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</tr>
</tbody>
</table>

The present version has been adopted in 2009 specifying the requirements of the Prime rail and IU rails having ultimate tensile strength (UTS) of 880 MPa, 1080 MPa CR and 1080 MPa HH. This specification also specify the requirements of special class of rail steel such as Niobium (NB), Vanadium (VN), corrosion resistant rail steel Copper Molybdenum (CM), Nickel Chromium Copper (NC)

1. SCOPE

This specification applies to Flat bottom Railway Rails. It specifies quality of the steel, manufacturing process, chemical composition, acceptance tests/ retests, qualifying criteria and other technical conditions of supply.

2. RAIL SECTION

The Section of the flat bottom rails shall be in accordance with the section profiles shown in Appendix-I, II, IIA, III, unless otherwise specified by the purchaser.

3. TEMPLATES AND GAUGES

The manufacturer shall submit, at his own expenses, two sets of templates (internal and external) made of stainless steel for each section of rail ordered or contracted for as per approved drawings. Two sets of plus and minus limit gauges made of stainless steel, in accordance with the stipulated maximum and minimum tolerances, shall also be submitted for approval of the Purchaser or his Authorised Inspecting Agency. The approval of purchaser or his authorised inspecting agency shall be obtained before the rolling of rails is commenced. The templates and gauges shall be stamped by the Purchaser/Authorised Inspecting Agency as a token of approval.

One set of templates of plus and minus limit gauges (called hereinafter master gauges) shall remain in possession of the Purchaser/Authorised Inspecting Agency during the period of acceptance. Only gauge bearing the stamp of the Purchaser/Authorised Inspecting Agency shall be valid for checking purpose.

Each template/gauge shall be suitably engraved with the manufacturer’s name and the number of the rail section together with such other marks as the Inspecting Agency or the purchaser may direct.

4. DEFINITIONS

4.1 Sequence-continuous casting

This term is used when a sequence of casts of the same grade of steel is poured through a continuous casting machine without interruption in flow of liquid steel into the moulds and strands. The pouring of the next cast from ladle into the tundish begins before the steel from the previous cast is completely poured off from tundish to the mould, leading to an inter-mixing of some liquid steel from the two successive casts.
4.2 Main cast
Blooms that are known to be entirely composed of steel from the same liquid steel melt.

4.3 Changeover, Overlap or Intermediate Bloom
Blooms that may contain steel from more than one cast i.e. material arising during the Changeover from one cast to the next in the sequence. Number of change over bloom will be mutually decided by manufacturer/Purchaser depending upon casting practice adopted by the manufacturer.

4.4 Classification of rails
52 kg/m , 60 kg/m, 68 kg/m & ZU-1-60 rails shall be classified as class ‘A’ and class ‘B’ based on tolerance in end straightness as specified in Clause 9.4.2.

5 MANUFACTURE

5.1 The steel used for the manufacture of rails shall be made by basic oxygen or electric arc furnace process and continuously cast. Any other method of casting shall have prior approval of the Purchaser. For molten steel secondary ladle refining is mandatory. The manufacturer in his offer shall furnish details of the steel making process including refining, vacuum degassing.

5.2 The cross sectional area of the bloom shall not be less than ten times that of the rail section to be produced.

5.3 The manufacturer shall apply the best accepted code of practice throughout manufacturing process to ensure that the rails meet the stipulations of this specification. The manufacturer shall, on request, inform the purchaser of the measures adopted for ensuring the above.

5.4 For head hardening, rails should be suitably heat treated to meet the requirements of this specification. The method of heat treatment adopted by the manufacturer should be made available to the purchaser and prior approval of the purchaser shall be taken before execution of the order.

6 INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser shall provide the following information to the supplier when inviting tender for supply of rails according to this specification:

i) Rail steel grade (Table 1)
ii) Rail Section profile (Appendix I to III)
iii) Class of rail
iv) Length of rail.
v) Undrilled or drilled rails ends.
vii) Colour code requirements (Appendix IV)
7 GRADE, CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

The steel for rails shall be of fully killed quality and shall conform to chemical composition and mechanical properties given in Table 1. These limits for chemical composition are applicable both for tests on ladle samples and for check analysis of finished rails. The ladle and check analysis of the steel, when carried out by the method specified in the relevant part of IS: 228 or any other established instrumental/chemical method, shall be as specified in table-1. In case of any dispute, the procedure given in the relevant part of IS: 228 shall be referred to Table 1.

8 MARKING

8.1 Brand Marks

Brand marks shall be rolled in relief on one side of the web of each rail at least every 3.0 meters. The brand marks on the rails shall be clearly legible and shall be rolled in letters in relief at least 20mm in height and minimum 1.0 mm above surface of the web of the rail.

The brand mark shall include:

a) The rail section.

b) The grade of steel, i.e.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 880</td>
<td>880</td>
</tr>
<tr>
<td>Grade 1080 HH</td>
<td>1080 HH</td>
</tr>
<tr>
<td>Grade 1080 Cr</td>
<td>1080 CR</td>
</tr>
<tr>
<td>Grade 880 Cu-MO</td>
<td>880 CM</td>
</tr>
<tr>
<td>Grade 880 Ni Cr Cu</td>
<td>880 NC</td>
</tr>
<tr>
<td>Grade 880 Vanadium</td>
<td>880 VN</td>
</tr>
<tr>
<td>Grade 880 Niobium</td>
<td>880 NB</td>
</tr>
</tbody>
</table>

c) Identification mark of the manufacturer

d) Month (using roman numbers) and last two digits of year of manufacture.

e) Process of steel making:

i) Basic oxygen - O

ii) Electric - E
<table>
<thead>
<tr>
<th>Grade</th>
<th>C</th>
<th>Mn</th>
<th>Si</th>
<th>S (max)</th>
<th>P (max)</th>
<th>Al (max)</th>
<th>Mo (max)</th>
<th>Cr</th>
<th>V (max)</th>
<th>Hydrogen content in liquid steel (max)</th>
<th>UTS (MPa) (Min)</th>
<th>Yield Strength ** (MPa) (Min)</th>
<th>Elongation % on gauge length – 5.65So (min)</th>
<th>Running surface hardness (BHN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>880</td>
<td>0.60-0.80</td>
<td>0.80-1.30</td>
<td>0.10-0.50</td>
<td>0.030*</td>
<td>0.030*</td>
<td>0.015</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.6 ppm</td>
<td>880</td>
<td>460</td>
<td>10.0 Min 260**</td>
<td></td>
</tr>
<tr>
<td>1080 Cr</td>
<td>0.60-0.80</td>
<td>0.80-1.20</td>
<td>0.50-1.10</td>
<td>0.025</td>
<td>0.025</td>
<td>0.004</td>
<td>0.20</td>
<td>0.20</td>
<td>20</td>
<td>1.6 ppm</td>
<td>1080</td>
<td>560</td>
<td>9.0 320-360</td>
<td></td>
</tr>
<tr>
<td>1080 HH</td>
<td>0.60-0.80</td>
<td>0.80-1.30</td>
<td>0.10-0.50</td>
<td>0.030*</td>
<td>0.030*</td>
<td>0.015</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.6 ppm</td>
<td>1080</td>
<td>460</td>
<td>10.0 340-390</td>
<td></td>
</tr>
</tbody>
</table>

So = Cross sectional area of tensile test piece in mm²

* 0.035 maximum for finished rail

The chemical compositions specified as above are applicable to Ladle analysis and Product Analysis. Manufacture shall ensure that chemical composition at ladle analysis should be such that product analysis also satisfies the requirement of chemical composition as above.

** Desirable Value.

*** Frequency to be mutually agreed by purchaser and manufacturer.
# SPECIAL RAIL STEEL

## TABLE 1 – Contd...

<table>
<thead>
<tr>
<th>Grade</th>
<th>Chemical Composition (percentage)</th>
<th>Mechanical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>Mn</td>
</tr>
<tr>
<td>NIOBIUM (NB)</td>
<td>0.60-0.80</td>
<td>0.80-1.30</td>
</tr>
<tr>
<td>VANADIUM (VN)</td>
<td>0.60-0.80</td>
<td>0.80-1.30</td>
</tr>
</tbody>
</table>

# CORROSION RESISTANT RAIL STEEL

<table>
<thead>
<tr>
<th>Grade</th>
<th>Chemical Composition (percentage)</th>
<th>Mechanical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>Mn</td>
</tr>
<tr>
<td>Copper- Molybdenum (CM)</td>
<td>0.60-0.80</td>
<td>0.80-1.30</td>
</tr>
<tr>
<td>Nickel Chromium Copper (NC)</td>
<td>0.60-0.80</td>
<td>0.80-1.30</td>
</tr>
</tbody>
</table>

So = Cross sectional area of tensile test piece in mm²

* 0.035 maximum for finished rail

The chemical compositions specified as above are applicable to Ladle analysis and Product Analysis. Manufacture shall ensure that chemical composition at ladle analysis should be such that product analysis also satisfies the requirement of chemical composition as above.

** Desirable Value.
8.2 Hot Stamping

Each rail shall be identified by a numerical, alphabetical or combined alphabetical and numerical code which will be distinctly hot stamped at least once every 4.0m on the web in figures and letters at least 15mm high from which following information can be obtained:

i) The number of the cast from which the rails has been rolled with letter ‘C’
ii) Number of the strand.
iii) For rails from change over bloom, cast number should be the preceding cast number with prefix letter ‘B’.

8.3 Cold Punching

8.3.1 Following should be cold punched on one of end face of each rail
a) Inspecting Agency Id and Group ID
b) Shift No in which product inspected
c) Date of Inspection

8.3.2 For IU rails
In addition to marking mentioned in this Specification, the letter “IU” (Industrial Use grade) as the case may be in 15 mm size shall be stamped on both end faces of rails.

