampling of molten metal may also be witnessed by Inspecting Official, if available in shop-floor during pouring. However, it shall be ensured that pouring must be witnessed at-least once in every 6 months. Prior to Stage-I inspection, wherever applicable, chemical composition shall be checked as per Clause 10.2.1 of Part – A of this specification.

For the designs of CMS Crossing manufactured by any firm, consistency of quality of which has been established as per norms prescribed by inspecting authority, inspecting official(s) shall begin inspection at Stage-II. The internal inspection shall, however, be carried out by the manufacturer at Stage-I which shall be verified by the inspecting official(s) at Stage-II.

10.4.1.1 **Stage–I:** Inspection shall be carried out after knockout/oxy-cutting/shot blasting etc. as per Clause 10.4.2 of Part – A of this specification.

10.4.1.2 **Stage–II:** Inspection shall be carried out after heat treatment and shot blasting etc. as per Clause 10.4.3 of Part – A of this specification.

10.4.1.3 **Stage–III:** Inspection shall be carried out after removal/rectification of defects and straightening as per Clause 10.4.4 of Part – A of this specification.

10.4.1.4 **Stage–IV (Final stage):** Inspection shall be carried out after final finishing for final acceptance as per Clause 10.4.5 of Part – A of this specification.

10.4.2 Metallurgical & Chemical inspection (Stage–I)

10.4.2.1 After fettling and shot blasting as per Clause 8.6 of Part – A of this specification, the defective areas of the surface of crossing, if any, shall be marked with the dimension of defects (i.e., length, width and depth) and shown in isometric view as shown in Annexure-IV and their locations indicated from a datum line. These details are to be tabulated by the manufacturer in a proforma as per Annexure-V and shall be submitted to the inspecting official for the verification and inspection. The inspecting official shall be vigilant about foundry defects like cracks, sand holes, cold shuts, pin holes porosity, extra metal, sand fusion etc. Crossing having cracks shall be straight way rejected.

10.4.2.2 One integral test bar shall be detached randomly from any crossing in a melt heat batch in a manner prescribed in Clause 7.5 & 7.6 of Part – A of this specification. The chemical composition shall be determined by taking sample from the integral test bar so detached which shall represent the entire melt heat batch. In cases where inspection is started by inspecting

official at Stage-II as mentioned in Clause 10.4.1 of Part – A of this specification, integral test bar shall be detached for determination of chemical composition in presence of inspecting official at Stage-II only i.e. after heat treatment and shot blasting.

10.4.2.3 The castings which are considered processable both metallurgically and chemically at this stage by the "manufacturer and inspecting official" or the "Manufacturer" as the case may be, shall be permitted for heat treatment as per Clause 8.7 of Part – A of this specification and Inspection Memo-II as mentioned in Annexure-II shall be signed.

10.4.3 Metallurgical & Dimensional Inspection (Stage-II)

10.4.3.1 After heat treatment as per Clause 8.7 of Part – A of this specification and shot blasting, the castings shall be offered to the inspecting official in the similar manner as in Stage-I for metallurgical and dimensional checkup. Surface inspection shall be carried out as detailed in Clause 6.2.1 and 10.4.2.1 of Part – A of this specification & defects shall be marked on isometric view & recorded in proforma given in Annexure-IV & V respectively. The chemical composition of crossing shall be determined by taking sample from the integral test bar as detailed in Clause 10.4.2.2 of Part – A of this specification, if not done earlier.

10.4.3.2 Crossings having crack(s) shall be rejected.

10.4.3.3 Integral test bars shall be detached from crossing in a manner prescribed in Clause 7.5 & 7.6 of Part – A of this specification. Impact bend test on integral test bar shall be conducted as per Clause 13.1 of Part – A of this specification in presence of the inspecting official and record of test shall be maintained. Suitable hardness test shall be conducted at this stage on casting/integral test bar as per Clause 13.2 of Part – A of this specification in presence of inspecting official and record shall be maintained.

10.4.3.4 The micro test piece shall be cut from the integral test bar duly heat treated along with CMS crossing as per Clause 8.7 of Part – A of this specification for determination of grain size and microstructure as per Clause 13.4 of Part – A of this specification.

10.4.3.5 At this stage, gross dimensions such as overall length, distance between actual nose and heel, actual nose and toe end, height at different locations,

flange thickness at different locations, flange way clearance, throat clearance, flange well depth, wheel tread at toe end, nose thickness, nose depression and off sets bottom, bottom width, tie thickness, extent of vertical bend etc. shall be checked and recorded in Inspection Memo-IV as mentioned in Annexure-II.

10.4.3.6 The castings after metallurgical and dimensional inspection shall be considered for further processing as per Clause 10.4.4 of Part – A of this specification and Inspection Memo- III & IV as mentioned in Annexure-II shall be signed by the inspecting officials along with the isometric view.

10.4.4 Metallurgical Inspection (Stage-III)

10.4.4.1 Before putting up to the inspecting officials, the castings shall be suitably prepared for the removal/rectification of defects as identified during Stage-I/Stage-II as per Clause 8.8 and straightened as per Clause 8.9 of Part – A of this specification. No crack shall develop on locations repaired by welding, due to straightening operation & the same shall be verified by conducting dye penetration test.

10.4.4.2 Repair welding shall be done strictly as per the procedure for repair/rectification of CMS crossing at Annexure-III. The manufacturer will produce a certificate to this effect.

10.4.4.3 The castings shall be offered to the inspecting official in the manner as in Stage-I and Stage-II for metallurgical inspection, if necessary. For the designs of CMS Crossing manufactured by any firm, consistency of quality of which has been established as per norms prescribed by inspecting authority, casting shall be offered to inspecting official for inspection during Stage IV/Final Inspection. In such cases, the internal inspection shall, however, be carried out by the manufacturer at Stage-III which shall be verified by the inspecting official(s) at Stage-IV/Final Inspection.

10.4.4.4 The crossings which are considered processable shall be permitted for final finishing by the "manufacturer and inspecting official" or the "manufacturer" as the case may be and Inspection Memo-V as mentioned in the Annexure-II shall be signed.

10.4.5 Final dimensional check-up and magnetic test (Stage-IV/Final Stage)

10.4.5.1 After final inspection and certification by the Works Inspector of the firm as per Clause 15 of Part – A of this specification, the crossing shall be offered finally for dimensional checkup (as per sequence shown in Annexure-VI) on the inspection table/marking table with the approved gauges/templates/equipment as mentioned in Clause 9.2 of Part – A of this specification.

As the geometry of the CMS/WCMS crossings are complex at several locations, hence for avoiding human interface and accurate measurement, their critical dimensions shall also be measured with the help of Electronic dimensional measurements with auto recording facility duly calibrated by a reputed laboratory. The electronic method of measurement should have facility for preservation of the records of measurements.

10.4.5.2 The castings shall be visually inspected for surface defects employing dye-penetrant tests as necessary. The casting shall also be tested for its non-magnetic character either by portable magnet or by suitable electro-magnet. The check will be done on head surface.

10.4.5.3 Dimensions of crossings shall be checked with the help of gauges/templates, fishing cord, straight edge, filler gauge etc.

10.4.5.4 At the discretion and as per directives of the inspecting official, the manufacturer shall produce the non-destructive test result (to be done in presence of inspecting official) at the frequency as detailed in Clause 6.2.3 of Part – A of this specification.

10.4.5.5 After the inspecting official(s) is (are) satisfied that the crossing conforms to relevant drawing and specifications, the crossing shall be accepted finally and the Inspection Memo-VI as mentioned in the Annexure-II shall be signed.

11.0 GENERAL

11.1 During inspection, no grinding operation, oxy-cutting and fettle-arc gauging shall be carried out in the area earmarked for inspection by the inspecting officials and no material shall be carried by any overhead crane over the area in the interest of safety. Crossings shall be placed 1 m apart (i.e. 1 m distance between centre lines of crossings) for easy application of

gauges/templates and for turning of crossings for the purpose of inspection. Suitable lighting arrangement and adequate handling facilities as considered necessary for conducting proper inspection, shall be provided.

11.2 The purchaser or inspecting official(s) shall have free access to the manufacturer's works at all reasonable times. He shall be at liberty to inspect the process of manufacturing at any stage and to reject any material that fails to conform to the provisions of the specifications.

11.3 All the provisions contained in RDSO's procedures laid down in Document No. QO- D-7.1-11 dated 19.07.2016 (titled "Vendor–Changes in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.

12.0 TOLERANCES

12.1 **Fishing Surface:** The standard template for fishing surface shall not stand away from the contour of web by more than 1.20mm and the clearance at the fishing surfaces shall not exceed 0.2 mm at any point as per Clause 9.1.1 of IRS: T-12- 2009.

12.2 **End Squareness:** The deviation from square at both heel and toe end shall not exceed 0.2 mm in both axes.

12.3 **Concavity/convexity (Both top and bottom surface)**

(a) Overall length: It shall not exceed ± 1 mm.

(b) Local: It shall not exceed ± 0.5mm. It shall be checked using 1 m straight edge at any point.

12.4 **Alignment**

(a) Overall length: It shall not exceed ± 1mm.

(b) Local misalignment: It shall not exceed ± 0.5 mm over a length of 1m at any point.

12.5 **Bolt Holes:** The holes in the web of crossing in fish plated area shall register with reference to the base of the crossing within ± 0.8mm provided that the fish bolt holes shall register within ±0.6mm tolerance in location and +0.8mm & -0.0 mm in diameter for machined joint.

12.6 Kink at fish plated joint: While checking end fitment of crossing in shop floor, the kink at fish plated joint shall not exceed ± 0.5mm.

13.0 TESTS

13.1 Impact Bend Test

13.1.1 Sample size

a) One test per cast (melt heat) per heat treatment batch shall be carried out on integral test bars.

b) The test bar for impact bend test shall have a 30 x 30 mm (tolerance ± 1mm) cross section and be 200mm in length. Four pieces, two from toe end and two from heel end, wherever available shall be taken for this test. Out of these four pieces, two (preferably one from toe end and one from heel end) shall be for the usual acceptance tests and two for any extra tests.

There may be cases where only three test bars are available (e.g. single crossing of particular melt heat and heat treatment batch, one test bar of which has been detached for chemical composition determination earlier). In such case, three pieces shall be taken, out of which two shall be used for usual acceptance test and balance one piece for retest.

c) Casting and detachment of integral test bar shall be done in a manner prescribed in Clause 7.0 of Part – A of this specification.

13.1.2 Execution of Tests:

a) The impact bend test pieces shall be of un-machined bar, the edges of which may have a chamfer not exceeding 1 mm. Prior to the test, bars shall be notched in a press to a semi-circle (r=1.5mm, depth=1.5mm) on one face at the centre across throughout the width in the presence of inspecting official.

b) The test pieces shall then be placed horizontally on two knife-edge supports spaced 160 mm apart, notch downwards and midway

between the two supports. The knife edge supports shall have a radius of 2mm. The test pieces must withstand 3 successive blows of a 50 kg weight falling freely from a height of 3m onto the surface opposite the notch. The part of the falling weight coming into contact with the test piece shall be rounded to a radius of 50 mm. The test arrangement shall be as per Annexure-VII.

13.1.3 Acceptance Criteria

(i) The test pieces must withstand three impacts. They may crack but the crack must not extend more than 7 mm up.

(ii) Both test pieces must comply with the above acceptance conditions for the castings of particular melt heat & heat treatment batch to be acceptable.

(iii) In case only three test pieces are available for impact bend test as mentioned at Clause 13.1.1(b) of Part – A of this specification, if both test pieces give unsatisfactory results, then castings of particular melt heat & heat treatment batch shall definitely be rejected.

13.1.4 Extra Tests– Further Heat Treatment

If one (in case of availability of only three test pieces as mentioned at Clause 13.1.1(b) of Part – A of this specification) or one/both (in other cases) impact bend tests give unsatisfactory results, the supplier may opt to request an extra test to be performed.

(i) On the casting as it is.

(ii) On the casting after further heat treatment. This, however, shall be possible only on a casting in the unfinished stage.

