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Ministry of Railways**MASTER COPY**

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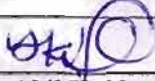
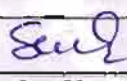
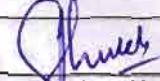
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**HOT COILED CYLINDRICAL SPRINGS FOR USE IN SUSPENSION OF I.R. COACHES
HAVING FIAT & TRAINSET DESIGN BOGIES**

1.0 PREAMBLE:

Indian Railways had entered into Transfer of Technology (TOT) agreement with M/s LHB, Germany for procurement of 24 numbers of all Stainless Steel Light Weight, High Speed Coaches suitable for operations at 160 kmph on existing Indian Railways track and upgradable to 200kmph. These coaches used FIAT design bogies which are provided with helical coil springs in primary and secondary suspension.

This specification is developed for manufacturers of coil springs for FIAT & Trainset (Vande Bharat) deign bogies of I.R. The specification may be altered or upgraded in future on the basis of experience gained.

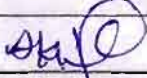

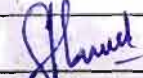
2.0 GENERAL:

2.1 Scope:

- 2.1.1. This specification is applicable for high performance cylindrical springs used in the suspension of IR coaches of LHB design having FIAT bogies, Vande Bharat Coaches and similar other applications. Described springs are manufactured out of circular section hot wound round bars.
- 2.1.2. Procurement of Spring Steel to be used in the manufacture of these springs shall be done only from reputed manufacturers approved by RDSO or any other agency nominated by the RDSO for the purpose.
- 2.1.3. Spring Steel bars duly inspected and passed by inspection agency mentioned in Purchase Order (PO) or any other agency nominated by the RDSO for the purpose shall be used for manufacture of springs.
- 2.1.4. The technical conditions for the delivery and supply of cylindrical springs shall be as follows:
- As per special technical provisions as appear on the drawings.
 - As per technical provisions of this specification, in as much as these do not conflict with the special provisions mentioned in the drawings.
- 2.1.5. Following shall be applicable when this item appears in RDSO's vendor directory:
- "All the provisions contained in RDSO's ISO procedures laid down in Document No. QO-D-8.1-11, Version No. 2.7 (or latest) with title "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."
- 2.1.6. The Government of India policy on 'Make in India' shall apply.

2.2 List of Reference Specifications:

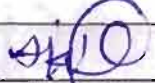

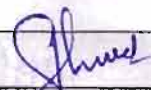
S. No.	Standard	Description
(i)	ISO 683-14	Heat Treatable steels, alloy steels and free cutting steels; Part-14: hot rolled steels for quenched and tempered springs.
(ii)	ISO 1462	Metallic coatings; Coatings other than those anodic to the basis metal; Accelerated corrosion tests; Method for the evaluation of the results.
(iii)	ISO 2162-1	Technical product documentation; springs; part-1; simplified representation.
(iv)	ISO 2162-2	Technical product documentation; springs; part-2;