8.4 Colour code

Rails shall be painted as per colour code given in Appendix-IV to distinguish grade, class, length and other special requirements. Paint of good quality should be used with the prior approval of the Inspecting Agency.

9 SECTIONS AND DIMENSIONS

Each section of rails shall be accurately rolled to its respective template within the tolerances specified in this clause.

9.1 Permissible Variations in Dimensions

The tolerances in sectional dimensions shown here under shall be allowed, provided,

For Prime quality rail the actual weight computed by weighing short pieces of rails, not less than 300mm each in length, shall fall within 0.5 percent below and 1.5 percent above the calculated weight shown in Appendix I, II and III for each rail section.

For IU Rail the actual weight computed by weighing short pieces of rails not less than 300 mm each in length is not less than the calculated weight shown in Appendix I,II, II-A & III of this specification for each section of rail by more than 1.5%.
9.1.1  Tolerances in sectional dimensions (For Prime Quality rails)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Height</td>
<td>+0.8 mm</td>
<td></td>
</tr>
<tr>
<td>of Rails</td>
<td>-0.4 mm</td>
<td></td>
</tr>
<tr>
<td>Width of Head</td>
<td>± 0.5mm</td>
<td>This will be measured 14mm below the rails top</td>
</tr>
<tr>
<td>Width of flange</td>
<td>± 1.0mm</td>
<td>For section less than 60Kg/m</td>
</tr>
<tr>
<td></td>
<td>+1.2 mm</td>
<td>For sections 60Kg and above</td>
</tr>
<tr>
<td></td>
<td>-1.0 mm</td>
<td></td>
</tr>
<tr>
<td>Thickness of web</td>
<td>+1.0 mm</td>
<td>This will be measured at the point of minimum</td>
</tr>
<tr>
<td></td>
<td>-0.5 mm</td>
<td>thickness</td>
</tr>
<tr>
<td>Verticality/Asymmetry</td>
<td>± 1.2mm</td>
<td>Measured by gauge shown in App. V)</td>
</tr>
<tr>
<td>Flange</td>
<td></td>
<td>The base of the rail shall be true and flat, but a slight concavity not exceeding 0.40mm shall be permissible.</td>
</tr>
<tr>
<td>Fishing surface</td>
<td></td>
<td>The standard template for rail 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 0.2mm at any point.</td>
</tr>
</tbody>
</table>

9.1.2  Tolerances in sectional dimensions (for IU rails)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Height</td>
<td>+2.0 mm</td>
<td></td>
</tr>
<tr>
<td>of Rails</td>
<td>-1.0 mm</td>
<td></td>
</tr>
<tr>
<td>Width of Head</td>
<td>± 2.0mm</td>
<td>This will be measured 14mm below the rails top</td>
</tr>
<tr>
<td></td>
<td>-2.0mm</td>
<td></td>
</tr>
<tr>
<td>Thickness of web</td>
<td>+2.0 mm</td>
<td>This will be measured at the point of minimum</td>
</tr>
<tr>
<td></td>
<td>-1.0 mm</td>
<td>thickness</td>
</tr>
<tr>
<td>Width of flange</td>
<td>+1.5 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-2.0mm</td>
<td></td>
</tr>
<tr>
<td>Flange</td>
<td></td>
<td>The base of the rail shall be true and flat, but a slight concavity not exceeding 0.40mm shall be permissible.</td>
</tr>
<tr>
<td>Fishing surface</td>
<td></td>
<td>The standard template for rail 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 0.2mm at any point.</td>
</tr>
</tbody>
</table>

All other requirements as regards variation in dimensions, length and falling weight test shall be as per Prime Quality rail (Para 9.1.1).

9.2  Length of rails

The standard length of rails shall be 13m or 26m. However, in case rails are to be procured in longer lengths, the same shall be prescribed by the purchaser.

The manufacturer shall be entitled to supply in pairs short lengths up to 10% by weight of the quantity contracted for or ordered. Such shorter lengths shall not be less than 10.0 m in lengths for standard length of rails of 13m and shall not be less than 24 m
in lengths for standard length of rails of 26m. The short lengths shall be in multiples of 1.0m.

<table>
<thead>
<tr>
<th>Type of Rail</th>
<th>Tolerance in length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Quality Rail</td>
<td>+20 mm</td>
</tr>
<tr>
<td>IU Grade</td>
<td>+30 mm</td>
</tr>
</tbody>
</table>

**9.3 End Squareness**

The deviation from square in both horizontal and vertical directions shall not exceed 0.60 mm on a length of 200mm.

**9.4 Straightness**

**9.4.1** The straightness of the whole rail shall be judged by naked eye but in case of doubt or dispute, the affected portion shall be checked using 1.5 meters straight edge. The maximum permissible deviation shall be 0.7mm measured as the maximum ordinate on a chord of 1.5m. Wavy, kinky and twisted rails shall not be accepted.

**9.4.2 End Straightness**

The tolerances for end straightness shall be as indicated in Table 2 and as illustrated in figure 1 and 2.

**Table –2**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Straightness</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class ‘A’ rails</td>
</tr>
<tr>
<td>1.</td>
<td>Horizontal</td>
<td>Deviation of 0.5 mm measured as maximum ordinate from the chord of 2.0 meters standard straight edge.</td>
</tr>
<tr>
<td>2.</td>
<td>Vertical a) Up sweep</td>
<td>Deviation of 0.4 mm measured as maximum ordinate from the chord of 2.0 meters standard straight edge.</td>
</tr>
<tr>
<td></td>
<td>b) Down Sweep</td>
<td>NIL</td>
</tr>
</tbody>
</table>
L= Length of straight edge specified in Table 2
d= Maximum tolerance specified in Table 2.

**Fig.1 TOP VIEW OF HORIZONTAL TOLERANCE AT RAIL ENDS**

Any rail not complying with these requirements may be rectified once by the Manufacturer and offered for re-inspection.

**10 FREEDOM FROM DEFECTS**

10.1 The rails shall be free from all detrimental defects such as cracks of all kinds, flaws, piping or lack of metal etc. having an unfavorable effect on the behavior of the rail in service.

10.2 The absence of harmful internal defects shall be ensured by the continuous on-line ultrasonic examination. This examination shall be carried out for all rails under the responsibility of the manufacturer to the satisfaction of the Inspecting Agency.

10.3 The manufacturer in his offer shall furnish the detailed method of on-line ultrasonic testing of rails to be followed by him. The limits of permissible defects for ultrasonic testing of rails shall be as follows and the standard test piece shall be as shown in appendix-VI.

- **Head**: 1.5 mm dia through hole
- **Web**: 2.0 mm dia through hole
- **Web & foot junction**: 2.0 mm dia through hole
- **Foot**: 0.5 mm deep, 12.5 mm long and 1.0 mm wide notch (inclined at 20° with vertical axis)
All Flash Butt Welds executed by the manufacturer for welding of rails in to long panels shall be subjected to ultrasonic testing along with other acceptance criteria as per provisions of Manual for Flash Butt Welding of Rails.

10.4 **EDDY CURRENT TESTING:**

The manufacturer should have eddy current testing covering bottom area of the rail as also the top surface and sides of surface head. The ECT probes should cover complete area of rail bottom and at least 80% area of top surface and sides of the head. The system should be capable of detecting the defects more than or equal to 0.5 mm depth and more than 10 mm long.

10.5.1 **SURFACE QUALITY**

10.5.1.1 Surface quality for Prime Quality Rail

10.5.1.2 Hot marks

Depth of rolling guide marks anywhere on the rail should not exceed 0.5mm. A maximum of two guide marks are allowed per rail. The width of each rolling guide mark should not exceed 4.0mm.

Depth and width of guide marks must conform to the following:

<table>
<thead>
<tr>
<th>Depth (mm)</th>
<th>Minimum width (mm)</th>
<th>Maximum width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>1.5</td>
<td>4.0</td>
</tr>
<tr>
<td>0.4</td>
<td>1.2</td>
<td>4.0</td>
</tr>
<tr>
<td>0.3</td>
<td>0.9</td>
<td>4.0</td>
</tr>
</tbody>
</table>

10.5.1.3 Cold Marks

Depth of longitudinal or transverse cold formed scratches anywhere on the rail should not exceed 0.5mm.

10.5.1.4 Seams

Rails with seams greater than 0.2 mm in depth are not acceptable and shall be ground. On the running surface of the rail, dressing shall be limited to 0.3mm deep and in other places; it shall be limited to 0.5 mm deep.
10.5.2 Surface Quality for IU rail

The rails shall be of uniform section throughout and shall be generally sound and free from twists, cracks and major surface defects.

The following maxima of dimensions of surface defects in the rail shall, however, be acceptable:

<table>
<thead>
<tr>
<th>Type of defect</th>
<th>Location</th>
<th>Permissible dimensions of defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seams</td>
<td>(a) Table of rails, side of the head of rail, bottom and side of the foot of rail (excluding middle third of the foot). (b) Middle third of the bottom surface of the foot of the rail.</td>
<td>Up to 3mm in depth Up to 2mm in depth</td>
</tr>
<tr>
<td>Scabs</td>
<td>Table of rail and side of the head of the rail.</td>
<td>75 mm x 25 mm not to exceed 3 mm in depth.</td>
</tr>
</tbody>
</table>

Number of scabs shall not be more than 3 in the standard rail lengths and shall be separated from each other by at least six times the length of the scab. There shall be no scab within 200mm from the end of the rail.

10.5.3 Protrusions

All protrusions in the head or foot of the rail shall be ground to match the parent contour. Protrusions on web greater than 1.5mm high and 20mm square shall be ground. All protrusions affecting the fitment of the fishplate shall be ground.