(iii) The extra test shall be carried out on the remaining two/one test piece subject to the same conditions as set out above for the first two tests. If one or both extra tests, gives unsatisfactory results, the castings of particular melt heat & heat treatment batch shall definitely be rejected.

13.2 Hardness Test

13.2.1 Sample size

On every crossing, two locations shall be selected at thin & thick section respectively.

13.2.2 Method of execution and acceptance criterion

13.2.2.1 The crossing, when tested for hardness by a portable hardness testing method approved by inspecting official, shall have a Brinell Hardness number not more than 229 or equivalent.

13.2.2.2 The integral test bar used for impact bend test shall also be selected for making sample for hardness test representing particular melt heat. The sample representing the particular melt heat shall be tested for hardness, in accordance with IS 1500 or the latest adopted revision in vogue and it shall have a Brinell Hardness number not more than 229 or equivalent.

13.3 Retest

13.3.1 Should any of the samples tested fail to meet the requirement of Clause 13.1 or 13.2 or both of Part – A of this specification, the manufacturer with the approval of the purchaser or the inspecting officer may reheat-treat the castings together with the test bars and resubmit for test.

13.3.2 Re-testing procedure shall be as prescribed in Clauses 13.1 and 13.2 of Part – A of this specification.

13.4 Grain size and microstructure

13.4.1 Sample size

Micro test piece shall be prepared from the integral test bar used for making samples for impact bend test.

13.4.2 Method of execution and acceptance criterion

13.4.2.1 Grain size of the micro structure of sample shall be 4 or finer as per IS 4748 and it should be single phase austenite, free from Carbide precipitation.

13.4.2.2 The manufacturer will keep an album of micro-photographs showing ideal structure acceptable structures and unacceptable structures either from literature or from his own heat-treated castings. The photographs should be approved by RDSO. Inspecting officials will judge the suitability or acceptability of micro structure with the help of these micro photographs and decision in regard to acceptability shall then be taken.

13.4.2.3 Software for determination of grain size can also be used. However before use validation with existing data should be approved by inspecting authority.

14.0 REJECTION

Any batch of crossings produced from the same melt and/or heat-treated together under the same conditions which fails to comply with the requirements of the specifications, shall be rejected. All rejected crossings shall be painted red on both sides of the web for a distance of 300 mm from each end, in addition to such stamp marks as may be desired by the inspecting official. These rejected crossing shall be cut by gas cutting or by any other means into minimum two pieces preferably near middle of the crossing in order to avoid mixing up with the crossings under processing/finishing/inspection and shall be kept stacked separately till their verification by inspecting official. A certificate to this effect shall be enclosed with the next inspection call. The inspection of CMS crossing based on next inspection call shall be taken up only after verification of cutting of rejected CMS crossing in at least two pieces by inspecting official.

15.0 RECORDS FOR THE PURPOSE OF INSPECTION AND ISSUANCE OF FINAL CERTIFICATE

15.1 Inspection Memo (I to VI) for pouring, Stage-I, Stage-II, Stage-III and Stage-IV inspection shown in Annexure-II shall be got printed by the manufacturer in sufficient numbers. These will be bound in booklet form with all pages duly machine numbered in triplicate. One set of inspection memo (in triplicate copy) shall be used for recording details of only one crossing during its different stages of manufacture/inspection

15.2 A register shall be maintained by the manufacturer giving the details of crossing, i.e. date of casting, batch number, date of inspection at different stages and date of issue of inspection certificate.

15.3 Before the crossings are submitted to the inspecting official for inspection, the manufacturer shall have examined these crossings and all defective crossings shall be disposed of in a manner specified in Clause 14 of Part – A of this specification.

15.4 The manufacturer shall provide to the inspecting official free of charge all tools and labour and gauges/templates required for inspection and also office accommodation with sitting arrangements, light, fan etc. for doing necessary paper work. The manufacturer shall also provide industrial helmet to inspecting official for use during inspection on shop floor.

15.5 No crossing shall be packed until it has been inspected, approved/accepted, stamped by the inspecting official. Crossings shall be dispatched only after issue of Dispatch Memo/Inspection Certificate by the authorized inspecting official.

16.0 STAMPING AND ISSUANCE OF INSPECTION CERTIFICATE

16.1 Crossing thus cleared shall be offered to the inspecting official for necessary stamping with inspecting official's steel stamp insignia. Inspection stamp shall be marked on top surface of the left-hand wing 25mm away from heel end.

16.2 After acceptance of crossing as per Clause 10.4.5.5 and stamping as per Clause 16.1 of Part – A of this specification above, inspection certificate shall be issued by the inspecting official authorized by the competent authority.

17.0 PAINTING

17.1 Stamped crossing shall be thoroughly cleaned to remove rust, scale dirt and oil and received primer coats on each surface to one of the following schedules:

(a) One coat of ready-mixed paint, brushing zinc chrome priming to IS:104 (latest adopted revision in vogue) followed by one coat of

ready mixed paint and drying red oxide-zinc chrome, priming to IS:2074 (latest adopted revision in vogue).

Or

(b) Two coats of ready-mixed paint, air drying red oxide, zinc chrome priming to IS: 2074 (latest adopted revision in vogue).

Or

(c) Two coats of red-oxide, zinc chromate primer to IRS specification no. P-31 (latest adopted revision in vogue).

17.2 The primer coats as indicated in Clause 17.1 (a), (b) and (c) of Part – A of this specification shall be protected by one finishing coat of ready-mixed paint, finishing, general purposes, Synthetic to IS: 13607-1992, smoke grey colour ISC No. 692 to IS:5 (latest adopted revision in vogue).

17.3 The paint shall be applied by brush. The first priming coat shall be applied within four hours after cleaning etc. The second priming coat shall be applied when the first priming coat has dried. The finishing coat shall be applied when the second priming coat has dried. The dry film thickness of the two coats of primer shall not be less than 40 microns and the complete system inclusive of finishing coat not less than 80 microns. Record of painting process shall be maintained.

17.4 The inspecting officials shall check the quality of paints that will be used as per relevant specifications once in two months or after painting of every lot of 200 crossings.

17.5 Quality of painting shall be checked at random once in a month as and when inspecting official is available in shop floor.

18.0 DISPATCH

All crossings, after approval, shall be loaded in a systematic manner to the satisfaction of inspecting official to avoid any damage in transit.

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PART – B

SPECIFICATION FOR WELDEDALE CAST MANGANESE STEEL (WCMS) CROSSINGS

1.0 SCOPE

1.1 This specification is intended to provide necessary guidelines for design, manufacture and use of Weldable Cast Manganese Steel (WCMS) Crossings for Indian Railways System. Weldable CMS Crossing eliminates the use of fishplate joints; therefore, it is a step towards provision of continuous welded rail track. This results in better transition between rail and crossing with gradual variation of inertia, requiring lesser maintenance efforts, resulting into increase in life span. It also provides improved safety and comfort to passengers.

1.2 This section of the specification covers design of Weldable CMS Crossing, welding of CMS crossing with normal 90 UTS/R-260 grade rail using an intermediate piece, physical and chemical testing and special tests required for welded joints. Manufacture of CMS crossing is covered by relevant provisions of this specification. Specification of rail to be welded with CMS crossing shall be covered under IRS:T-12/2009 with its latest amendments. It also defines geometrical tolerances for finished welded joints and their acceptance criteria to ensure quality.

1.3 Wherever current specifications or recommended practices of other standardizing bodies, such as American Society for Testing and Material (ASTM), American Railway Engineering and Maintenance-of-Way Association (AREMA), EN and other relevant codes are appropriate, same is made part of this specification by reference.

2.0 GENERAL REQUREMENTS FOR WELDED PARTS AND WELDING OPERATION

2.1 Weldable CMS crossing consists of 3 parts i.e., the CMS crossing casting, an intermediate piece and connecting rail. The rail is first welded to the intermediate piece which in turn is welded to CMS crossing casting.

2.2 Fatigue test shall be done in RDSO or Structural Engineering Research Centre (SERC), Chennai or any of IITs. Other Tests shall be conducted in manufacturer's premises/Central Government Lab/Any IIT/NABL accredited lab/RDSO. The cost of testing shall be borne by the manufacturer.

2.3 CMS CROSSING

Manufacturing process of Weldable Cast Manganese Steel (WCMS) crossing is covered by Part – A of this specification and for metallurgical composition and other activities related to WCMS specifically shall be governed by Part – B of this specification.

2.4 CONNECTING RAIL

Normal 90 UTS rail of UIC-60 profile/ R-260 grade rail of 60E1 profile shall be used for welding. The rail shall be cut to proper length providing adequate extra length of 15mm since during welding process rail burn off takes place. The cut shall be performed at an angle of 90º ± 0.5º to the longitudinal axis. All cuttings shall be deburred carefully before welding. Specification of this rail will be covered by IRS: T-12/2009 with its latest amendments.

2.5 INTERMEDIATE MATERIAL

Intermediate material profile shall be prepared matching the shape of rail. Intermediate material shall normally be either cast or rolled to the shape of the rail. The cross section of intermediate rail shall be normally kept larger by around 0.5 mm at head and web portion and by around 1.5 mm at rail foot. This size of intermediate piece is kept larger, to take care of grinding after welding. Normally each firm may be having patent for this item.

2.6 After welding, alignment of the crossing should be checked and corrected using suitable straightening machine.

3.0 TESTS ON CMS CROSSING

For all purposes Part – A of this specification will be followed for CMS crossings except for tests/inspections mentioned in Clause 3.1 to 3.4 below for which Clause 3.1 to 3.4 of Part – B of this specification as under will be applicable:

3.1 DIMENSIONAL CHECK

Dimensional check as per drawing shall be carried out. Special care should be taken for dimensional tolerances at the end of crossing which should be same as of normal rail and will be governed by IRS:T-12/2009 with its latest amendments.

Electronic dimensional measurements with auto recording facility duly calibrated by a reputed laboratory shall be used for final dimensional check as specified in Clause 10.4.5.1 of Part – A of this specification.

3.2 CHEMICAL ANALYSIS

Chemical analysis shall be carried out to verify specified chemistry of Weldable Cast Manganese Steel (WCMS) either by spectrometer or any other method specified. Chemical composition of liquid metal shall be within the following limits:

Element	Wt.%
Carbon	0.95 – 1.30
Silicon	0.65 max
Manganese	* 11.5 – 14.0
Phosphorus	0.050 max
Sulphur	0.030 max
Nickel	1.75 max
Molybdenum	0.75 max
Chromium	0.50 max
Copper	0.30 max
Aluminum	0.045 max

* Manganese shall not be less than 10 times the carbon content.

Other alloying elements shall not be deliberately added. The total percentage of unspecified elements shall not exceed 1(one)%. Test procedure will be governed by Clause 4.0 of Part – A of this specification.

3.3 RADIOGRAPHIC EXAMINATION

3.3.1 Radiographic examination of flange portion of CMS crossing will be governed by Clause 6.2.3 of Part – A of this specification.

3.3.2 In addition, ends of 80mm of CMS crossing to be welded with rail shall be tested radiographically in entire cross section at frequency as specified in Clause 6.2.3 of Part – A of this specification. Following method will be used:

Surface Condition

- The surface must be machined or ground.
- No surface defects shall be visible with the unaided eye
- Before radiographic testing, the weld side ends of castings may be subjected to dye penetrant examination

Technique

Radiation source: Co 60 or Ir 192 radiation or 1-2 MV X-rays Film

Agfa Structurix D5 or Agfa Structurix D7

Acceptance Standard

According to ASTM E-446 Maximum:

A1, B1, C1

Schemes of film arrangements are enclosed as Annexure-IX.

3.4 DP TEST

Dye penetration (DP) examination shall be undertaken after machining in accordance with IS 3658 : 1999 or latest version.

The areas to be examined comprise the machined surfaces on top of the crossing as follows:

i) Lengths of 400mm centred on the changes of section

ii) On the Vee, as length of 400mm extending back from the crossingnose(s) plus the adjacent wing rails

iii) A length of 400mm in the throat (knuckle) area, extending from the tip of the nose

iv) Fastening locations

These locations are indicated in diagram enclosed as Annexure-X.