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		presentation of data for cylindrical helical compression springs.
(v)	ISO 2162-3	Technical product documentation; springs; part-3; Vocabulary.
(vi)	ISO 3887	Steel, non-alloy and low-alloy; determination of depth of decarburization.
(vii)	ISO 4288	Rules and procedures for the measurements of surface roughness using stylus instruments.
(viii)	ISO TR 4949	Steel names based on letter symbols.
(ix)	ISO 4540	Metallic Coatings; Coatings cathodic to the substrate; Rating of electroplated test specimens subjected to corrosion tests.
(x)	ISO 4967	Steel; determination of content of non-metallic inclusions; Micrographic method using standard diagrams.
(xi)	DIN EN ISO 9227	Corrosion tests in artificial atmospheres- Salt Spray Tests.
(xii)	ISO/TR 10108	Steel, conversion of hardness values to tensile strength values
(xiii)	ISO 10209-1	Technical product documentation; vocabulary; Part-1; terms relating to technical drawings; general and types of drawings.
(xiv)	IS: 3618	Specification for phosphate treatment of Iron and Steel for protection against corrosion.
(xv)	ICF/MD SPEC-155	STR for Procurement of Bright Spring Steel Rounds Peeled & Centerless Ground
(xvi)	ASTM E 709	Standard Guide for Magnetic Particle Testing.
(xvii)	UIC Code 822	Technical Specification for the supply of helical compression springs, hot or cold, for tractive and trailing stock.
(xviii)	BS EN:10089	Hot Rolled Steels for Quenched and Tempered Springs - Technical delivery conditions.
(xix)	BS EN:10060	Hot Rolled Round Steel bars for General Purposes – Dimensions and tolerances on shape and dimensions.
(xx)	EN 13298:2003	Railway applications-Suspension Components-Helical Suspension Springs, Steel
(xxi)	EN 13906-1:2013	Cylindrical Helical springs made from round wire and bar- Calculation and Design
(xxii)	M&C/PCN/132/2021	RDSO Specification for Painting of Helical Coil Springs of LHB Coaches and Similar Applications (Single Pack)
(xxiii)	EN 45545-2	Railway Applications-Fire properties on Railway Vehicles-Part 2: Requirements of Fire behavior of materials and components
(xxiv)	DIN EN ISO:9443	Surface Quality Classes for Hot Rolled bars and wire rod
(xxv)	DIN EN ISO:9934-1	Non-destructive Testing-Magnetic Particle Testing-Part 1: General Principles
(xxvi)	DIN EN ISO:9934-2	Non-destructive Testing-Magnetic Particle Testing-Part 2: Detection media
(xxvii)	DIN EN ISO:9934-3	Non-destructive Testing-Magnetic Particle Testing-Part 3: Equipment
(xxviii)	DIN EN ISO:3059	Non-destructive Testing-Magnetic Particle Testing-Penetrant Testing and Magnetic Particle Testing –Viewing Conditions
(xxix)	DIN EN ISO:9712	Non-destructive Testing- Qualification and certification of personnel
(xxx)	DIN EN ISO:2409	Paints and varnishes- Cross-cut Test

The reference to various specifications as above quoted herein shall generally be taken as reference to the latest version of the specification concerned.

Specific provisions in this document will take precedence over those contained in the above specifications where these are not in conformity with one another. Any special requirements given in the drawings will over ride this specification.

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3.0 **SPRING CLASSIFICATION:**

- 3.1 Depending upon their loading condition, springs have been divided into two categories shown in the Table below:

Category A	Category B
Axial and transverse stiffness and/or bowing defined	Only axial stiffness defined

4.0 **RAW MATERIAL:**

4.1 **Material Grade & Specification:**

For finished rod diameter 25-65mm, material shall be grade 52CrMoV4 to specification ISO 683 Part-14 or EN 10089. In case dia is out of this range, material must be stated in the relevant drawing.

4.2 **Chemical Composition:**

- 4.2.1 Since the duty cycle of springs covered by this specification will be very tough, following restrictions are considered essential for the raw material composition:

Maximum Sulphur (S) content	-	0.010% by weight
Maximum Phosphorous (P) content	-	0.015% by weight
Vanadium (V) content	-	0.14 to 0.20% by weight
Molybdenum (Mo) content	-	0.20 to 0.30% by weight

4.3 **Manufacture:**

- 4.3.1 Steel shall be manufactured by Blast furnace/DR (Direct Reduction) followed by Basic Oxygen/EAF for primary steel making and secondary refining in ladle refining furnace/ladle furnace with vacuum degassing facility followed by continuous casting.

Alternatively, steel manufacturing through EAF process is also permitted subject to input raw material shall have minimum 20% sponge iron/pig iron. This should be followed by secondary refining in ladle refining furnace/ladle furnace with vacuum degassing facility followed by continuous casting.

Appropriate electromagnetic stirring to be used to ensure homogeneity in the material with reduced gas levels Nitrogen content 70.0 ppm (max.), Oxygen content 15 ppm (max.) and Hydrogen content 2.0 ppm (max.) in liquid steel.