10.6 During examination on the inspection banks, any shrinkage cavity, inclusion & segregation visible to the naked eye shall result in rejection of such rail or cutting out of the defective portion and re-examination.

10.7 Any operation carried out either in the hot or cold state with the object of hiding a defect is strictly forbidden.

11 Finishing

11.1 Cold straightening shall be effected by means of gradual pressure without impact. The rails may be roller straightened only once in each direction. The markings must be protected from the action of the straightening rolls.

11.2 The rails must be cut to length when cold. Burrs shall be removed without any perceptible beveling of the section.

12 TESTING FACILITIES

The manufacturer shall, at his own expense, supply all templates and gauges, prepare and supply test pieces and sample of steel, sample rails and drillings, and supply
labour and apparatus/equipment, for testing which may be required by the Inspecting Agency for carrying out all the tests and render reasonable assistance in execution of such tests as desired by the Purchaser/Inspecting Agency.

13 QUALIFYING CRITERIA

The following test shall be done for each rail section, grade and class after any change in the process of manufacture which may affect the results or annually for first three years after adoption of the revised specification. If results of these three years are consecutively found satisfactory, this frequency may be relaxed to three years by Purchaser. The test shall be undertaken by the supplier to demonstrate compliance with the qualifying criteria. If so desired, the purchaser /Inspecting Agency should be provided all facilities to check the sample and witness the test.

a) Residual stress measurement.
b) Fracture toughness measurement
c) Fatigue test

The samples for these tests shall be collected from finished rails. These samples shall not be subjected to any further mechanical or thermal treatment. The tests shall be carried out by an accredited/recognised laboratory approved by the purchaser and the test results shall be reported to the purchaser. The purchaser shall have access to all test records, calibrations and calculation which contribute to the final results.

In case any sample fails to meet the requirement laid in the qualifying criteria the manufacturer shall review its process of manufacturing within six months to eliminate any shortcomings and fresh qualifying criteria test shall be undertaken under intimation to the Purchaser.

14 NATURE OF TESTS

All tests shall be carried out as per latest version of reference specifications mentioned in this document.

14.1 ACCEPTANCE TESTS

14.1.1 Following acceptance tests shall be conducted for Grade 880, 1080 CR, 880 CM, 880 NC, 880 VN & 880 NB Rails:
a) Chemical Analysis
b) Tensile Test
c) Sulphur Print
d) Hardness test (for information and record)
e) Falling Weight Test
f) Hydrogen content
g) Inclusion Rating Level
14.1.2 For Grade 1080 Head Hardened (1080 HH) Rails all the tests stipulated in Para 14.1.1 above shall be conducted except tensile test and hardness test, prior to heat treatment. Following tests shall be carried out after heat treatment:

   a) Tensile Test  
   b) Hardness Test  
   c) Macroscopic Test

14.2 The choice of the test sample location within the cast and strand shall normally lie with the manufacturer. The test sample position within the bloom/rail shall be selected at the discretion of the Inspecting Agency.

14.3 The initial test pieces and also the samples intended for retest must not be taken from the change over or intermediate blooms. Tests will only be carried out on these blooms when part or the whole of the adjacent cast has been withdrawn as not conforming to specification, or for supplying supplementary information, if required by the purchaser.

14.4 The test methods and the conditions, under which the tests are carried out, shall conform to the standard in force in the country of manufacture, in so far as they are not defined in the present specification.

15 TEST SAMPLE

15.1 The samples drawn for preparation of the test pieces shall be marked and stamped under the supervision of the Inspecting Agency.

15.2 If during the preparation of test pieces, any marks have been removed, they shall be replaced on the actual test pieces in the presence of the Inspecting Agency.

15.3 The test pieces shall be machined in the cold state and must not be subjected to any cold or hot working or heat treatment except for stress relieving treatment at 100°C for two hours for tensile test pieces at the option of the manufacturer.

16 CHEMICAL ANALYSIS

16.1 The manufacturer shall, at his own expense, make a complete ladle sample analysis of each cast from which the rails are to be rolled and shall submit an authenticated copy of the results to the Inspecting Agency in the proforma at Appendix-VII. The percentage of each specified element shall conform to the limits specified in table-1 of clause 7.

16.2 Extent of test (Product)

For casts \( \leq 150 \)t, one test per cast.

For casts \( > 150 \)t, two tests per cast, one sample taken from first half of the cast and the other from the second half and different strand.
16.3 If chemical analysis of any cast fails to conform to the provisions of clause 7, the cast shall be subjected to the retest as per provisions of clause 16.4.

16.4 Retest

Two additional chemical analyses shall be made. If both analyses pass, the casts shall be considered as complying with clause 7. If one or both of the analyses fail, the cast shall be rejected.

16.4.1 If a cast does not satisfy the conditions of the specification, the intermediate metal belonging to preceding and succeeding cast shall be rejected or subjected to a retest.

16.5 The chemical analysis for specified elements shall also be made either from drillings taken from a hole drilled in the rail, or by spectrography or any other approved method from the position shown (in fig. 3), rolled from the same cast or from the tensile test piece or piece selected by the Inspecting Agency and the percentage of each specified element shall be within the range specified in table 1 of clause 7.
17 TENSILE TEST

17.1 For 880, 1080 CR, 880 CM, 880 NC, 880 VN, and 880 NB grade Rails:

17.1.1 Nature of Tests

The manufacturer shall determine the tensile properties of the steel in accordance with the requirements of IS: 1608. Such tests shall be made on standard test pieces taken from position shown in figure 4.

Fig. 4 LOCATION OF TENSILE TEST PIECE

Fig. 5 STANDARD ROUND TENSILE TEST PIECE

Three sizes of the standard test piece, as shown in fig.5 are given in table 3, any of which may be adopted.

Table-3

<table>
<thead>
<tr>
<th>Diameter (D mm)</th>
<th>Area of cross section (A mm²)</th>
<th>Gauge length (G mm)</th>
<th>Parallel length (P mm)</th>
<th>Radius at Shoulder (R mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.64</td>
<td>333.33</td>
<td>100</td>
<td>120</td>
<td>18</td>
</tr>
<tr>
<td>14.56</td>
<td>166.67</td>
<td>75</td>
<td>90</td>
<td>13</td>
</tr>
<tr>
<td>10.00</td>
<td>78.50</td>
<td>50</td>
<td>55</td>
<td>10</td>
</tr>
</tbody>
</table>
17.1.2 Extent of Tests

For casts \( \leq 150t \), one test per cast.
For casts \( > 150t \), two tests per cast, one sample taken from first half of the cast and the other from the second half and different strand.

17.1.3 Results to be obtained

The tensile strength obtained shall not be lower than the minimum value given in table 1, clause 7. Should the test piece break outside the middle half of the gauge length, it may be discarded and such breaks should not be considered as a failure of the test. A fresh test or fresh tests may be made by the manufacturer with a test piece or test pieces taken from rail from the same cast from which the discarded test piece was taken.

17.1.4 Retests

When the first tensile test does not give satisfactory result, three retests shall be made. The two retests shall be made on any of the rails from the same strand and the third retest on any of the rails from another strand of the same cast.

The check tests must not be carried out on rails produced from intermediate blooms of a sequential continuous cast.

If all the three retests are satisfactory, all the rails of the cast shall be accepted.

If any of the two retests from original strand does not give satisfactory result and the third retest from the other strand gives satisfactory result, all the rails of the original strand shall stand rejected and rest of the rails of the cast shall be accepted.

If third retest does not give satisfactory result, further retest shall be made strand by strand as above up to 50% of strands.

For sequential continuously cast material, in the event of rejection or withdrawal of rails from one or more strands of a cast, the rails rolled from the change over blooms between the ends of these strands of the previous and next cast in the sequence shall either be deemed not to comply with the requirements or shall be subjected to retest which shall be carried out, one on rail from the strand represented by the original test and the other from another strand. In the event of failure of either of these retests, rails rolled from change over blooms shall be rejected.
17.2 For 1080 HH (Head Hardened) Grade Rails

17.2.1 Nature of Test

The manufacturer shall determine the tensile properties of the steel in accordance with the requirements of IS: 1608. Such test shall be made on standard test pieces taken from position as shown in fig.6 given below.

![Figure 6](image)

The diameter of the test piece shall be 6 mm with gauge length 3.54D or 21 mm.

17.2.2 Extent of Tests

One test per 1000 meter of heat treated rail from one heat.

17.2.3 Results to be Obtained

The minimum tensile strength after heat treatment shall not be less than 1080 MPa with a minimum elongation of 10% and 0.2% proof stress shall be measured and record maintained. If the test piece breaks outside the middle half of the gauge length, it may be discarded and such breaks shall not be considered as failure of the test. A fresh test or fresh tests may be made by the manufacturer with a test piece or test pieces taken from a rail from the same lot from which discarded test piece was taken. If the tests fail to meet the above requirements, the rails may be retreated at the option of the manufacturer and such rail may be retested as above.

18 Sulphur Print Test

18.1 For Grade 880/1080 Cr/1080 HH /880 CM/ 880 NC/ 880 VN & 880 NB Rails

18.1.1 Nature of test

A Baumann-type impression is obtained by the application of bromide paper, previously impregnated with a solution of Sulphuric acid, to the clean rail sections drawn from a location within the cast at the discretion of the Inspecting Agency.

The sections intended to be used for these tests are cold sawn and are then sufficiently cleaned on one surface in order to eliminate completely all machining marks and to obtain a sharp impression.
The initial samples and also those intended for the retests must not be taken from rails of changeover blooms. Tests will only be made on these rails when part or whole of the adjacent cast has been withdrawn as not conforming to specification.