Acceptance criteria

All crossings shall qualify the acceptance criteria laid down in Clause 6.2.1 of Part – A of this specification. In addition, maximum dimension of any linear defect indication shall not exceed 5 mm.

4.0 TESTS ON FINISHED WELDED JOINT

Following tests are required to be done on finished welded joints:

4.1 DP TEST

4.1.1 Extent

100% of the flash butt weld shall be checked.

4.1.2 Surface Condition

Test shall be performed after profile grinding and straightening of crossing. Rust, loose scale shall be removed by grinding. Oil, grease etc. shall be removed with cleaning liquids commonly used for Dye Penetration Test, acetone or equivalent oil-soluble liquids.

4.1.3 Test Procedure

- Surface cleaning
- Penetrating (as specified by the manufacturer)
- Cleaning
- Developing (As specified by the manufacturer)
- Evaluation of indications starts right after drying of developer

4.1.4 The chemicals used for DP test shall conform to IS 3658: 1999 or latest version.

4.1.5 A single indication must be considered to be linear if its length is more than or equal to 3 times its average width. A single indication must be considered to be a surface indication if its largest dimension is less than 3 times its average width. Two indications must be considered to be grouped and only forming a single indication if the distance separating them is less than or equal to the smallest length of both indications.

Acceptance Criteria:

Isolated indications with biggest dimension no greater than 0.5mm must not be taken into account unless they are aligned and or a quantity greater than 3 along a distance of less than or equal to 3mm in this case, they must be considered to be a group of indications.

Following must not be accepted:

- Any linear indication
- Any isolated surface indication or group of indications of >3mm
- The total surface area of the indications must be less than $10mm^2/dm^2$.

4.2 DIMENSIONAL

Dimensional check shall be conducted on 100% finished welds by using a 1m and 10cm steel straight edge and feeler gauge. Following tolerances are permitted:

• Vertical misalignment	+0.30mm - 0mm	at the centre of 1m straight edge
• Lateral misalignment at running edge	~~± 0.25mm~~ +0.25 mm, -0mm	at the centre of 1m straight edge
• Head finishing (in width)	Side of rail should be finished to ± 0.20mm on gauge side at the centre of 10cm straight edge	
• Finished of top table surface	+0.20mm - 0mm	at the centre of 10cm straight edge

(For above (+) indicates hump and (-) indicates cupping)

Welds not meeting these standards, if rectifiable by grinding can be re-ground, failing which they shall be rejected. Results shall be maintained as per proforma given in ~~Annexure-XI~~ Annexure VI.

4.3 ANALYSIS OF WELDING GRAPH

Welding graphs shall be analyzed with respect to set parameters by the shift supervisor and should be available for scrutiny during inspection. Both the welding graphs of each joint shall be checked simultaneously. (Sample graph enclosed as Annexure-XII). Firm should preserve these welding graphs for record for 04 years in digital form and will produce to RDSO representatives / inspecting officials on demand.

4.4 HARDNESS TEST

The purpose of this test is to verify the absence of marked heterogeneity between the hardness of the basic constituents and those of the molten areas or areas thermally affected by the welding operation. In particular, it must make it possible to ensure that no continuous microstructure phase, hard and fragile, has been formed following the welding operation:

The hardness test (in BHN) must be carried out in accordance with the standard IS 1500: 2005 or latest version.

Indentations may be made on the surface (head) at 5 mm interval of welded length of CMS crossing, on condition that they cover a width of at least 20 mm beyond the thermally affected areas, both on the cast manganese steel side and on the rail steel side. The hardness indentations for above will be with ±10mm of longitudinal centre line of the head.

4.4.1 Results to be obtained:

In the warm treated area (Heat Affected Zone) the hardness of rail steel grade R 260 may deviate from the basic hardness by -30/+60 BHN.

Frequency of this test shall be 1 in 100 crossings initially upto 1000 crossing and thereafter 1 in 300 crossings.

4.5 ULTRASONIC TEST

The firm will solely be responsible for defect free welding in Weldable CMS Crossing (WCMSC). In this regard, the firm will ensure Ultrasonic

Testing as per their own Internal Test Protocol (ITP) on 100% of WCMSC. Firm's Internal Test Protocol should be duly certified by their expert technology provider (Collaborator/ JV partner). After USFD/UT/Radiographic testing the firm is required to submit a certificate to Railways with supply stating that:

"The WCMSC No.___ Lot__Cast dated__has been tested by Ultrasonic testing/Radiographic testing and the results are meeting the criteria as per our Internal Test Protocol (ITP) in this regard. This WCMSC is safe and sound for use in IR Track."

Results of Ultrasonic Testing (UT) testing shall not be used for passing / rejection of the WCMSC by the Inspecting Official. Instead, the Firm will maintain and preserve the data of USFD testing of each WCMSC and radiographic testing (wherever required). Such Data of USFD includes printout / softcopies of recorded signal patterns along with horizontal signal movement and vertical peak heights for each WCMSC. Firm will use such data for records and analysis purposes and shall be ready to share such data and analysis to Indian Railway whenever asked for the same.

5.0 Test for weld process approval

Before starting actual welding, weld process approval is required to ensure a constant quality of welding (calibration and maintenance, function tests etc.). This welding process approval shall be done once in a year or 1 in 1200 WCMSC whichever is earlier. For weld process approval, sample test pieces should be welded as under:

Cast Manganese Rail	Intermediate Material (e.g. Inox, etc.)	IRS:T-12/2009, 90 UTS Rail/ R 260 grade rail

Its profile shall be the same as the rail on its total length. It shall be made of 3 elements welded in the same conditions as the CMS crossing and intermediate piece. The length of the sample should be minimum 1200mm (600mm normal rail, 600mm cast manganese rail and intermediate piece of suitable length). Initially before starting of actual welding for manufacturing of weldable CMS crossing, ~~05 weld sample~~ 11 weld samples are to be prepared for testing purpose for weld process approval.

Flash butt welding for preparation of weld samples shall be done in presence of RDSO representatives / inspecting officials. A computerized graph shall be obtained for different parameters for each weld of entire welding process which is recorded by auto weld recorder for Weld Process Approval. A copy of same shall be provided to RDSO for record. The three important parameters current, force and feed travel shall be plotted with respect to time.

For welding process approval, tests mentioned at Clause 5.1 to 5.5 of Part – B of this specification shall be conducted. Out of the ~~05~~ 11 samples, 02 samples shall be used for Macro Examination, Micrographic Examination and Hardness Test. ~~01~~ 05 samples shall be used for Static Bending Test and ~~01~~ 03 samples for Fatigue Test. Remaining 01 sample shall be kept as spare which may be used in case of damage during testing arrangements etc.

Fatigue test shall be required during initial approval. Once the weldable CMS crossing, manufactured after weld process approval, performs satisfactorily in field trial, the same shall not be required again. After that, during quality audit, no fatigue testing/field trial shall be required, even though ~~04~~ 08 samples shall be required for welding process approval. However, in case of change in rail section or grade the Fatigue test shall be invariably conducted.

Weld process shall be approved only if weld samples pass all the 05 tests mentioned in Clause 5.1 to 5.5 of Part – B of this specification. In case of failure of weld samples to meet the acceptance criteria in any of these tests, the entire process of preparing weld samples and testing shall be repeated. Total two chances shall be given to any tenderer for weld process approval failing which Performance Guarantee Bond shall be forfeited and the contract shall be rescinded.

Additional 'Static Bending Test" is to be carried out under supervision of Inspecting Authority during bulk production of WCMS crossings:

Static Bending test on one test weld, prepared in the same manner as done for developmental stage, at the time of starting the bulk production of WCMSC crossings and then after every 100 nos. of WCMS crossings initially upto 1000 nos. of WCMS crossings. After production of 1000 nos. of WCMS crossings, Static Bending test shall be on one test weld after every 300 nos. of WCMS crossings.

5.1 MACRO EXAMINTION

The metallurgical quality of the weld area shall be verified by means of a macro graphic examination. The examination shall be carried out on a sample in accordance with Annexure-XIII.

5.1.1 The surface being examined shall be vertical section cut along the entire height of the profile and in the longitudinal direction on the profile axis of the sample. The length of the preparation must cover at least the length of the weld area. Polishing of the surface to be examined must be done using abrasive paper up to grade 220. Etching shall be carried out using FRY reagent (for 10 litres of compound : 1.875 kg of copper chloride, 5 litres of hydrochloric acid, 4.2 litres of distilled water) of any other reagent suitable to visualize the macro structure.

The duration of etching (30 minutes minimum) shall be set in order to make the whole weld show no excessive etching effect i.e. the thermally affected areas, the connection areas between the various constituents of the welded joint (cast manganese steel – intermediate piece – rail). The inspection of etched surfaces shall be carried out with the naked eye, or possibly complemented using a G x 10 magnifying glass.

5.1.2 Welded defects of the following types shall not be accepted: folded bonding, crack, crescents with crack indications.

Isolated non-cracked crescents of a length of ≤ 3 mm shall not be taken into account.

The following shall be accepted along the length of the connection zone or zones:

- Isolated non-cracked crescents of a length of ≤ 7 mm provided that the distance separating them is > 3mm;

- Isolated non-crescents of a length of > 7mm and ≤ 15 mm provided that their number does not exceed 4 and that the distance separating them is > 7mm.

A photograph must be attached to the examination report.

5.2 MICROGRAPHIC EXAMIANTION

These are intended to complement the macrographic examination by an analysis of the structure of the various metallurgical constituents. They shall be implemented on longitudinal sections removed from the elements having been subjected to macrographic examination.

The samples are removed from the rail head area, in the core and in the rail foot area as shown in the diagram in Annexure-XIV. These three basic removed samples may be complemented by samples removed from single zones that may have been exposed during the macrographic examination in Para 5.1 of Part – B of this specification.

The width of the surfaces to be examined must make it possible to observe the totality of the heat affected zone (in particular on the steel side of the rail) and must not be less than 20mm from both sides of the connection zones.

The preparation of the surfaces to be examined is carried out according to the requirements of the standard.

NF A 05-150 or equivalent polishing is done to the „diamond 3 µm" finish.

Etching of polished sections must be done using the reagent NITAL 4% or equivalent.

The end-post part may be etched using a reagent more appropriate to its microstructure. The structures and their constituents must be clearly exposed after etching. The examination shall be done using a metallographic microscope for enlargement of x50, x100, x200 and possible beyond if necessary, for example in order to better identify a particular metallurgical phase.

5.2.1 Results to be obtained:

The following shall not be accepted:

- Inter-or intra- granular carbide precipitations visible upon enlargement by 50 (manganese steel side)
- Micro cracks resulting directly from the welding operation as well as bonding

- Crescents of a significant size, which are shrunk and/or cracked
- Continuous inter-granular carbide film and acicular shaped carbide Martensitic non tempered structure presence

The following will be acceptable:

- Localized structures on micro-crescents, the presence of carbides, provided that these components are at a stage where they will not cause weakening.

Photographs of various enlargements from 50 to 200 must be attached to the examination report.

5.3 HARDNESS TEST

The purpose of this test is to verify the absence of marked heterogeneity between the hardness of the basic constituents and those of the molten areas or areas thermally affected by the welding operation. In particular, it must make it possible to ensure that no continuous microstructure phase, hard and fragile, has been formed following the welding operation:

The hardness test (in BHN) must be carried out in accordance with the standard IS 1500 : 2005 or latest version.

Indentations may be made on the removed samples having been subjected to the macrographic or micrographic examinations stipulated in Clause 5.1 and 5.2 of Part – B of this specification, on condition that they cover a width of at least 20mm beyond the thermally affected areas, both on the cast manganese steel side and on the rail steel side.

Indentations are executed at 5mm apart following a parallel line and situated 5mm from the rail head running surface and from the non-thermally affected area of the cast manganese steel, passing through all the weld connection.