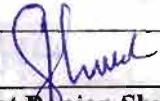
Steel manufacturers shall use Hydriis and Cylox tubes to ensure specified contents of Hydrogen & Oxygen in liquid stage. Proper arrangement for this is to be done by manufactures in VD stage. For nitrogen content and additional test for confirmation of H₂ & O₂ content in liquid steel, vacuum tubes and spectrometry may be used. Suitable chilling media should be used to chill the samples taken in vacuum tubes. Any other method instead of vacuum degassing used during the secondary metallurgy process is also acceptable provided that it has not any negative influence on the final product. Proper record of above tests should be maintained for every heat produced and same shall be made available as when required by inspecting /RDSO officials.

4.4 **Marking on Billets:**

Following information shall be hot stamped/pasted on stickers on one cross section of each billet by the steel manufacturer:

- Grade
- Cast number
- Month & Year

Any deviation or exception from above may be accepted if vendor establishes alternate method will not have any negative implication on quality and traceability.

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5.0 BLACK BARS (AS ANNEALED):**5.1 Manufacture:**

5.1.1 The bars shall be manufactured by hot rolling process and the size of the ingots, billets or continuous cast billets (raw material) for any given size of bar shall be such that a minimum rolling reduction ratio of 16:1 from the minimum cross sectional area of the ingot or continuous cast billets to the maximum cross-sectional area of the product is ensured, to have freedom from "Primary" dendritic structure.

5.1.2 Spring steel rounds may be manufactured through Ingot- forging- rolling route also by maintaining minimum reduction ratio of 16:1. Hydrogen content shall be limited to 1.5 ppm (Max.) and nitrogen content shall be limited to 70 ppm (Max.).

In case of foreign manufacturer of springs, not having any RDSO approved vendor for raw material (Spring Steel Rounds) in the country in which springs are being manufactured, raw material shall be sourced from the sources approved in QAP only. Moreover, as Railway officials posted in foreign countries can also conduct inspection, inspection procedure for supply of springs can be decided by purchaser as per feasibility on case to case basis.

5.2 Properties:**5.2.1 Surface:**

5.2.1.1 Visual checks should indicate that bars are smooth and free from distortion, twist, kinks and harmful defects namely seams, folds, laps, cracks, holes, deep pits, grooves & excessive scaling which may lead to impairing of their serviceability.

5.2.1.2 The permissible depth of seams and laps in the bars shall not be more than 1% of the bar diameter or 0.3 mm whichever is less.

5.2.1.3 Carry out Auto MFL (Magna-flux Leakage) testing and Auto Ultrasonic Test (UT) on 100% black bar before annealing and repeat Auto MFL (Magna-flux Leakage) testing and Auto Ultrasonic Test (UT) after annealing (if supplied as black bar) to ensure surface completely free from cracks, seam, inclusions, lap, etc. for sub surface crack detection. Test infrastructure for Auto MFL (Magna-flux Leakage) should be capable to detect surface cracks up to 0.3mm in black bar and shall be in accordance with EN10228-1/ASTM E709 (latest) and Ultrasonic Test shall be carried out as per EN13298. Probe shall be of dia. 10 mm and 5 MHz frequency, for Auto UT purpose, Series of such probes or as suggested by OEM may be engaged with following rejection criteria:


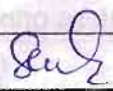
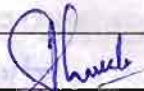
- Any anomaly greater than the one of the reference defect, reference defect is a hole with a flat bottom and 1.2 mm diameter, drilled into the middle of the reference bar of the same dimension and quality as destined for the fabrication of the springs.
- Any attenuation of the ground echo greater than 50 %.

The Qualification of testing personnel shall be minimum level-II from ISNT/ASNT. Probing surface shall be from curved surface and not from the end surface. Black bars duly passed in Auto MFL (Magna-flux Leakage) and Auto UT shall only be supplied by bar manufacturers.

5.2.1.4 Proper record of bars failed in Auto MFL (Magna-flux Leakage)/Auto UT and further disposal should be recorded.

5.2.2 Hardness:

Hardness of as annealed bars shall be 248 BHN (Max.) as per Table 6 of EN 10089 (latest).