18.1.2 Extent of Tests

Sulphur print tests shall be carried out at the rate of one each per cast for casts \( \leq 150 \) t and two per cast for casts > 150 tones.

18.1.3 Results to be Obtained

The prints obtained must not reveal macrographic defects more marked than those of the limit prints shown in (or equivalent to those shown in) the album of macrographic prints given in Appendix-VIII.

18.1.4 Retests

If Macrographic examination (Sulphur print) conducted according to 18.1.3 does not give satisfactory results, three further samples, two from the same strand and one from the other strand shall be tested.

If all the retests are satisfactory, all the rails of the cast shall be accepted.

If any of the two retests from the original strand does not give satisfactory result but the third retest from the other strand gives satisfactory result, all the rails of the original strand shall stand rejected and rest of the rails of the cast shall be accepted.

If the third retest from the other strand does not given satisfactory result, further retest shall be conducted strand by strand.

For rails from sequential continuously cast blooms, in the event of rejection or withdrawal of rails from one or more strands of a cast as a result of macrographic test, the rails rolled from the change over blooms at the end of these strands of the next cast in sequence shall either be deemed not to comply with requirements or shall be subjected to retest which shall be carried out one on the rails from the strand represented by the original test and the other from any other strand. In the event of failure of either of these retests, the rails rolled from change over blooms shall be rejected.

18.2 Inclusion Rating Level

18.2.1 The inclusion rating level, when examined as per IS: 4163, shall not be worse than 2.5 A, B, C, D thin or 2.0 A,B,C,D thick. Reporting for a parameter is to be in either thin series or thick series.

18.2.3 This test shall be done once every day at random. The record of the test results shall be communicated to purchaser.
18.3 Macro-Structure Test (For 1080 HH grade Rails)

One macro structure test of hardened layer per 1000 meter of heat treated rails shall be performed. Macro structure of heat affected zone shall confirm to figure 7.

![Macro Structure Test Diagram]

<table>
<thead>
<tr>
<th>a,c</th>
<th>&gt;</th>
<th>10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>&gt;</td>
<td>15 mm</td>
</tr>
</tbody>
</table>

Figure -7

19 Brinell Hardness Test

19.1 For 880/1080 CR, 880 CM, 880 NC, 880 VN & 880 NB Rails

19.1.1 Nature of Test

For carrying out this test, impression shall be made on the running tread of a test piece drawn at the discretion of the manufacturer. The test shall be performed in accordance with IS: 1500.

19.1.2 Extent of Test

Test on 10% of the casts shall be carried in case of 880 grade rails and 1080 grade rails for the purpose of records and for any corrective action as required. The hardness values should preferably be as under:

- Grade 880 rails Minimum 260 BHN
- Grade 1080 HH 340 - 390 BHN
- Grade 1080 Cr 320 - 360 BHN

Results of the test should be average of five observations on the same test piece.

19.2 For 1080 Grade (Head Hardened) Rails

19.2.1 Nature of Test:

The hardness test on the rail head surface shall be carried out for 10% of rails, at one end of the rail (after removing the decarburised surface), at regular interval of heat treatment and the hardness should be in the range of 340-390 BHN for 1080 HH Grade Rails. In case of non-conformance of any rail, 9 consecutive rails on either side of the rails having non-conformed value shall be checked for hardness in the sequence. Rails...
not meeting the hardness stipulations maybe retreated only once at the option of the manufacturer and such rails may be retested as above.”

19.2.2 Results to be obtained:
Hardness of rail head surface after heat treatment shall be within Brinell Hardness No. 340 to 390.

![Hardness Distribution](image)

Figure -8 Hardness Distribution

19.2.3 Hardness Distribution Test
The hardness distribution test shall be conducted on transversely cut rail sections as shown in figure 8. Hardness value at any point shall not exceed 390BHN. The cross sectional hardness distribution of heat treated rails shall slope towards the inside. No sharp drop in hardness should be present. The hardness at 10 mm below, the rail head table at centre shall be 340 BHN minimum. The hardness at 15 mm below, the rail head table at centre shall be between 315-325 BHN.

19.2.4 Extent of Test:
One hardness distribution test per 1000 m length of heat treated Rail shall be performed.

19.2.5 Microstructure:
Test piece for microstructure should be taken from the top of rail head. Test piece should be polished, etched and viewed under microscope X100 and X500 magnification. The microstructure shall be fine pearlite without formation of any martensite and Bainite. One test per 1000m of heat treated rail from one heat to be carried out.

20. FALLING WEIGHT TEST

20.1 Nature of Test

20.1.1 Falling weight test piece 1.5 meters long shall be cut from a location as per choice of the Inspecting Agency. For heat treated rails, the sample shall be taken after heat treatment. The test piece shall be placed in horizontal position with the head up on two iron or steel supports resting on a solid metal anvil. The weight of the metal anvil block shall not be less than 12 t and the area of the base not less than 4.2 sq.m. The
metal anvil block shall be supported direct on a concrete or masonry foundation weighing not less than 25 metric tons and having an area of not less than 9.3 sq.m. No timber or spring shall be permitted between the rail supports and the anvil or between the anvil and the foundation. Block guides shall be provided which shall permit free fall of the weight. The upper surface of the supports shall be curved to a radius of not more than 75mm.

One blow shall be delivered midway between the supports, by means of a freely falling iron weight or ‘TUP’, the striking face of which shall be rounded to a radius of not more than 125mm, the weight of the “TUP”, the distance between the centre of the bearings, the height between the surface of the rail and the bottom of the “TUP”, before the latter is released shall be as specified in table-4.

Table-4

<table>
<thead>
<tr>
<th>Rail Section</th>
<th>Weight of Tup (kg)</th>
<th>Distance between centers of bearers (m)</th>
<th>Height of drop (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 kg</td>
<td>1270</td>
<td>0.85</td>
<td>6.4</td>
</tr>
<tr>
<td>60kg</td>
<td>1270</td>
<td>0.85</td>
<td>7.4</td>
</tr>
<tr>
<td>ZU-1-60</td>
<td>1270</td>
<td>0.85</td>
<td>7.4</td>
</tr>
<tr>
<td>68 kg</td>
<td>1270</td>
<td>0.85</td>
<td>8.4</td>
</tr>
</tbody>
</table>

20.2 Extent of Tests

One Test per cast shall be carried out. Sample for 20% (minimum) of the fresh casts rolled per day shall be selected at random from straightened rails and the remaining samples shall be hot sawn. No retest shall be permitted on account of sample from straightened rails failed in Falling weight test. However, present provision of retests shall be applicable to rest 80% of samples taken from un-straightened rails. Choice of the test sample location within cast and strand shall normally lie with the manufacturer. The test sample position within bloom/ rail shall be selected at the discretion of the inspecting agency.

20.3 Results to be Obtained

20.3.1 The blow shall be sustained without fracture, and the permanent set resulting from the blow shall be measured after every test, over the specified distance between the centers of the bearer and recorded and advised to the purchaser.

20.3.2 The Inspecting Agency shall be entitled to test to destruction any rail piece subjected to the falling weight test or carry out any other test/examination/analysis in order to confirm that the rails are sound.

20.4 Retest

Test sample shall be selected at random from the finished rails at the discretion of the Inspecting Agency.
If a falling weight test piece gives unsatisfactory result, three retests shall be made on two rails from the same strand and one from any other strand. If all the three tests are satisfactory, all the rails of the cast shall be accepted.

If either of the two tests from original strand gives unsatisfactory result and the third test from the other strand gives satisfactory results, all the rails of the original strand shall be rejected and other rails of the cast shall be accepted.

If the third test from the other strand gives unsatisfactory result, further retest shall be conducted strand by strand. For sequential continuous cast, if rails are rejected or withdrawn from one or more stands of a cast, the rails rolled from the changeover bloom at the end of the same strands of the previous and next cast in the sequence shall either be withdrawn or subjected to two retests, failure of either of retest shall result in rejection of the rails rolled form the changeover blooms of the same strand.

21 **DETERMINATION OF HYDROGEN CONTENT**

Vacuum degassing of liquid steel shall be done to reduce the hydrogen content. For this purpose RH degasser shall be used. The vacuum level and the duration for which liquid steel shall be kept under this vacuum level shall be decided mutually by the purchaser and the manufacturer. All measurement of hydrogen shall be done for the liquid steel in tundish or mould. Any other method of sampling or determination of hydrogen will require prior approval of the purchaser.

21.1 The measurement of hydrogen shall be done by following method:

21.1 (a) On-Line/Instantaneous Method-

HYDRIS is approved as method of on-line instantaneous measurement. The method of measurement as prescribed by the manufacturer of HYDRIS system shall be adopted with approval of the purchaser. Any other alternate method of determination of hydrogen will require prior approval of the purchaser.

(b) Pin Sample Method-

In case, the manufacturer has not installed the facility for on-line/instantaneous facility for measurement of hydrogen as described in Para (a) above, this method may be adopted with prior approval of the purchaser.

In this method, sample of liquid steel shall be taken by plunging the sampler 300 mm below the molten slag-metal interface. The sample should be held for 2 to 3 seconds and then quenched in cold water so that sample temperature falls to below 150°C within 5 seconds.

The sample should be removed from cold water and packed in dry ice if analysis is carried out within 48 hours of sampling or placed in liquid nitrogen if analysis is to be carried out beyond 48 hours after sampling. Sampling should be done by 6 mm dia vacuum tube of Pyrex glass with wall of thickness of 1.0mm and approximately 0.5 mm thick in the fill-end. The tube should have desired vacuum of $10^{-3}$ mm of Hg.