5.3.1 Results to be obtained:

In the warm treated area the hardness of rail steel grade R 260 may deviate from the basic hardness by -30/+60 BHN. This has to be checked via a “hardness line” (distance of checking 5mm) on the head (2-5mm under the surface) in the vertical longitudinal rail axis.

The hardness line must contain at least 3 measuring points on the non-treated basic material. The mean value of these 3 measuring points is taken as basic hardness.

The hardness on the manganese steel side shall be recorded for information.

The indentation hardness curves must be attached to the test report giving details in abscissa of the connection area.

5.4 STATIC BENDING TEST

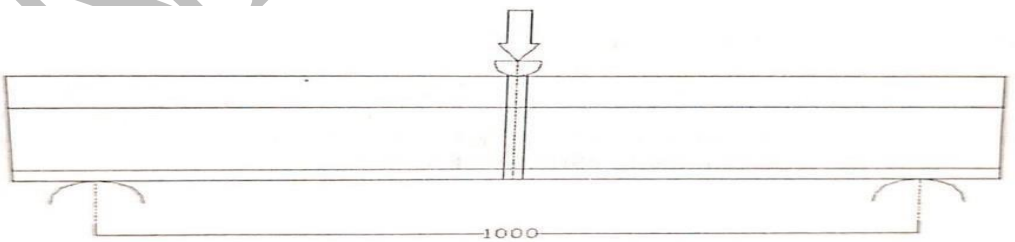
The sample shall be placed on its foot supported on two rigid cylindrical supports (with a radius of between 23 and 80mm) at a distance of one meter, equally apportioned in comparison with the weld axis. The force of pressure must be applied vertically on the running surface in the weld axis using a punch placed between the sample running surface and the head of the test machine.

The punch must rest on the width of the running table along a length of 40mm ±2mm in order not to create a punching force. Its edges shall be rounded by a minimum radius of 40mm.

The load must be applied progressively, without interruption, at a maximum 60kN/second, from the beginning of the test until the sample breaks.

The equipment must make it possible to ensure recording of the load and deflection at the centre until the sample breaks.

- General testing arrangement shall be as given below:-



STATIC BENDING TESTING ARRANGEMENT

Acceptance Criteria:

The sample must show minimum deflection of 18mm at the centre before breaking. The minimum bend test force at breakage must not be less than ~~850 KN~~ 950kN.

The breakage faces must not show weld defects of the bonding, oxidation and fusion craters of volume when examined with the naked eye.

The recording of the load-deflection curve and photographic illustration of the breakage faces must be attached to the test report.

5.5 FATIGUE TEST

This test shall be conducted to check the fatigue strength of the weld joint.

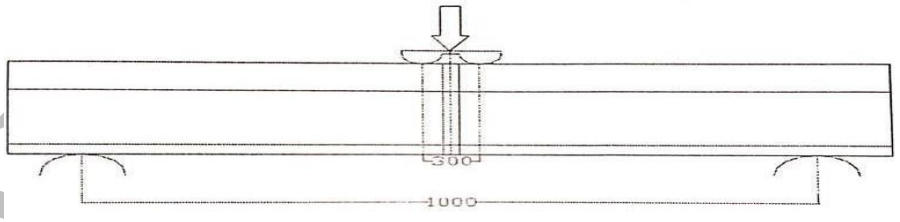
Following test scheme shall be followed for fatigue testing of weld joints:-

(i) ~~One weld sample~~ Three weld samples out of ~~05 weld~~ 11 weld samples already prepared in presence of RDSO representatives/inspecting officials shall be usedfor fatigue test.

(ii) The test sample must correctly bear ~~2 million cycle~~ 5 million cycle of load as shown in the following table. Frequency of load applied shall be 8.33 – 10 hertz.

Profile	Max. Load	Min. Load
UIC 60kg - 880 Grade/60E1 R-260 Grade	300 kN	30 kN

(iii) General testing arrangements shall be as given below:-



FATIGUE TESTING ARRANGEMENT

Acceptance Criteria:

The test sample shall not develop any cracks on the surface which may be shear, flexural or torsional rupture (due to local buckling) in nature. Hairline localised cracks may be permissible provided there is no reduction in the load carrying capacity of sample.

* * * * * * *

ANNEXURE – I

PROFORMA FOR RESULTS OF METALLURGICAL TESTS AND DIMENSIONAL CHECK AND INSPECTION REPORT FOR INTERNAL DEVELOPMENT OF THE CMS CROSSINGS BY M/S

1	Cast-on-serial number on crossing	
2	Type of crossing and section	
3	Drawing number	
4	Date of casting	
5	Heat number	
6	Date of heat treatment	
7	Date of material inspection	
8	Chemical analysis of metal (sample taken at the end of pouring) C% Mn% Si% S%	
9	Solidity test after sectioning at 7 locations as indicated in Clause 6.2.2 of Part – A of this specification From toe, end Location – 1 Face A Face B Location – 2 Face A Face B	Defects if any with %age of cross-sectional area

continued…

	Location – 3	Face A	
		Face B	
	Location – 4	Face A	
		Face B	
	Location – 5	Face A	
		Face B	
	Location – 6	Face A	
		Face B	
	Location – 7	Face A	
		Face B	
10	Results of bend tests conducted on integral test bar		
11	Surface condition (visual) (Defects, if any, shall be shown on a sketch at Annexure-IV).		
12	Result of Radiographic test conducted on flanges as indicated in Clause 6.2.3 of Part – A of this specification		
13	Result of Hardness test (BHN) on top and sectional faces of pieces (7 Nos.) obtained after solidity test.		
14	Result of dimensional check recorded in the format prescribed by the inspecting official.		

Manager (QC) of the Firm

ANNEXURE – II

INSPECTION MEMO FOR CAST MANGANESE STEEL CROSSING

NAME OF FIRM		P.O.NUMBER & DATE		CALL NUMBER & DATE	
DRAWING NUMBER		TYPE		SECTION	
CROSSING SL. NO.		MELT HEAT NUMBER		DATE OF CASTING	

INSPECTION MEMO-I (Prior to Stage-I)	INSPECTION MEMO-II (Stage-I)	INSPECTION MEMO-III (Stage-II)
To Inspect during pouring	To inspect after Knock out, fettling & shot blasting	To inspect after heat treatment for Metallurgical examination
Date of Offer :	Date of Offer :	Date of Offer :
1.Chemical Analysis BT BP EP	Ref. of Integral Test Bar	1. Whether integral test bar detached earlier? Yes / No
C%	Date of detachment	Ref. of Test Bar
Mn%	1.Chemical Analysis C%	Date of detachment
Si%	Mn%	Chemical Analysis, if not done earlier
P%	Si%	C% : Mn% : Si% : P% : S%:
S%	P%	Certified that integral test bar has been detached in the presence of inspecting official & details recorded
2.Temperature ^{0}C at	S%	2. Surface defects, if any (metallurgical)
a)Melting	Certified that integral test bar has been detached in the presence of inspecting official & details recorded	a) No surface defects Or b) Surface defects as shown in figure
b)Tapping		
c)Pouring	2.Surface defects, if any (metallurgical)	Heat treatment batch number & date:
Number of Crossing cast (In order of pouring)	a) No surface defects or b)Surface defects as shown in figure	3. Impact bend test results
Serial No. of Crossing	Certified that chemical composition of the crossing conforms to IRST-29.	Integral test bar number / Test result
	Certified that there is no crack observed at any location of crossing	4. Hardness test (Integral test bar no.:_____)
	Certified that crossing is suitable from metallurgical and chemical point of view and fit to undertake heat treatment	Thick section of Xing
		Thin section of Xing
		Integral test bar
Certified that the material obtained from the above heat conform to IRST-29 in respect of chemical analysis.		5. Microstructure & grain size Int. test bar no. : Grain size: The micro structure is single phase austenitic structure and is acceptable.
		Certified that the crossing is suitable from metallurgical and chemical point of view and crossing is fit for further processing
QC Officer of Firm& Seal		
Witnessed/Verified		
Inspecting Official / QC Officer of Firm & Seal / Inspecting Official / QC Officer of Firm&seal / Inspecting Official		

continued…

CROSSING SL. NO.		CROSSING SL. NO.		CROSSING SL. NO.	
INSPECTION MEMO-IV (Stage-II)		**INSPECTION MEMO-V(Stage-III)**		**INSPECTION MEMO-VI (Stage-IV/Final Stage)**	
To inspect after heat treatment for Dimensional examination		**To inspect after removal/rectification of defects by repair welding & straightening**		**To inspect finally**	
Date of Offer :		**Date of Offer :**		**Date of Offer :**	
Heat treatment batch number & date:		1. Certified that the defects as shown in sketch have been removed by grinding/gouging		1. Certified that no welding was done on the casting	
Overall length:				or	
Distance between actual nose and heel:				2.Certified that the defects mentioned in inspection memo-III for this crossing have been rectified fully by welding in accordance with the welding procedure laid down by RDSO	
Distance between actual nose and toe end:					
Flange way clearance:		2.Dye penetration test conducted in presence of inspecting official showed no crack before welding		3. Dye penetration test conducted in presence of inspecting official at following location and found satisfactory	
Nose thickness:				a)'V' nose for a length of 300 mm both on faces and table	
Throat clearance:	Flange well depth:			b) Vertical Joint between fishing plane & vertical web	
Vertical bend:				c) Area rectified by welding	
Wheel tread at toe end		3. Certified that no welding was done on the casting		4.The crossing has not shown any magnetic behavior when checked with portable magnet/electromagnet	
Nose depression and offsets bottom		Or		5. Radiographic testing has been done on crossing no. _____ , test results of which has been checked and found satisfactory	
Flange Thickness	1.	4.Certified that the defects mentioned in inspection memo-III for this crossing have been rectified fully by welding in accordance with the welding procedure laid down by RDSO		6. Dimension of the finished crossing have been checked and found to be within permissible limits of relevant specification and drawings. Components/fittings to be supplied with the crossing as mentioned in the contract are tested/ checked in lots and found to conform to relevant drawing and specification. The crossing components may now be released for dispatch.	
2.	3.				
4.	5.				
Height	1.				
2.	3.	5.Certified that after removal/rectification of defects, the straightening has been done gradually in hydraulic press and dye penetration test conducted on crossing shows no sign of crack.			
4.	5.				
Bottom Width	1.				
2.	3.				
4.	5.				
Tie Thickness	1.				
2.	3.				
4.	5.				
Certified that crossings is suitable from dimension point of view and fit for further processing		Certified that the crossing is fit for further processing		7. Painting records have been checked	
				Certified that crossing conforms to specification in all respect and hence accepted	
QC Officer of Firm &seal	Inspecting Official	QC Officer of Firm &seal	Inspecting Official	QC Officer of Firm &seal	Inspecting Official

ANNEXURE – II A

INSPECTION MEMO FOR WEDABLE CAST MANGANESE STEEL CROSSING

OFFER MEMO OF WCMS-CROSSING

Name Of Firm:			
DRAWING NUMBER			
CROSSING SL.NO.			
INSPECTION MEMO-I(Prior to stage-I)			
To inspect during pouring			
Date of Offer:			
1. Chemical Analysis			
	BT	BP	EP
C% 0.95-1.3			
Mn% 11.5-14			
Si% (max) 0.65			
P% (max) 0.05			
S% (max) 0.03			
Ni% (max) 1.75			
Mo% (max) 0.75			
Cr% (max) 0.50			
Cu% (max) 0.30			
Al% (max) 0.045			
2. Temperature °C			
a) Melting			
b) Tapping			
c) Pouring			
Number of Crossing cast (in order of pouring)			
Serial No. of Crossing	Type		
Certified that material obtained from the above heat conforms to IRS : T - 29 in respect of chemical analysis			
QC officer of Firm & Seal			
Witness/Verified			
Inspecting Official			