The hydrogen sample can be analysed by inert gas fusion technique in which sample is to be fused at approximately 1900°C in an induction heating graphite crucible. A nitrogen carrier gas transports the released hydrogen to thermal conductivity cell. The amplified and integrated output of the cell is to be calibrated for hydrogen in ppm.
LECO – RH –2 Hydrogen Analyser may be used for Hydrogen determination. Any other size and material of tube and method of hydrogen determination will require prior approval of the purchaser.

21.2 The level of hydrogen measured by the method described under Para 21.1 above shall be as under for acceptance of a heat for production of rail:

i) When measured by the method described under Para 21.1 (a) = 1.6 ppm max.

ii) When measured by the method described under Para 21.1 (b) = 2.0 ppm max.

22 QUALIFYING CRITERIA TESTS

22.1 Residual Stress Measurement

22.1.1 Residual stresses are measured by attaching electrical strain gauge at various locations on the rail surface. The surfaces to which the strain gauges are attached are progressively isolated from the rail and the relaxed strain are then used to estimate the stresses which have been relieved whilst the original residual stresses are taken to be these values but with a change of sign.

22.1.2 Procedure of Measurement of Residual Stresses

A test piece of 1.0 m length shall be cut from the sample rail. A 150 mm long area in the centre of the test piece shall be ground by hand using fine stones. During grinding it shall be ensured that the surface does not get overstressed. Final finishing shall be done using emery-paper. Strain gauges shall be fixed on minimum 7 & 12 locations on the rail as shown in figure 9.

The strain gauge location shall be accurately marked and these locations shall be cleaned with the help of Acetone and cotton. Rust shall be cleaned by acid and the acid cleaned locations shall be treated by basic solutions. Strain gauges shall be fixed using...
proper adhesive and then connecting wires and terminals are soldered. Null balancing of strain shall be done and reading of each strain gauge brought to zero using balancing bridge and strain indicator. The wires shall be disconnected from the balancing bridge and 60 to 80 mm length of samples shall be cut containing all the strain gauges. Wires shall be connected to the balancing bridge and reading of strain gauge taken using same setting of balancing bridge as was before cutting the samples. The reading of strain at the corresponding locations shall be converted to stress by multiplying with Young’s modulus of elasticity for steel (2.05 x 10⁶ Kg/cm²). Residual stress will have same value as relieved stress with opposite sign.

22.1.3 Results to be obtained

Residual tensile stress anywhere in the rail section shall not exceed 190 MPa, anywhere in the section.

22.2 Fracture Toughness \( K_{1c} \)

22.2.1 Test pieces and test methods

Tests shall be performed in accordance with APPENDIX-XI

22.2.2 Qualifying Criteria:

The values of \( K_{1c} \) shall comply with table given below:

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>Minimum single value ( K_{1c} ) (MPa m ( \frac{1}{2} ))</th>
<th>Minimum Mean ( K_{1c} ) (MPa m ( \frac{1}{2} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>880</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>1080 Cr</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>1080 HH</td>
<td>30</td>
<td>32</td>
</tr>
</tbody>
</table>

Note: In some circumstances \( K_Q \) values can be used for the purpose of qualification – see B.6 of appendix XI.

22.3 Fatigue Test

22.3.1 The constant amplitude fatigue test shall be carried out in accordance with ASTM E606.

22.3.2 Test Pieces

The test pieces shall be machined from the sample rail at a location at least 2m from the rail ends.

22.3.3 Number of Tests and Test Conditions

A minimum of three tests shall be performed under the following conditions:-

Test temperature = Ambient

Control variable shall be axial strain amplitude.
Note:- Load control during the test is acceptable provided the requirements of ASTM E606, clause 10.2.1 are complied with.

The strain cycle shall be symmetrical about the initial zero load strain level.

22.3.4 Each sample should endure 10 million cycles at strain of 0.00135. For rails of Grade 1080 HH the each sample should endure 10 million cycles at strain of 0.00166.

23 INSPECTION

23.1 The purchaser/Inspecting Agency shall have free access to the works of the manufacturer at all reasonable times. The Inspecting Agency shall be at liberty to inspect at every stage the process of steel manufacture and rail production and cross check the results of the stipulated tests when so desired by it.

23.2 Rails rolled from passed heats only shall be inspected by the Inspecting Agency or as mutually agreed by purchaser and Inspecting Agency. The acceptance procedure should not interfere with the normal manufacturing process. When a cast is rolled in several batches, tests carried out on the first part of the cast may be considered valid for the remaining parts of the cast in agreement with the Inspecting Agency.

23.3 Before the rails are submitted to the Inspecting Agency, these rails shall be properly examined by the manufacturer’s inspectors and all defective rails shall be conspicuously marked and segregated. Rails passed in internal inspection should only be offered for examination by the Inspecting Agency.

23.4 The analysis of all casts rolled together with a report on the manufacturer’s rejections shall be submitted in proforma as appendix IX and X to the Inspecting Agency.

23.5 After inspection, every accepted rail shall be clearly stamped with the Inspecting Agency’s stamp at one end in the presence of the Inspecting Agency and painted as per colour code specified in clause 8.4. Cast numbers shall be cold stamped on the faces of the rails at one end.

23.6 Passed rails should be properly stacked on leveled and well drained stacking area. Rails shall be stacked in head up position with 100 x 25mm mild steel flats as spacers at a distance of 3.0 meters between successive layers.

23.7 For lifting rails, single point slinging is not permitted. For 13m long rails, there should be two lifting point spaced at 6 to 7.5 m apart and the maximum rail end overhang beyond the lifting point should not be more than half of the distance between the lifting point. For lifting longer rails the spacing between lifting points shall not be more than 7.5 m. Lifting of rails using magnetic chucks shall be preferred.

23.8 Sudden impact on rails during loading, unloading, stacking or transferring from one point to the other shall be avoided.
24 METHOD OF PAYMENT

24.1 The calculated weights of rails given in appendix I, II, II-A and III of this specification shall be regarded as actual weights and payment shall be made on these weights unless otherwise agreed to.

25 SHIPMENT

25.1 No rail shall be loaded or dispatched until notification has been received from the Inspecting Agency that it has been inspected and has satisfactorily passed all specified tests.

25.2 Industrial Use (IU) rails should be loaded in one wagon and should not be mixed with other rails for dispatch.

25.3 Import Shipment

The rails shall be loaded in bundles of three rails each bundle containing one rail upside down placed in between two rails snugly fitting and suitable tied by M.S. straps at four or more places along the length of rails so that they will not get loosened during their transportation from manufacturer’s place to site of work.

25.4 Rail Transport

Transportation within the country

Rails shall be loaded in wagons in layers with wooden/steel spacer flats between them so that the rails do not get damaged during transportation. Any missing bolster in BFRs/BRHs/BRNs shall be replaced by the manufacturer at his expense. The rails shall be tied as per the extant instructions.
IRS-52 kg/m

APPENDIX-I

CALCULATED WEIGHT 51.89 kg per metre
CROSS SECTION AREA 66.15 sqcm
APPENDIX-II

UIC  60 kg/m

CALCULATED WEIGHT 60.34 KG PER METRE
CROSS SECTION AREA 76.86 sqcm
ZU 1-60 PROFILE

WEIGHT PER METER 73 kg/m
AREA OF SECTION 93 cm³
136 RE 14 (68 kg/m)  

APPENDIX - III

CALCULATED WEIGHT; 67.364 kg/m  
SEC. AREA : 86.131 sqcm  
ALL DIMENSION ARE IN MILLIMETRES  
FOR INDIAN RAILWAYS, HEAD SLOPE HAS BEEN KEPT 1:20 IN PLACE OF 1:40 AS AREMA PROFILE
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Grade</th>
<th>Colour Code</th>
<th>13m, 26m, 130m, 260m</th>
<th>12m, 25m, 129m, 259m</th>
<th>11m, 24m</th>
<th>10m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GR. 880</td>
<td>Only common length wise colour code and no paint on web surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GR.1080 H.H.</td>
<td>In addition to common length wise colour code, <strong>Blue</strong> paint on both sides of web surface for a distance of 500 mm from each end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Gr 1080 Cr</td>
<td>In addition to common length wise colour code, <strong>Green</strong> paint on both sides of web surface for a distance of 500 mm from each end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CLASS’ A’ RAIL</td>
<td>In addition to common length wise colour code, grade code as 1, 2 &amp; 3 and <strong>Green</strong> paint on gauge/non gauge face for a distance of 500 mm from each end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>NIOBIUM 880 NB</td>
<td>In addition to common length wise colour code, <strong>Purple</strong> paint on both sides of web surface for a distance of 500 mm from each end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>VANADIUM 880 VN</td>
<td>In addition to common length wise colour code, <strong>Yellow</strong> paint on both sides of web surface for a distance of 500 mm from each end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Copper- Molybdenum 880 CM</td>
<td>In addition to common length wise colour code, <strong>White</strong> paint on both sides of web surface for a distance of 500 mm from each end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Nickel Chromium Copper 880 NC</td>
<td>In addition to common length wise colour code, <strong>Brown</strong> paint on both sides of web surface for a distance of 500 mm from each end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>IU</td>
<td>In addition to common length wise colour code, <strong>Blue</strong> paint on end face of flange and both sides of flange for a distance of 500mm from each end.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Common lengthwise colour code**

1. No paint on gauge/non-gauge face indicates class ‘B’ rails.
2. Yellow paint on each end face on web region indicates 13m, 26m, 130m, and 260m length.
3. Blue paint on each end face on web region indicates 12m, 25m, 129m, and 259m length.
4. White paint on each end face on web region indicates 11m, 24m length.
5. Green paint on each end face on web region indicates 10m length.

Note: - This colour code is for new rails, for second hand rails Para 321 of IRPWM-1986 may be referred to.
GAUGE FOR CHECKING THE ASYMMETRY

H = Height of the rail.
L = Width of the railfoot.
C = Nominal width of the railhead.
a = Distance between the orthogonal projections, measured on the base of the foot, of the end of the foot and the bottom edge of the extreme rounding all of the running surface.

\[ a = \frac{L - C}{2} \]

x = Depends on the section, according to the general table of tolerances.
b = Height, relative to top of rail, of the bottom of the extreme rounding all of the running surface (for the construction of the gauge, H - b may be rounded off to the nearest mm).

The (-) gauge, applied against the base of the railfoot, is pushed sideways towards the rail.
The (-) stop must not come into contact with the railhead.

The (+) gauge, applied against the base of the railfoot, is pushed sideways towards the rail.
The (+) stop must not come into contact with the railhead.
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. FBH DENOTES FLAT BOTTOM HOLE.
3. DIMENSIONS ARE NOT TO SCALE.
4. HOLES AT LOCATIONS 1, 3, 4, 6 ARE REPT.
5. FOR ALIGNMENT SETTING PURPOSES ONLY.
6. FOR SYMMETRICAL RAIL SECTION
7. APPENDIX-V
8. MAX: 15 mm BASE WEB JUNCTION

FOR SYMMETRICAL RAIL SECTION

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. FBH DENOTES FLAT BOTTOM HOLE.
3. DIMENSIONS ARE NOT TO SCALE.
4. HOLES AT LOCATIONS 1, 3, 4, 6 ARE REPT.
5. FOR ALIGNMENT SETTING PURPOSES ONLY.
6. FOR SYMMETRICAL RAIL SECTION
7. APPENDIX-V
8. MAX: 15 mm BASE WEB JUNCTION FOR SYMMETRICAL RAIL SECTION
9. FOR ASYMMETRICAL RAIL SECTION
10. SECTION - A
11. SECTION - B
12. SECTION - C
13. SECTION - D
14. SECTION - E
15. SECTION - F

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. FBH DENOTES FLAT BOTTOM HOLE.
3. DIMENSIONS ARE NOT TO SCALE.
4. HOLES AT LOCATIONS 1, 3, 4, 6 ARE REPT.
5. FOR ALIGNMENT SETTING PURPOSES ONLY.
6. FOR ASYMMETRICAL RAIL SECTION
7. APPENDIX-V
8. MAX: 15 mm BASE WEB JUNCTION FOR ASYMMETRICAL RAIL SECTION
9. FOR SYMMETRICAL RAIL SECTION
10. SECTION - A
11. SECTION - B
12. SECTION - C
13. SECTION - D
14. SECTION - E
15. SECTION - F

INCLINED NOTCH 20° WITH VERTICAL
12.5 mm LONG
10 mm WEB
MINIMUM DEPTH 0.25 mm AT 20° ANGLE
### LADLE ANALYSIS OF RAIL STEEL

<table>
<thead>
<tr>
<th>Date</th>
<th>HEAT NO</th>
<th>PERCENTAGE</th>
<th>H₂ PPM</th>
<th>O₂ PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>Mn</td>
<td>Si</td>
<td>S</td>
</tr>
</tbody>
</table>


ALBUM
OF
MACROGRAPHIC PRINTS
## MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>DATE</th>
<th>HEAT NO</th>
<th>SPECIMEN</th>
<th>BEFORE FRACTURE</th>
<th>AFTER FRACTURE</th>
<th>% ELONGATION</th>
<th>BREAKING LOAD kg</th>
<th>YS MPa</th>
<th>UTS MPa</th>
<th>HARDNESS (BHN)</th>
<th>FALLING WEIGHT TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BROKEN/NOT BROKEN</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BROKEN/ NOT BROKEN</th>
<th>DEFLECTION mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>BROKEN</td>
<td>12</td>
</tr>
<tr>
<td>NOT BROKEN</td>
<td>13</td>
</tr>
</tbody>
</table>
## DETAILS OF RAILS OFFERED FOR INSPECTION

<table>
<thead>
<tr>
<th>Date</th>
<th>Heat no</th>
<th>No of blooms produced from the heat</th>
<th>Wt. Of blooms produced from the heat</th>
<th>No of rails of length</th>
<th>No of rails found o.k. after internal inspection</th>
<th>No of rails rejected during internal inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>260 M</td>
<td>259 M</td>
<td>130 M</td>
<td>129 M</td>
<td>26 M</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>25 M</td>
<td>24 M</td>
<td>13 M</td>
<td>12 M</td>
<td>11 &amp; 10 M</td>
<td>11 &amp; 10 M</td>
</tr>
</tbody>
</table>
Standard test method for the determination of the plane strain fracture toughness (K_{Ic}) of rails

B.1 Test methods

This test shall be performed in accordance with the requirements of ASTM E399 except where superseded by the requirements specified in this part of IRS T 12. The requirements specified in this part of the IRS T 12 apply only to the determination of plane strain fracture toughness of railway rail steels covered by the definitions and requirements of this standard.

B.2 Test pieces

B.2.1 The location of the test piece in the rail’s transverse section is shown in Figure B.1.

B.2.2 The thickness “B” of all test pieces shall be 25 mm. For any rail head transverse profile the test piece width “W” shall be the maximum achievable of the following dimensions:

- 40 mm;
- 45 mm;
- 50 mm.

B.3 Number of tests

A minimum of 5 tests from each sample shall be performed.

B.4 Test conditions

B.4.1 Fatigue pre-cracking shall be carried out in the temperature range +15°C to +25°C using a stress ratio in the range > 0 < +0.1. Fatigue pre-cracking shall be carried out at a cyclic frequency in the range 15 Hz to 120 Hz. The final crack length to test piece width ratio shall be in the range 0.45 to 0.55.

B.4.2 The single edge notched bend test piece shall be loaded under displacement control using three point bending with a loading span (S) equal to four times the test piece width (W).

B.4.3 Tests shall be performed at a test temperature of -20°C ± 2°C. Test piece temperature shall be measured using a beadless thermocouple spot welded to the test piece at the location shown in figure B.2.

1) It is recommended that the chevron notch in ASTM E399 is used to avoid crack front curvature problems.
B.5 Analysis of test data

B.5.1 The calculation of $K_Q$ shall be in accordance with ASTM E399. The checks made to establish whether this value is a valid $K_{lc}$ shall be in accordance with ASTM E399 except for the requirements of B.5.2 to B.5.6.

B.5.2 $P_{\text{max}} / P_Q$ shall be less than 1.10 for force-crack mouth opening curves where pop-in does not occur before the intersection of the curve with the 95% secant. There shall be no $P_{\text{max}} / P_Q$ criterion for other types of curve.

B.5.3 The linearity of force-crack mouth opening curves la. lb. lla and lll (see figure B.3) shall be checked in the following manner.

Measure the distance ($\nu_1$) between the tangent OA and the force-crack mouth opening curve at a constant force of 0.8 $P_Q$. Measure the distance ($\nu$) between the tangent OA and the force-crack mouth opening curve at a constant force of $P_Q$. For a test result to be valid $...\nu_1 \leq 0.25\nu$

B.5.4 The linearity of force-crack mouth opening curves llb and llc (see Figure B.3) shall be checked in the following manner.

Measure the distance between the tangent OA and the force-crack mouth opening curve at constant forces of 0.8 $P_Q$ and $P_Q$, recording these values as $\nu_1*$ and $\nu*$. Respectively.

Measure the crack mouth opening values arising from all “pop-ins” that occur up to $P_Q$. This is done by measuring the horizontal distance travelled along the crack mouth opening axis between the start and finish of each “pop-in”. Sum the values for “pop-ins” occurring below 0.8 $P_Q$ and for those occurring between 0.8 $P_Q$ and $P_Q$, recording them as $\sum \nu_{1p1}$ and $\sum \nu_{p1}$, respectively.

For a test result to be valid $...[\nu_1 - \sum \nu_{1p1}] \leq 0.25[\nu - (\sum \nu_{p1} + \sum \nu_{1p1})]$

B.5.5 The linearity criterion cannot be applied to force-crack mouth opening curve IV.

B.5.6 For all force-crack mouth opening curves the $K_Q$ value shall be subjected to the validity check that the test piece thickness ($B$) and crack length ($a$) are equal to, or greater than, the value of $2.5(K_Q / R_{p0.2})^2$, where $R_{p0.2}$ is the 0.2% proof stress at the fracture test temperature of $–20^\circ\text{C}$.

B.6 Reporting of results

All measurements required to calculate the test result and to show that the test conditions were as specified in the test procedure shall be recorded.

All results shall be reported as either $K_{lc}$ values $K_Q*$-values or $K_Q$-values; where $K_Q*$-values are those $K_Q$ values which failed the validity criteria due only to one or more of the following:

i) $P_{\text{MAX}} / P_Q > 1.1$;
ii) Exceedence of the $2.5(K_Q / R_{p0.2})^2$ criterion;
iii) Crack mouth opening displacement-force relationship.
The mean and standard deviation of both $K_{1c}$ and $K_{Q*}$ results shall be recorded. For each grade of rail tested these results shall be included in a table giving the following information.

<table>
<thead>
<tr>
<th>Steel Grade</th>
<th>0.2% proof stress at $-20^\circ$C (MPa)</th>
<th>Mean $K_{1c}$ (MPa m$^{1/2}$)</th>
<th>Number of $K_{1c}$ results</th>
<th>Samples standard deviation (MPa m$^{1/2}$)</th>
<th>Mean ($K_{Q*}$) (MPa m$^{1/2}$)</th>
<th>Number of $K_{Q*}$ results</th>
<th>Sample standard deviation (MPa m$^{1/2}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The value to be used for the acceptance criteria is that of the mean $K_{1c}$ and shall be based on a minimum of five $K_{1c}$ values.