P.O NUMBER & DATE			
Type:			
MELT HEAT NUMBER			
INSPECTION MEMO - II(stage-I)			
To inspect after knock out, fettling & shot blasting			
Date of offer:			
Ref. of integral Test Bar			
Date of detachment			
1. Chemical Analysis			
C%		Ni%	
Mn%		Mo%	
Si%		Cr%	
P%		Cu%	
S%		Al%	
Certified that integral test bar has been detached in the presence of inspecting official & detail recorded			
2. Surface defects, if any (metallurgical)			
a) No surface defects			
OR			
b) Surface defects as shown in figure			
Certified that chemical composition of crossing conforms to IRS:T-29			
Certified that there is no crack observed at any location of crossing			
Certified that crossing is suitable from metallurgical and chemical point of view and fit to undertake heat treatment			
QC officer of Firm & Seal		Inspecing Official	

CALL NUMBER & DATE				
SECTION				
DATE OF CASTING				
INSPECTION MEMO-III(stage-II)				
To inspect after heat treatment for metallurgical examination				
Date of offer:				
1. Whether integral test bar detached earlier ?				
	Yes		No	
Ref. of Test Bar				
Date of detachment				
Chemical analysis, if not done earlier				
C%	Si%	S%	Mo%	Cu%
Mn	P%	Ni%	Cr%	Al%
Certified that integral test bar has been detached in the presence of inspecting official & detail recorded				
2. Surface defects, if any (metallurgical)				
a) No surface defects OR				
b) Surface defects as shown in figure				
Heat Treatment Batch Number & date:				
3. Impact bend test results				
Integral test bar number		Test result		
4. Hardness Test(Itegral Test bar no...........) IN BHN				
Thick section of xing				
Thin section of xing				
Integral test bar				
Micro structure & grain size		Grain Size:		
Integral test bar number:				
The Micro structure is single phase austenitic structure and is acceptable				
Certified that crossing is suitable from metallurgical and chemical point of view and fit for further processing.				
QC Officer of Firm & Seal		Inspecting Official		

continued…

OFFER MEMO OF WCMS-CROSSING

CROSSING SERIAL NO-: TYPE:

INSPECTION MEMO - IV (Stage-II)	INSPECTION MEMO - V (Stage-III)	INSPECTION MEMO - VI (Stage-IV/Final Stage)
To inspect after Heat Treatment for **Dimensional Examination**	To inspect after removal/rectification of defects by **Repair Welding & Straightening**	**To inspect Finally**
Date of offer:	**Date of offer:**	**Date of offer:**
Heat Treatment batch No. & date:	1) Certified that the defect as shown in sketch have been removed by grinding/gauging	1) Certified that no welding was done on the casting
Overall length		OR
Distance between actual nose & heel		
Distance between actual nose and Toe end		2) Certified that defects mentioned in inspection memo-III for this crossing have been rectified fully by welding in accordance with the welding procedure laid down by RDSO
Flange way clearance	2. Dye penetration test conducted in presence of inspecting official and showed no crack before welding	
Nose Thickness		
Throat clearance: Flange well depth:		
Vertical bend:	3. Certified that no welding was done on casting	3. Dye penetration test conducted in presence of inspecting Official at following location and found satisfactory a) "V" Nose for length of 400 mm either side, both faces and table b) Heel and Toe end change in section for a length of 400 mm c) Extent of 100% of the flash butt weld joints d) Fastening Locations e) Area rectified by welding
Wheel tread at toe end:		
Nose Depression and offsets bottom	OR	4) Computerised welding graphs of weld joints verified and found satisfactory
Flange Thickness: 1		
2 3	4. Certified that the defects mentioned in inspection memo-III for this crossing have been rectified fully by welding in accordance with the welding procedure laid down by RDSO	5) Ultrasonic test conducted on flash butt weld joints as per certificate submitted by firm and found satisfactory
4 5		
Height: 1		6) The crossing has not shown any magnetic behaviour when checked with portable magnet/electromagnet.
2 3		
4 5		
Bottom width: 1		7) Radiographic teting has been done on crossing no. Test results of which have been checked and found satisfactory.
2 3		
4 5	5. Certified that after removal/rectification of defects, the straightening has been done gradually in hydraulic press and dye penetration test conducted on crossing shows no sign of crack	8) Dimension of the finished crossing have been checked and found to be within permissible limits of received specification and drawings. Components/Fittings to be suplied with the crossing as mentioned in the contract are tested/checked in lots and are found to conform to relevant drawing and specification. The crossing components may now be released for dispatch.
Tie Thickness: 1		
2 3		
4 5		
All Dimensions are in mm		
Certified that crossing is suitable from dimensional point of view and fit for further processing		9. Painting Records have been checked
	Certified that crossing is fit for further processing	
		Certified that crossing conforms to specification in all respect and hence accepted
QC Officer of the firm & Seal Inspecting Official	QC Officer of the firm & Seal Inspecting Official	QC Officer of the firm & Seal Inspecting Official

ANNEXURE – III

PROCEDURE FOR REPAIR / RECTIFICATION OF CMS CROSSIGNS BY WELDING

1.0	**LIMITATIONS**
1.1	Crossings which are found metallurgically acceptable by the inspecting official, shall only be put up for dimensional inspection. The details of dimensional deviations of the crossings, if any, may be indicated on the sketch as shown in Annexure-IV and put up to the inspecting official.
1.2	Crossing surfaces/areas/locations i.e. running surfaces, non-running surface, highly stressed locations, nose, wings on either side of nose shall be broadly classified in the following categories (as shown in Annexure-VIII) depending upon their criticality from the service considerations, for the purpose of repair by welding: **Category-I:** 300mm of the top of nose, 300mm of the wings on either side of actual nose of crossing and edges of both top and bottom flanges (upto 25mm from edge). **Category-II:** Running surface other than the area mentioned in Category-I. **Category-III:** Non-running surface other than the area mentioned in Category-IV and top surface of "Vee" not coming in contact with running wheels of rolling stock. **Category-IV:** Non-vulnerable areas like bearing plates, walls of end sections (excluding head portion).
1.2.1	At locations covered in Category-I, no casting defects shall be permitted.
1.2.2	At locations covered in Category-II, no rectification shall be allowed on the running surface. Scattered minor defects (excluding cracks) of size less than 4mm dia and upto 1.5mm depth anywhere on this area of the casting shall be left as such, provided these defects are at a minimum distance of 15mm from each other and not more than 3 numbers in a particular location.

continued…

1.2.3	At locations covered in Category-III, defects appearing in the crossing surface shall be permitted to be rectified by welding adopting the usual procedure and precautions at the discretion of the inspecting official.
1.2.4	At locations covered in Category-IV, surface defects of size <30mm in diameter and depth <1/3 of thickness may be permitted to be rectified by welding taking necessary precautions and with the knowledge of the inspecting official and to be recorded in the final inspection certificate.
2.0	**PROCEDURE FOR WELDING**
2.1	Before carrying out weld-reclamation, the defective areas shall be removed by grinding/gauging. The locations shall be tested by dye-penetrant to ensure complete freedom from the cracks. These operations, grinding/gauging and testing shall be repeated till the area is free from the defects and cracks.
2.2	Only those crossings which are considered suitable for rectification by welding shall be rectified by using any of these brands of electrodes approved by RDSO under Class H3B. These crossings can also be reconditioned/ rectified by using H3C hard facing electrodes. Maximum upto 4mm dia electrodes shall only be used to avoid high heat input.
2.3	The electrodes shall be dried at the specified temperature and time as per the recommendations of the electrode manufacturer. The electrodes having cracked and damaged flux covering shall be discarded.
2.4	Welding shall be carried out using DC welding generator with reversed polarity using the lower limit of the current range or as recommended by the electrode manufacturer and shortest possible arc length practicable during welding, so as to reduce the heat input in the base metal, thereby reducing the dilution of the weld metal which would otherwise cause embrittlement of the weld.
2.5	Welding shall be intermittent so that at no time more than one run is deposited simultaneously and welding is not done continuously for more than 2 minutes at a stretch.
2.6	For ensuring quick cooling of the weld deposit and the heat affected zone, compressed air shall be used just after welding or the crossing shall be kept submerged in a water bath during welding.

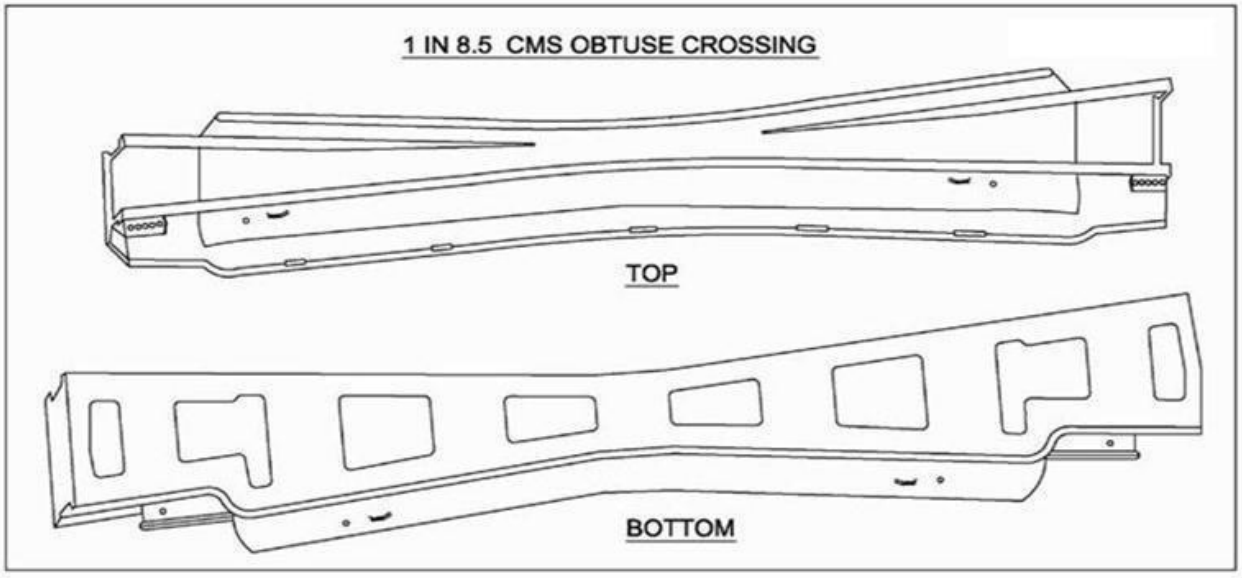
continued…

2.7	Peening of the weld deposit shall be carried out just after welding so as to minimize residual stresses. To minimize the heat buildup more than one crossing shall be welded at a time by rotation welding being restricted to one or two widely separated areas on each casting at a time. If necessary, welding at one area may also be done intermittently by a rotation to ensure and intervals of at least 25 minutes between two weld deposits in the same location/area.
3.0	**WELDERS:**
3.1	Only highly skilled welders, qualified as per IS:7318/3991 (MTI) II size A5 P28 Corr. 71 or as per the latest revision in vogue, from some reputed testing Authority shall be engaged to undertake the work of weld rectification Welding shall be carried out under the supervision of the Metallurgical/Quality Control Officer of the firm.
4.0	**INSPECTION**
4.1	The details of welding rectification carried out on the crossing shall be recorded in a sketch shown in Annexure-IV and put up to the inspecting official.
4.2	Rectified crossings after cooling and grinding shall be subjected to by dye-penetrant for ensuring that no surface defects remain after repair welding.
4.3	The Metallurgist/Quality Control Officer of the firm shall issue a test certificate to the Inspecting Officials stating that the welding has been carried out strictly in accordance with the provisions laid down in this procedure.