When five $K_{1c}$ values have not been obtained any $K_{Q*}$ values shall be included with any $K_{1c}$ values in the mean value to be used for the acceptance criteria. In this event the number of test results shall be at least ten.

All values of $K_{1c}$ and $K_{Q*}$ shall be above the minimum value specified in Table 2.

Dimension in millimetre

**Figure**

**Key**

1. Notch machined in this face
2. Section through rail heat
3. Letter ‘H’ to be stamped on end face of test piece as shown

$B = 25$

$W =$ see B.2.2

For all other test piece proportions See ASTM E399

**Figure B.1-Location and section of fracture toughness test pieces**
**Key**
1. Notch
2. Thermocouple to be placed in the shaded zone
3. Fatigue crack tip

**Figure B.2—Location of thermocouple on fracture toughness specimens**

**Key**
1. Force, P
2. Crack mouth opening displacement (v)
Key
1. Force, P
2. Crack mouth opening displacement (v)

Figure B.3 – Force-Crack mouth opening curves
As per list enclosed.


(ii) This office letter of even no. dated 22.07.2011.

Please find enclosed herewith Addendum and Corrigendum Slip No. 1 to Indian Railway Specification for Flat Bottom Rails, IRS T-12:2009.

This has the approval of competent authority.

DA: 05 Pages
ADDENDUM & CORRIGENDUM SLIP NO. 1
TO
INDIAN RAILWAYS STANDARD SPECIFICATION FOR FLAT BOTTOM RAILS
IRS T-12:2009

I. In Table No. 1 of chemical composition and mechanical properties corresponding to Clause 7 for corrosion resistant rail is replaced as per table enclosed herewith as Annexure-A.

II. Following note below table of Para 9.1.2 is deleted.
“All other requirements as regards variation in dimensions, length and falling weight tests shall be as per prime quality rail 9.1.1”

III. Appendix V (wrongly written) at Page no. 34 is replaced with Appendix VI and VI-A for test rail for USFD testing of rails referred in Clause10.3. Details of test rail for symmetrical rail section is shown in Appendix VI and details of test rail for asymmetrical rail section is shown in Appendix VI-A.

IV. Clause 23.6 at is to be replaced as under: -

“23.6 Passed rails should be properly stacked on leveled and well drained stacking area. Rails shall be stacked in head up position with 100 x 25 mm mild steel flats as spacers at a distance of 4.0 m between successive layers. Recommended arrangement for stacking of rails shall be as per RDSO drawing no. RDSO/T-6219, as Appendix XII.”
TABLE 1 – Contd...

CORROSION RESISTANT RAIL STEEL

<table>
<thead>
<tr>
<th>Grade</th>
<th>Chemical Composition (percentage)</th>
<th>Mechanical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>Mn</td>
</tr>
<tr>
<td>Copper-Molybdenum</td>
<td>0.60-0.80</td>
<td>0.80-1.30</td>
</tr>
<tr>
<td>(CM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel Chromium Copper</td>
<td>0.60-0.80</td>
<td>0.80-1.30</td>
</tr>
<tr>
<td>(NC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

So = Cross sectional area of tensile test piece in mm²

* 0.035 maximum for finished rail

The chemical compositions specified as above are applicable to Ladle analysis and Product Analysis. Manufacture shall ensure that chemical composition at ladle analysis should be such that product analysis also satisfies the requirement of chemical composition as above.

** Desirable Value.
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. FBH DENOTES FLAT BOTTOM HOLE.
3. DIMENSIONS ARE NOT TO SCALE.
4. HOLES AT LOCATIONS 1, 3, 4, 10 ARE KEPT FOR ALIGNMENT/SETTING PURPOSE ONLY.
5. SENSITIVITY LEVEL SHALL BE WITH REFERENCE HOLES/NOTCHES AT LOCATIONS 2, 5, 6, 7, 8, 9, 11, 12:
   - TOP HEAD Ø 1.5 THROUGH HOLE ------------------- 1 NO.
   - SIDE HEAD Ø 1.5 FBH ------------------------------ 1 NO.
   - WEB Ø 2.0 FBH ----------------------------------- 3 NO.
   - FOOT WEB JUNCTION: Ø 2.0 THROUGH HOLE ------------ 1 NO.
   - LEFT FOOT-12.5mm LONG, 1.0mm WIDE RECTANGULAR NOTCH INCLINED 20° WITH VERTICAL AXIS
   - RIGHT FOOT - 12.5mm LONG, 1.0mm WIDE RECTANGULAR NOTCH INCLINED 20° WITH VERTICAL AXIS

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. FBH DENOTES FLAT BOTTOM HOLE.
3. DIMENSIONS ARE NOT TO SCALE.
4. HOLES AT LOCATIONS 1, 3, 4, 10 ARE KEPT FOR ALIGNMENT/SETTING PURPOSE ONLY.
5. SENSITIVITY LEVEL SHALL BE WITH REFERENCE HOLES/NOTCHES AT LOCATIONS 2, 5, 6, 7, 8, 9, 11, 12:
   - TOP HEAD Ø 1.5 THROUGH HOLE ------------------- 1 NO.
   - SIDE HEAD Ø 1.5 FBH ------------------------------ 1 NO.
   - WEB Ø 2.0 FBH ----------------------------------- 3 NO.
   - FOOT WEB JUNCTION: Ø 2.0 THROUGH HOLE ------------ 1 NO.
   - LEFT FOOT-12.5mm LONG, 1.0mm WIDE RECTANGULAR NOTCH INCLINED 20° WITH VERTICAL AXIS
   - RIGHT FOOT - 12.5mm LONG, 1.0mm WIDE RECTANGULAR NOTCH INCLINED 20° WITH VERTICAL AXIS

FOR SYMMETRICAL RAIL SECTION
1. All dimensions are in millimetres.
2. FBH denotes flat bottom hole.
3. Dimensions are not to scale.
4. Holes at locations A, A1, B, B1, B2, B3, B4, B5, B6, B7, C1, D3 & E1 are kept for alignment/setting purpose only.
5. Sensitivity level shall be with reference holes/notches at locations B, B2, C, D, D1, D2, E, F, F1 i.e. top head Ø1.5 through hole ----------- 1 no.
6. Left foot-Ø2.0 through hole (length min 20mm) at the centre of side of foot (at one side)-------1 no.
7. It is essential that the bottom of all blind holes are drilled flat for FB holes.
8. Specified hole tolerance:
   - 1.5 mm hole: 1.5 to 1.55 mm
   - 2.0 mm hole: 2.0 to 2.06 mm
   - 5.0 mm hole: 5.0 to 5.08 mm
   (All other tolerances of the above holes shall be in accordance with ASTM E-428).
9. Not to scale.

For asymmetrical rail section
RAILS / PANELS

MILD STEEL FLAT SECTION
100 X 25@ 4000mm C/C.

GROUND LEVEL

10 mm DIA BARS @ 150 mm c/c

SIDE ELEVATION

CONCRETE BED OF M 20
CEMENT CONCRETE 1:4.8 OR LIME CONCRETE
OR WELL RAMMED MOORUM OR BRICK
BALLAST 75 mm THICK.

FRONT ELEVATION

10 mm DIA BARS @ 150 mm C/C

EMBEDDED RAIL 52 Kg / 90 R
(No. OF RAILS SHALL BE AS
INDICATED IN THE TABLE
GIVEN BELOW)

SCHEDULE OF DIMENSIONS

<table>
<thead>
<tr>
<th>RAIL LENGTH / WELDED PANEL (METRES)</th>
<th>NUMBER OF EMBEDDED RAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 / 13</td>
<td>4 @ 4000 mm C/C</td>
</tr>
<tr>
<td>26</td>
<td>7 @ 4000 mm C/C</td>
</tr>
<tr>
<td>39</td>
<td>10 @ 4000 mm C/C</td>
</tr>
<tr>
<td>130</td>
<td>33 @ 4000 mm C/C</td>
</tr>
<tr>
<td>260</td>
<td>66 @ 4000 mm C/C</td>
</tr>
</tbody>
</table>

7. ONE RAIL PANEL MAY BE REDUCED AFTER EVERY THIRD LAYER TO ACHIEVE PROPER STACKING FROM BOTH SIDES.
6. BETWEEN TWO LAYERS OF RAILS M.S.FLAT OF SIZE 100X25 mm SHOULD BE PROVIDED AT 4000 mm C/C AND IT SHALL BE ENSURED THAT RAIL ENDS DO NOT OVERHANG BY MORE THAN 1500 mm.
5. ONLY ONE TYPE OF FREE RAILS / WELDED PANELS SHALL BE STACKED IN ONE STACK.
4. MAX. NUMBER OF LAYERS IN WHICH FREE RAILS AS WELL AS WELDED PANELS CAN BE STACKED, SHALL BE LIMITED TO 10.
3. 52 Kg per m. / 90 R RAIL SHALL BE EMBEDDED IN THE CONCRETE BED OF M-20 GRADE CONCRETE (TO IS:456-1978) AS SHOWN IN THE DRG: ABOVE.
2. A SLOPE OF 1:400 MAY BE GIVEN IN CONCRETE BED ACROSS THE LENGTH OF RAIL.
1. ALL DIMENSIONS ARE IN MILLIMETRES EXCEPT WHERE OTHERWISE SHOWN.

NOTE

SPECIFICATION

SCALE

ALT:

DESCRIPTION

DATE

R. D. S. O. /T- 6219
No. CT/Specification/T-12

Dated: 03.02.2012.

As per list enclosed.


Ref: Railway Board’s letter no. Track/21/2010/0513/7 dated 01.02.2012.

Please find enclosed herewith Addendum and Corrigendum Slip No. 2 to Indian Railway Specification for Flat Bottom Rails, IRS T-12:2009.

This has the approval of competent authority.

DA: 01 Page
26.0  WARRANTY

As a warranty for supply of rails free from manufacturing defects by rail suppliers, after initial USFD testing of new rails in rail manufacturing plants, a USFD test free period of 25% of service life of rails in terms of GMT as given below (Para 302 (i) (d) of IRPWM-2004 as amended from time to time) shall be applicable. This clause of test free period of 25% of service life of rails shall also be applicable for all types of 90 UTS (grade 880) and higher grade of rails of this specification.

<table>
<thead>
<tr>
<th>Rail Section</th>
<th>Assessed GMT service life for 90 UTS rails</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 Kg</td>
<td>800</td>
</tr>
<tr>
<td>52 Kg</td>
<td>525</td>
</tr>
<tr>
<td>90 R</td>
<td>375</td>
</tr>
</tbody>
</table>
No. CT/Specification/T-12

Dated: 27.06.2012.

As per mailing list enclosed.


Ref: Railway Board’s letter no. Track/21/2008/0801/7 dated 22.06.2012.

Please find enclosed herewith Addendum and Corrigendum Slip No. 3 to Indian Railway Specification for Flat Bottom Rails, IRS T-12:2009.

This has the approval of competent authority.

DA: As above

(सोनवीर सिंह)
(कार्यकारी निदेशक/रेलपथ-1)
कृते महानिदेशक/रेलपथ
The Rails in regard to their quality, manufacturing process, chemical composition, testing/ retesting, qualifying criteria, etc., shall be complying with Indian Railway Specification IRS-T-12-2009 for Flat Bottom Rail with following amended clauses.

1. **Clause 5.4: Head Hardening Process**
   For head hardening, rails shall be suitably heat treated to meet the requirements of the specification. The method of heat treatment adopted by the manufacturer should be made available to the purchaser. In-line established deep Head Hardening methods using air quenching process would be acceptable with the prior approval of the Purchaser. Any other process of Head Hardening would also be acceptable with the prior approval of the Purchaser.

2. **Clause 7: Grade, Chemical Composition and Mechanical Properties**
   The steel for the rails shall be of fully killed quality and shall confirm to chemical composition and mechanical properties given in Table -1. Micro alloying elements of Cr(0.3% max.) & V (0.01% max.) may also be acceptable, as it helps in improving mechanical properties. The limits for chemical composition are applicable both for tests on ladle samples and for check analysis of finished rails. Ladle and check analysis of steel, will be carried out by the method specified in the relevant part of IS: 228 or by any other established instrumental/chemical method of testing with the approval of the purchaser. In case of any dispute, the procedure given in the relevant part of IS:228 shall be referred.

3. **Clause 8.1: Brand Marks**
   With the prior approval of purchasers, brand marks of suitable size clearly legible, shall be rolled in relief on one side of web at 3.0 to 4.0 meters interval.

   The brand mark shall include:
   a) The rail section.
   b) The grade of steel, i.e.
      Grade 880
      
     880
| Grade 1080 HH | 1080 HH |
| Grade 1080 Cr | 1080 CR |
| Grade 880 Cu-MO | 880 CM |
| Grade 880 Ni Cr Cu | 880 NC |
| Grade 880 Vanadium | 880 VN |
| Grade 880 Niobium | 880 NB |

c) Identification mark of the manufacturer
d) Month (using roman numbers) and last two digits of year of manufacture.
e) Process of steel making:
   i) Basic oxygen - O
   ii) Electric - E

4. **Clause 8.2: Hot Stamping**

Each rail shall be identified by a numerical, alphabetical or combined alphabetical and numerical code which will be distinctly hot stamped at least once every 5.0m on the web in figures and letters of suitable size from which following information can be obtained:

i) The number of the cast from which the rails has been rolled with letter ‘C’

ii) Number of the strand.

iii) For rails from change over bloom, cast number should be the preceding cast number with prefix letter ‘B’.

5. **Clause 8.3: Cold Punching**

8.3.1 Following should be cold punched on one of end face of each rail

a) Inspecting Agency ID and Group ID
b) Shift No in which product inspected
c) Date of Inspection

To avoid damage to the HH rails, instead of cold punching, any other method of marking can be adopted, with the prior approval of the Purchaser.
6. **Clause 8.4: Colour code**
Rails shall be painted as per colour code given in Appendix-IV to distinguish grade, class, length and other special requirements. Paint of good quality should be used with the prior approval of the Inspecting Agency. Alternatively, different colour code may also be decided by the supplier with the prior approval of purchaser.

7. **Clause 9.2: Length of Rails**
The standard length of rail shall be 13 meters or 25 meters or 26 meters. The manufacturer shall be entitled to supply in pairs of short lengths up to 10% by weight of the quantity contracted for or ordered. Shorter lengths shall not be less than 10.0m in length for 13.0M and shall not be less than 23M in lengths for 25M and 24 M in lengths of rail for 26M. Short lengths shall be in multiples of 1.0M. In case of ZU 1-60, 1080 HH grade Rails, length shall be suitable for turnout design offered/proposed.

<table>
<thead>
<tr>
<th>Type of Rail</th>
<th>Tolerance in length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Quality Rail</td>
<td>+20 mm</td>
</tr>
<tr>
<td>IU Grade</td>
<td>+30 mm</td>
</tr>
</tbody>
</table>

8. **Clause 18.3: Macro-Structure Test (For 1080 HH Grade Rails)**
One macro-structure test of hardened layer per 1000 meters of heat treated rails shall be performed. Macro structure of heat affected zone shall confirm to figure 7.

Due to specific process of heat treatment being adopted by the manufacturer e.g. inline air quenching method, Macro-structure of heat affected zone may not
show distinct zones, as shown above in figure-7, supplier should advise about the same to the purchaser in advance.

9. **Clause 19.2.3: Hardness Distribution Test**

   The hardness distribution test shall be conducted on transversely cut rail section as shown in figure-8. Hardness value at any point shall not exceed 390BHN. The cross sectional hardness distribution of heat treated rails shall slope towards the inside. No sharp drop in hardness should be present. The hardness at 10mm below, the rail head shall be 340BHN minimum. The hardness at 15 mm below the rail head table at centre shall be minimum 315BHN.

10. **Clause 21: Determination of Hydrogen Content**

    Vacuum degassing of liquid steel shall be done to reduce the hydrogen content. For this purpose, RH degasser or REDA (Revolutional Degassing Activator) shall be used. In case, any other method of vacuum degassing is adopted, then the same will require prior approval of the Purchaser. The vacuum levels and the duration for which liquid steel shall be kept under this level shall be decided mutually by the purchaser and manufacturer. All measurement of hydrogen shall be done for the liquid steel in tundish or mould. Any other method of sampling or determination of hydrogen will require prior approval of the purchaser.

    **Clause 21.1** The measurement of hydrogen shall be done by following method:

    **Clause 21.1 (a) On-Line/Instantaneous Method**-

    HYDRIS is approved as method of on-line instantaneous measurement. The method of measurement as prescribed by the manufacturer of HYDRIS system shall be adopted with approval of the purchaser. Any other alternate method of determination of hydrogen will require prior approval of the purchaser.

    **(b) Pin Sample Method**-

    In case, the manufacturer has not installed the facility for on-line/instantaneous facility for measurement of hydrogen as described in Para (a) above, this method may be adopted with prior approval of the purchaser.
In this method, sample of liquid steel shall be taken by plunging the sampler 200mm - 300 mm below the molten metal surface in mould and molten slag-metal interface in tundish. The sample should be held for 2 to 3 seconds and then quenched in cold water so that sample temperature falls to below 150°C within 5 seconds.

The sample should be removed from cold water and packed in dry ice if analysis is carried out within 48 hours of sampling or placed in liquid nitrogen if analysis is to be carried out beyond 48 hours after sampling. Sampling should be done by 6 mm dia vacuum tube of Pyrex glass with wall of thickness of 1.0mm and approximately 0.5 mm thick in the fill-end. The tube should have desired vacuum of $10^{-3}$ mm of Hg.

The hydrogen sample can be analysed by inert gas fusion technique in which sample is to be fused at approximately 1900°C in an induction heating graphite crucible. A nitrogen carrier gas transports the released hydrogen to thermal conductivity cell. The amplified and integrated output of the cell is to be calibrated for hydrogen in ppm.

LECO – RH –2 Hydrogen Analyser may be used for Hydrogen determination.

Any other size and material of tube and method of hydrogen determination will require prior approval of the purchaser.

21.2 The level of hydrogen measured by the method described under Para 21.1 above shall be 1.6 ppm maximum for acceptance of a heat for production of rail.

11. Clause 26: WARRANTY

As a warranty for supply of rails free from manufacturing defects by rail suppliers, after initial USFD testing of new rails in rail manufacturing plants, a USFD test free period of 25% of service life of rails in terms of GMT as given below (Para 302 (1) (d) of IRPWM-2004 as amended from time to time) shall be applicable. This clause of test free period of 25% of service life of rails shall also be applicable for all types of 90 UTS (grade 880) and higher grade of rails of this specification. If any rail fracture due to suspected manufacturing defect is detected within a period of 25% service life of rail in terms of Gross Million Tonne, then investigation will be conducted jointly by purchaser and supplier to ascertain the cause of failure”.

<table>
<thead>
<tr>
<th>Rail Section</th>
<th>Assessed GMT service life for 90 UTS rails</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 Kg</td>
<td>800</td>
</tr>
<tr>
<td>52 Kg</td>
<td>525</td>
</tr>
<tr>
<td>90 R</td>
<td>375</td>
</tr>
</tbody>
</table>