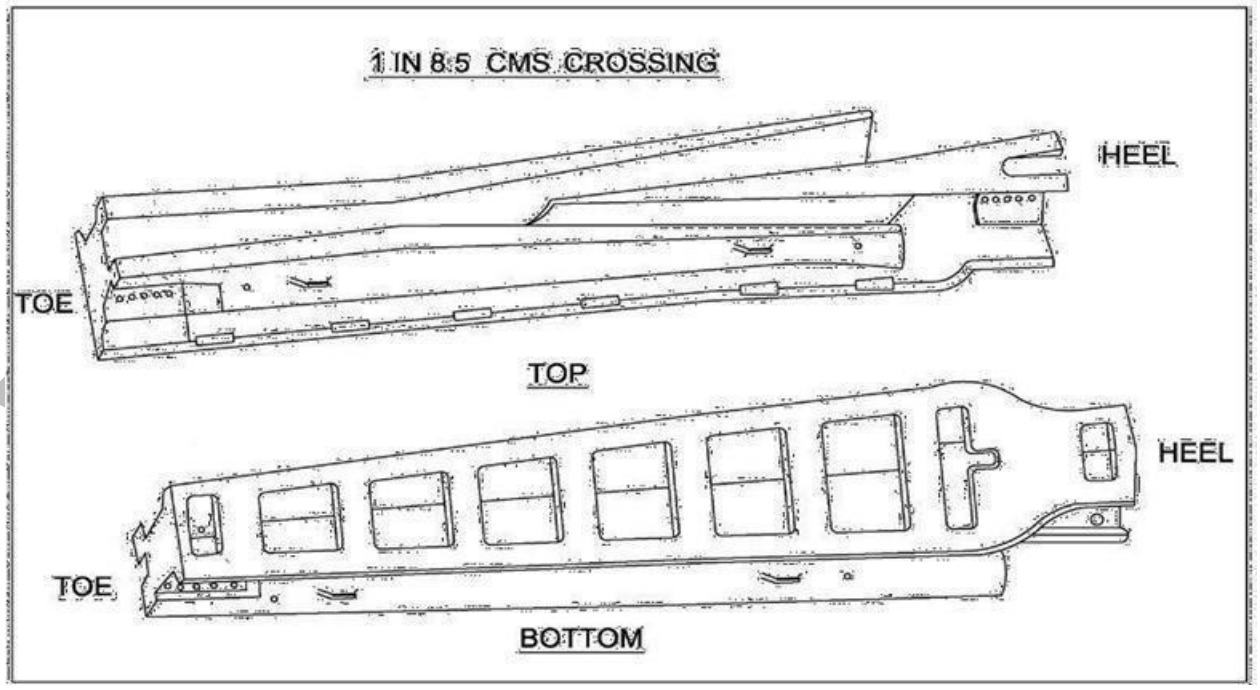
ANNEXURE – IV

SKETCH FOR SHOWING METALLURGICAL DEFECTS OF CMS CROSSINGS

Serial No. of Crossing: **Section:**



Serial No. of Crossing: **Section:**



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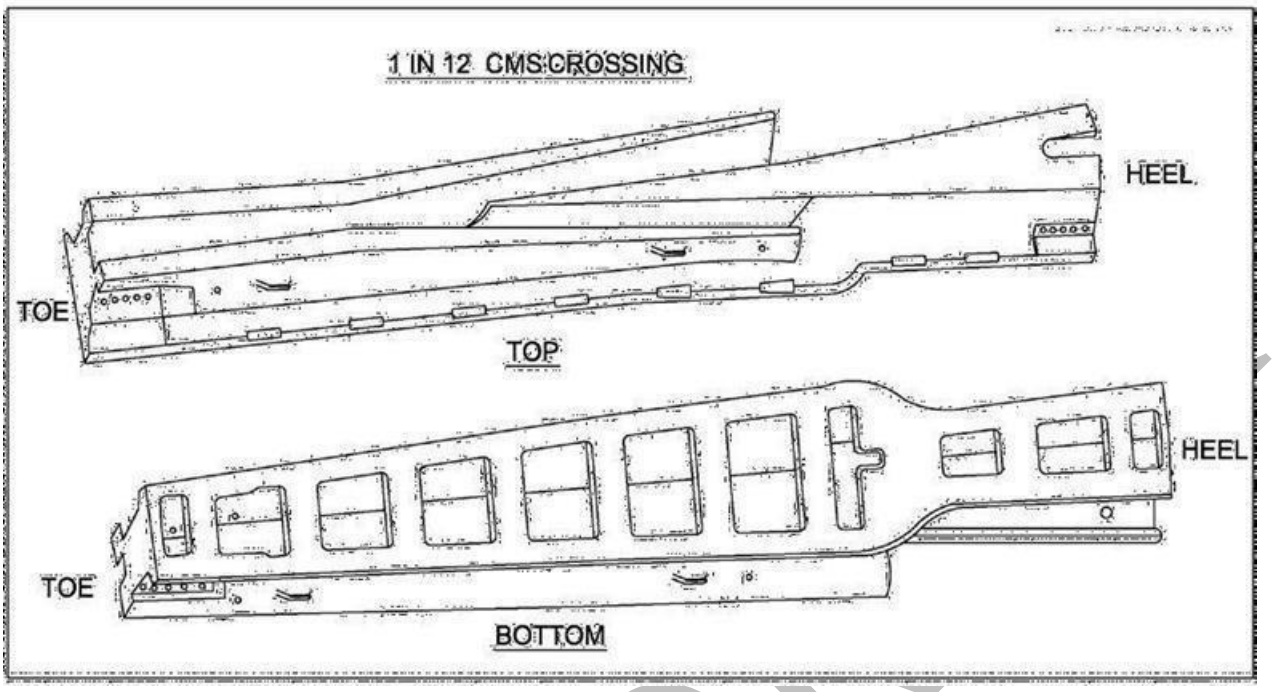
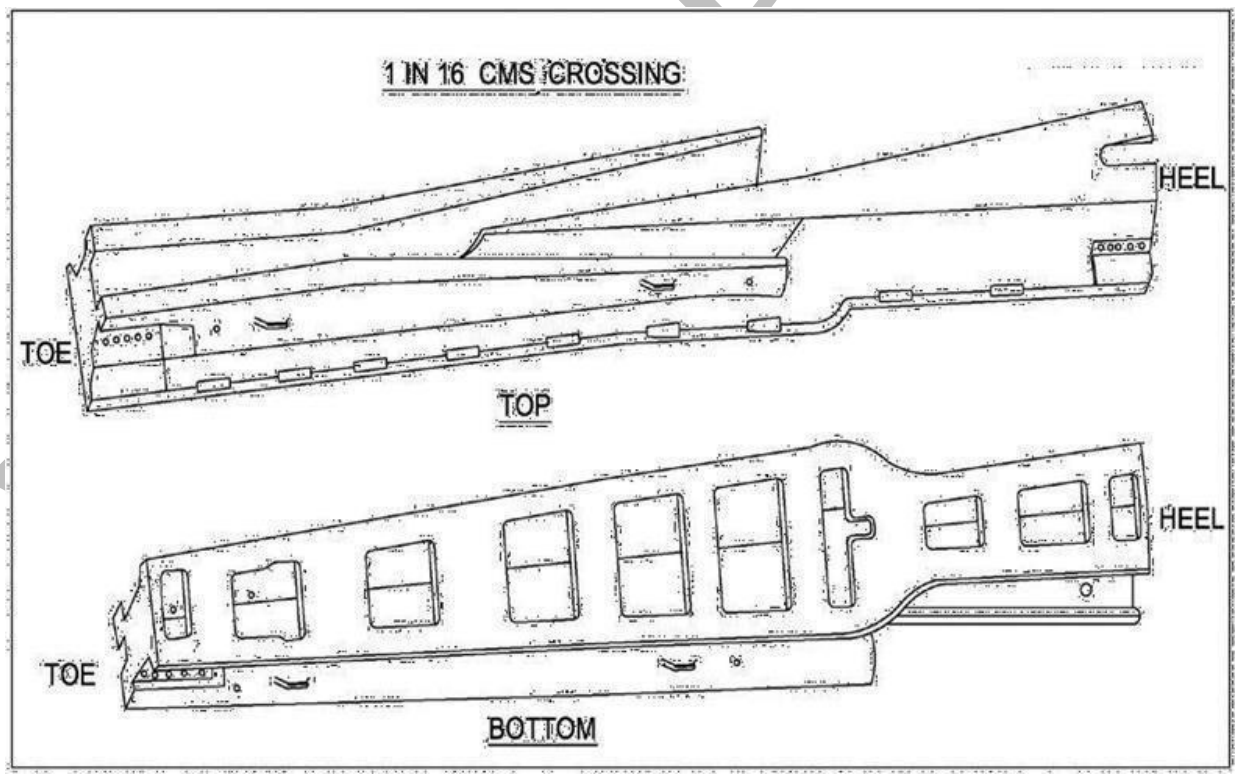
Serial No. of Crossing: **Section:**



Serial No. of Crossing: **Section:**



ANNEXURE – V

PROFORMA FOR SHOWING METALLURGICAL DEFECTS OF CMS CROSSINGS

Crossing number: **Design:**

Drawing No.: **Date of Casting:**

Date of Examination:

Reference Number of Annexure-IV	Location	Type of defect (cracks, sand holes, cold shuts, pin holes porosity, extra metal, sand fusion, others)	Remarks

Inspecting Official (Signature & Seal) **Manager (QC) of the firm**

ANNEXURE – VI

PROFORMA FOR DIMENSIONAL INSPECTION OF CAST MANGANESE STEEL CROSSING

1	Cast on serial number	
2	Type and section with drawing number	
3	Date of inspection	
4	Heat number	
5	Items to be inspected **5.1 Position of Crossing (Running surfaceup)** 5.1.1 End fitments (both toe and heel end) 5.1.2 Alignment at the fish-plated joint matching etc. 5.1.3 Length 5.1.4 Wheel tread 5.1.5 Top edge contour 5.1.6 Offset (both toe end and heel end) 5.1.7 Flange well depth (including surface condition of flange well) 5.1.8 Flange way clearance 5.1.9 Overall alignment (including local misalignment) 5.1.10 Throat clearance Top surface level 5.1.11 Top surface level 5.1.12 Concavity/convexity/twist. If any 5.1.13 Wing rails 5.1.14 Nose thickness 5.1.15 Nose depression 5.1.16 Height at different locations 5.1.17 Fish bolt holes 5.1.18 Fishing plane 5.1.19 Bond holes	

continued…

	5.2 Position of crossing (Bottom up) 5.2.1 Bottom surface 5.2.2 Web thickness 5.2.3 Tie (thickness, width etc.) 5.2.4 Bottom width 5.2.5 Flange thickness (including thickness at recesses) 5.2.6 Roof thickness (i.e. below flange well, Vee portion etc.) 5.2.7 Condition of end section – faces (both heel and toe end) **5.3 Other items, if any**	

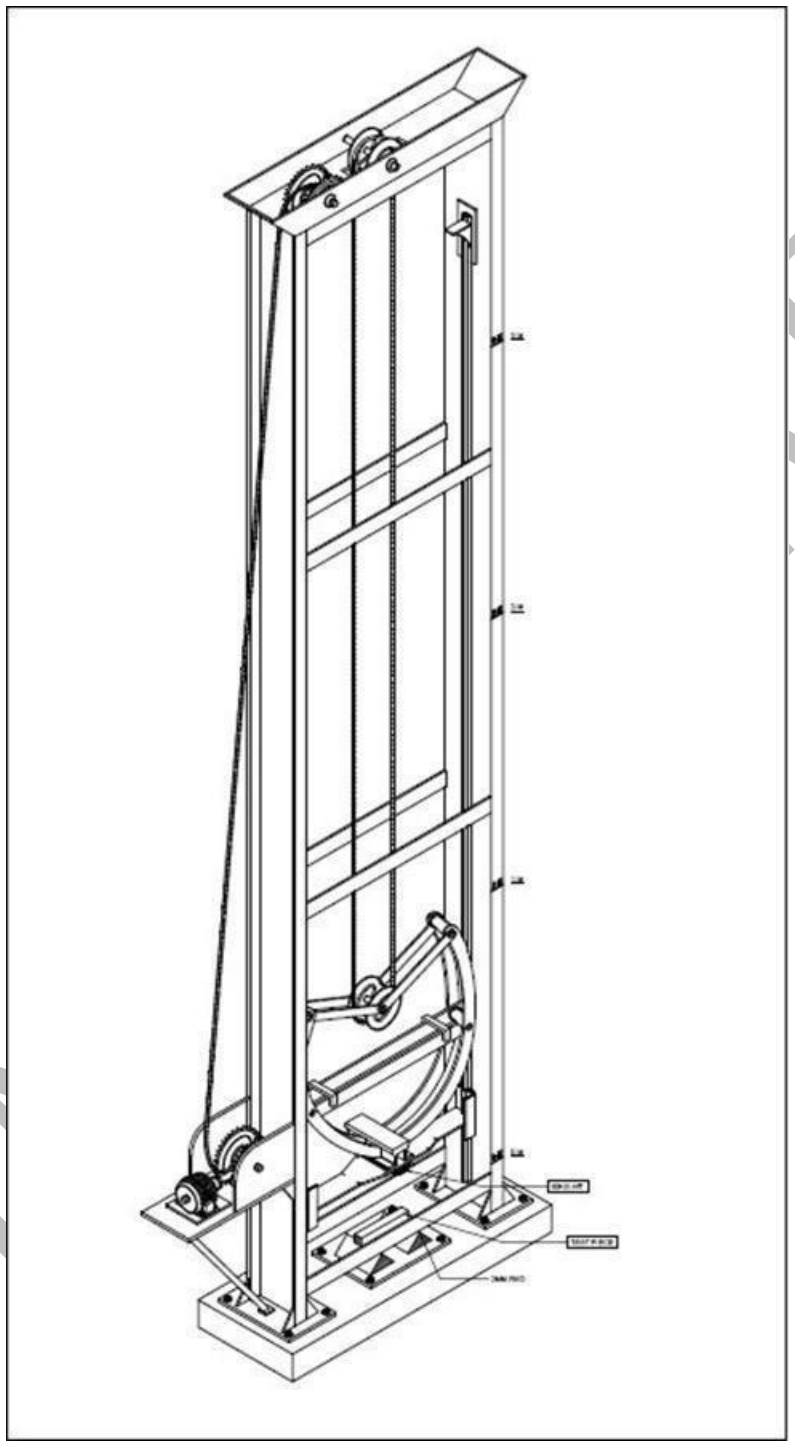
Manager (QC) of the Firm **Inspecting official**

Note: 1. Defect, if any, be marked on a sketch at Annexure-IV.

2. Marking of certain locations with chalk to be done on the crossing as desired by inspecting official to expedite inspection with the help of gauges/templates.

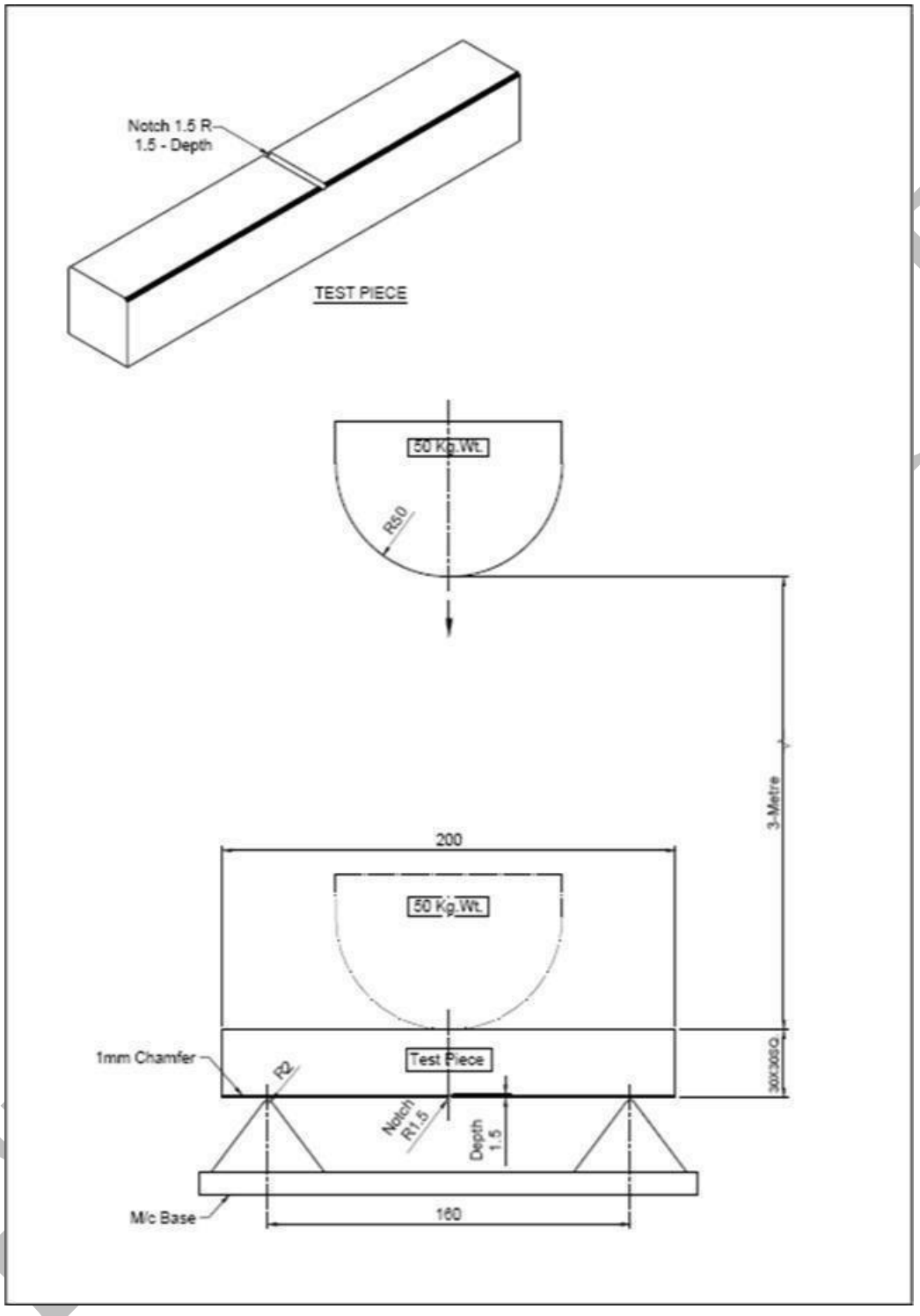
ANNEXURE – VII

SCHEMATIC DIAGRAM FOR IMPACT BEND TEST



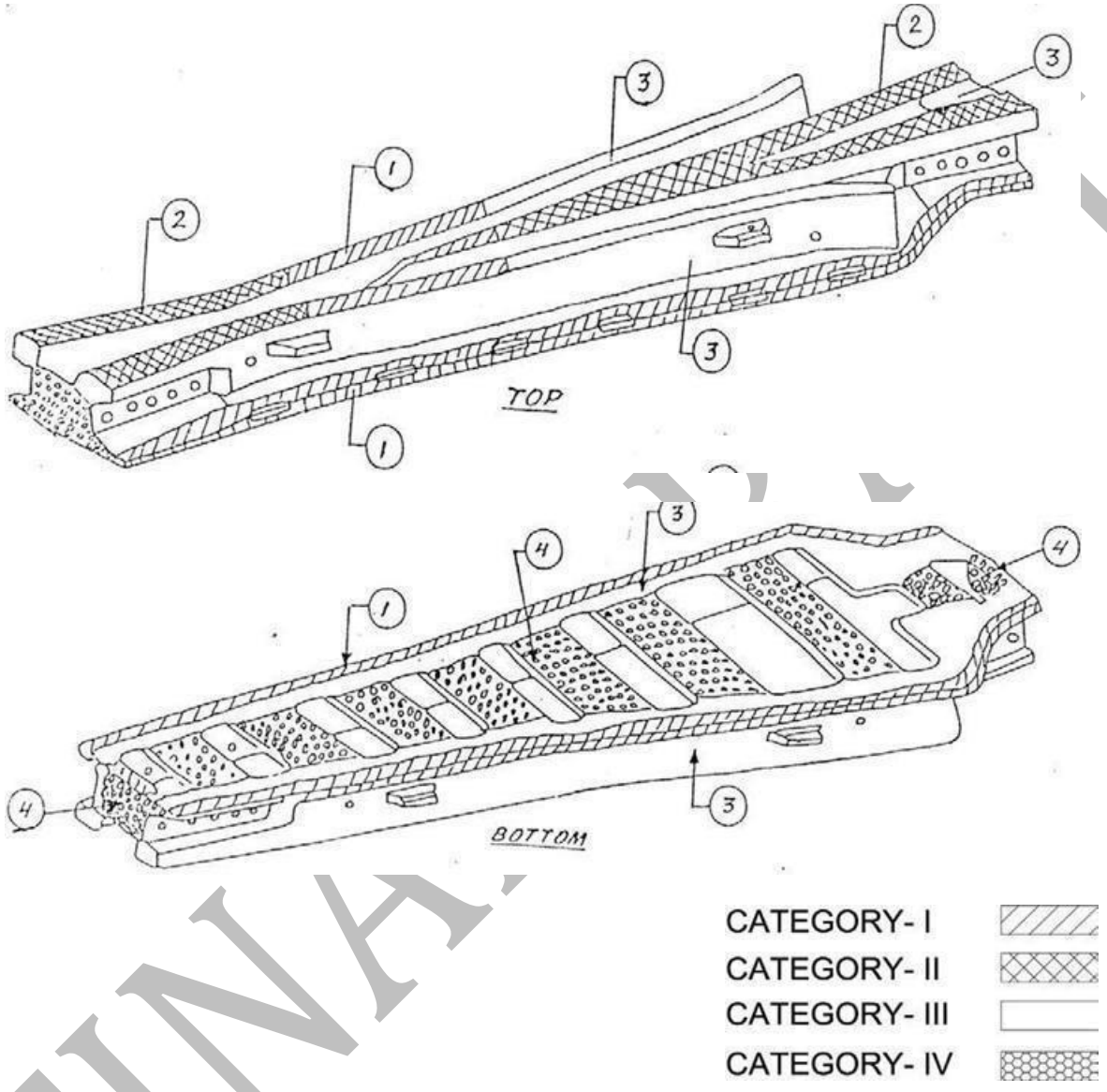
continued…

ARRANGEMENT FOR IMPACT BEND TEST



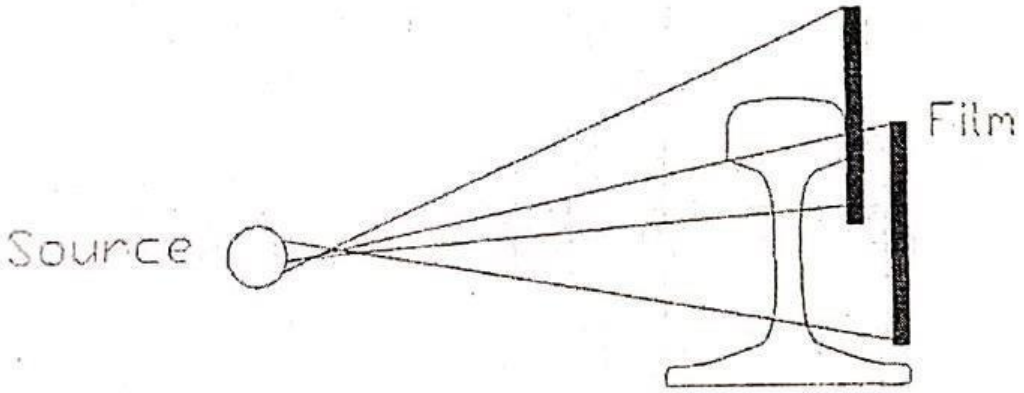
ANNEXURE – VIII

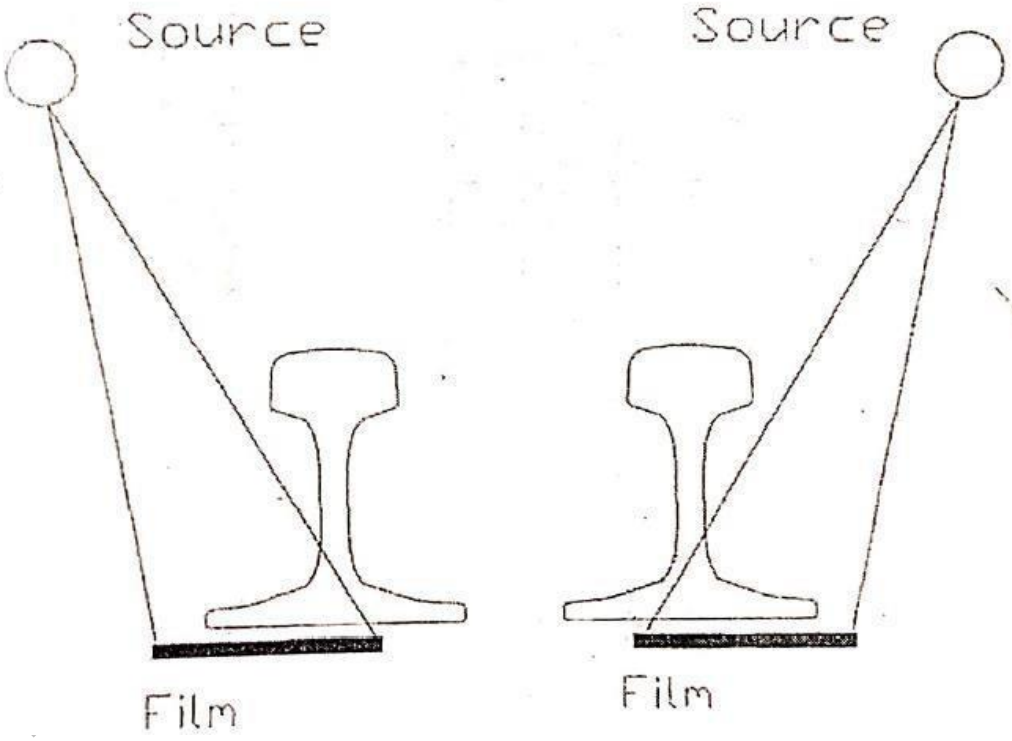
SKETCH SHOWING DIFFERENT CATEGORIES OF LOCATION TO BE CONSIDERED FOR REPAIR BY WELDING



ANNEXURE – IX

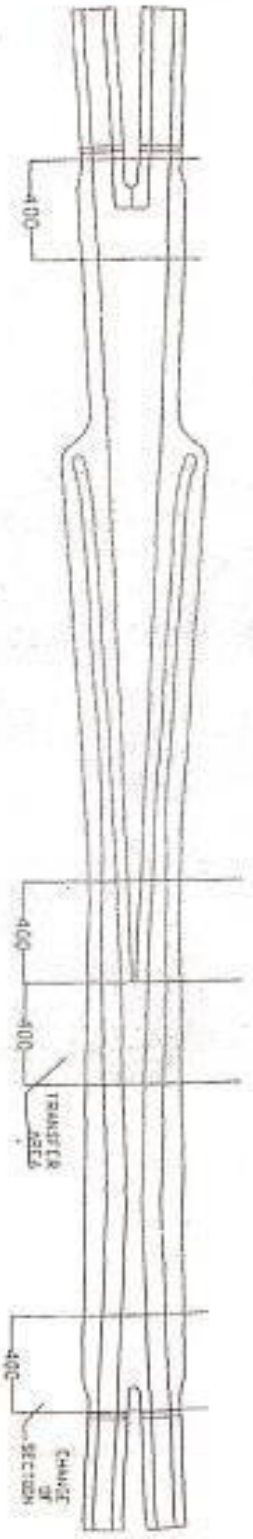
SCHEMES FOR FILM ARRANGEMENT





ANNEXURE – X

DYE PENETRATION TEST LOCATIONS FOR CROSSING



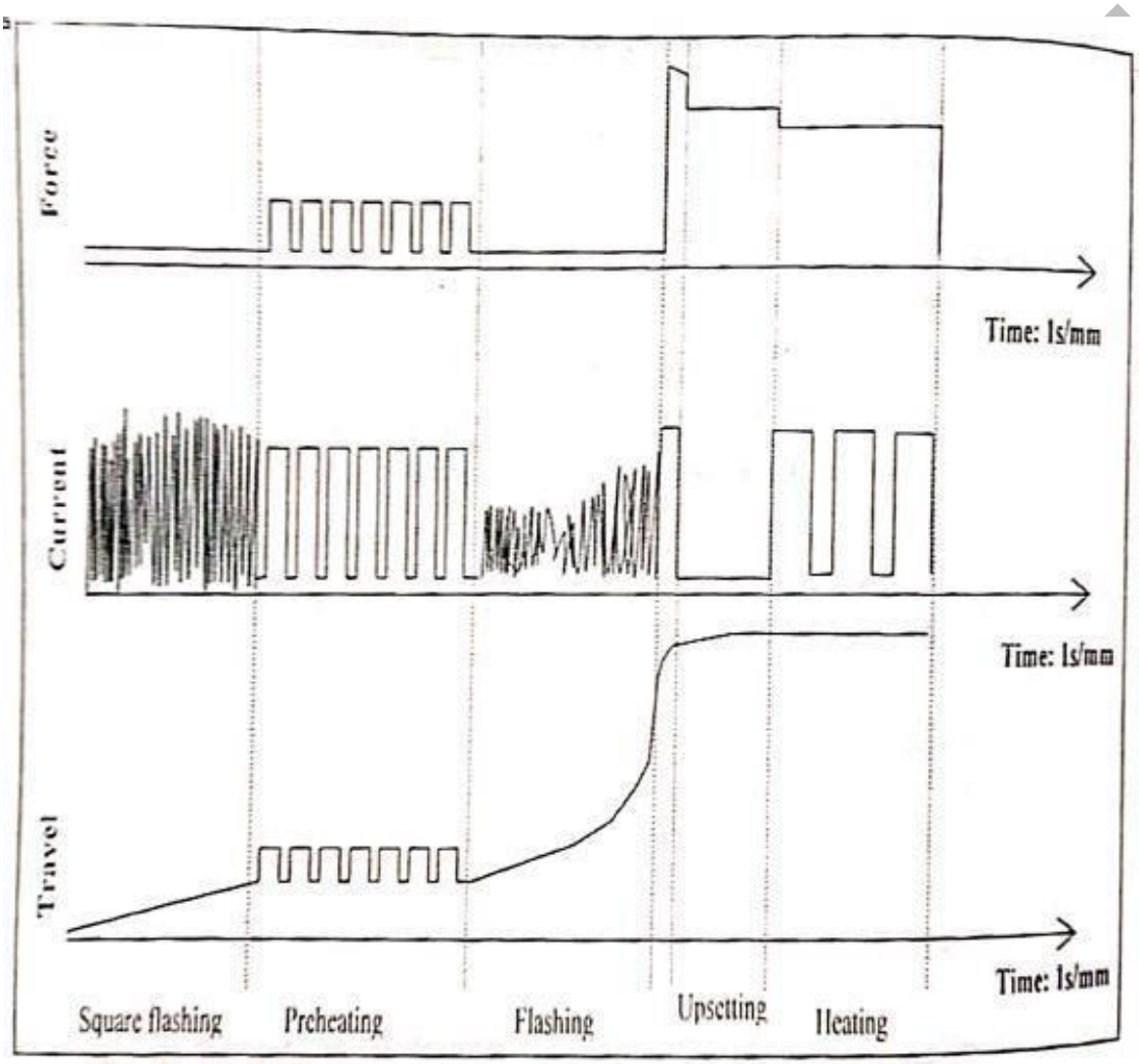
ANNEXURE - XI

FORMAT FOR DIMENSION RECORD FOR WELDING JOINT

Firm‟s Name							
Contract./P.O no. & date							
WCMS Crossing No.							
Date of Inspection							
	1 meter straight edge			10 cm straight edge			Remarks
	Rail head top table	Rail head side LH	Rail head side RH	Rail head top table	Rail head side LH	Rail head side RH	
Welding Joint 1							
Welding Joint 2							
Welding Joint 3							
Welding Joint 4							
Signature of the Inspector					Signature of the firm‟s Rep.		

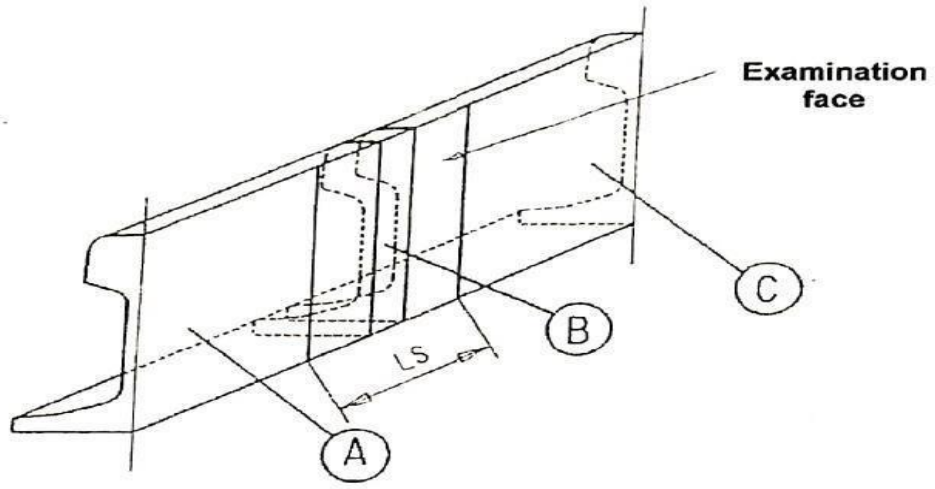
ANNEXURE – XII

SAMPLE WELDING GRAPH



ANNEXURE – XIII

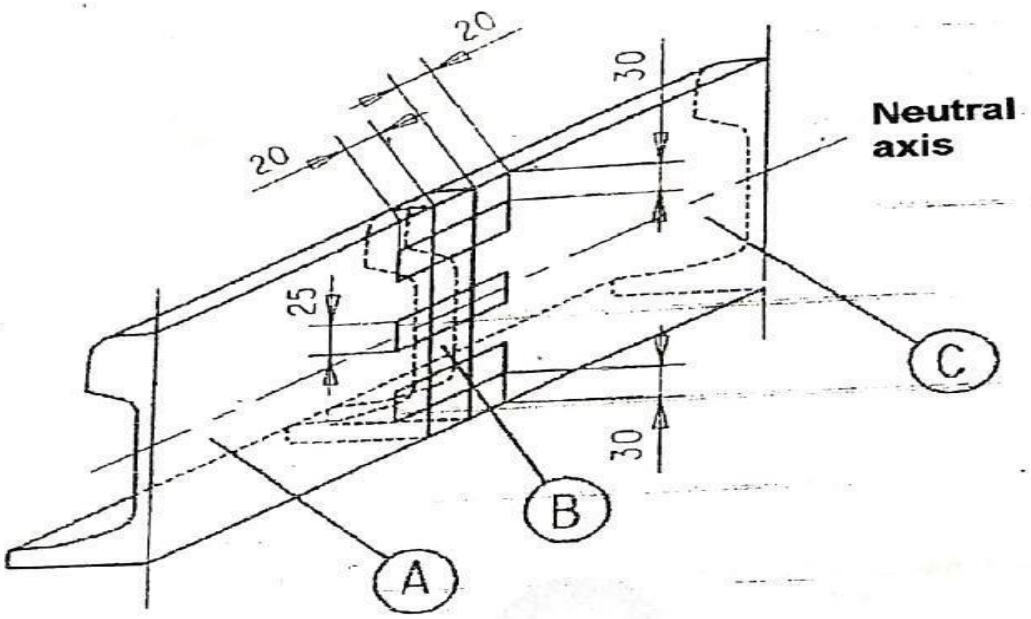
SECTION SKETCH FOR MACROGRAPHIC TEST



A - Cast manganese steel
B - Weld area (with insert)
C - Rail
LS - Examined length > insert length + HAZ rail side and cast steel side

ANNEXURE – XIV

SECTION SKETCH FOR MICROGRAPHIC TEST



A - Cast manganese steel
B - Weld area (with insert)
C - Rail