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5.2.3 Geometric Condition:

- 5.2.3.1 Diameter of as annealed black bars shall be such that which enables reduction in its diameter after peeling and centerless grinding/polishing by at least 3% of nominal bar diameter or 1 mm whichever is more. For placing the purchase order for black bars, spring manufacturer should ensure proper allowance for above operations so that the finished diameter of rods must be as per Para 6.2.2.2.
- 5.2.3.2 Ovality of the bars should be controlled in such a manner so as to ensure minimum removal of the material by at least 3% of nominal bar diameter or 1 mm whichever is more.
- 5.2.3.3 Bars shall be supplied in straightened condition and the limit for out of straightness shall be 1.5 mm/metre length (maximum).

5.2.4 Metallurgy:

5.2.4.1 Macro-etching:

In the cross-section (micro-section surface), no microscopic defects such as cavities, pores cracks or liquidations are permitted. Macro etch level shall not be worse than C2, R2, S2, of ASTM -381 Plate I for blooms and billets.

5.2.4.2 Microscopic:

- Entire cross-section should have even annealed structure with depth of rim decarburization not more than 0.4mm.
- Average grain size of the bar shall be as per ASTM no.6 or finer.
- In longitudinal section, non-metallic inclusion rating shall not be worse than 1.0 A, B, C, D for thick and 1.5 A, B, C, D thin series when compared to the chart for determining the inclusion content of secondary refined steels (Fig.2) of IS:4163 (latest). Alternatively, non-metallic inclusion at every heat may be checked by the steel procedure in accordance to ASTM E45.

5.3 Marking on Black Bars (As Annealed):

Following information shall be hot stamped/pasted on stickers at the one extreme end of each bar:

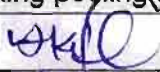

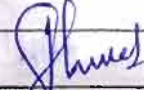
- Code of the manufacturer
- Smelt number
- Nominal diameter
- Nominal length
- Month/Year

Any deviation or exception from above may be accepted if vendor establishes alternate method will not have any negative implication on quality and traceability.

6.0 RODS (PEELED, GROUND/POLISHED, AS ANNEALED BARS):

6.1 Manufacture:

- 6.1.1 Rods (peeled, ground & polished as annealed bars) shall be manufactured out of bars described in Para 5 above.
- 6.1.2 Bars of such size shall be selected for rod manufacture which enables reduction in its dia. after peeling and centreless grinding/polishing by at-least 3% of nominal rod diameter or 1 mm whichever is more.
- 6.1.3 Generally, the bars should be procured in exact lengths so that cropping of bars does not become necessary. In case of multiple /excess lengths, bars may be cut to lengths by shearing /cutting carefully.
- 6.1.4 Bars as per Para 5.2.3.3 shall be straightened in bar straightening machine before undertaking peeling and centreless grinding operation.

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6.1.5 Straightened and as annealed black bars shall be peeled, ground/polished to make rods used for manufacture of springs. Peeling and grinding/polishing of as annealed black bars is mandatory requirement. As annealed black bars should be procured from raw material suppliers and should be centerless ground/polished on centerless grinding/polishing machine available with the spring manufacturers just before spring manufacturing. For any deviation, approval of RDSO must be taken with detailed technical justification.

6.1.6 Properties:

6.2.1 Surface:

6.2.1.1 On the surface, defects which can be seen by the naked eyes (e.g. cracks, wrinkling, longitudinal grooves, burned spots, tool marks & dent marks) or depressions from handling and transport are not permitted.

6.2.1.2 Carry out Magnetic Particle Testing (MPT) on 100% annealed rods to ensure surface completely free from cracks, seam, inclusions, lap, etc. For sub surface crack detection, Ultrasonic Test (UT) on 100 % rods to be done. Test method and test infrastructure for Magnetic Particle Testing (MPT) shall be in accordance with relevant standards EN10228-1/ASTM E709 (latest). The ultrasonic test shall be carried out as per EN13298. Probe shall be of dia. 10 mm and 5 MHz frequency. Following rejection criteria shall be employed.

- Any anomaly greater than the one of the reference defect, reference defect is a hole with a flat bottom and 1.2 mm diameter, drilled into the middle of the reference bar of the same dimension and quality as destined for the fabrication of the springs.
- Any attenuation of the ground echo greater than 50 %.

The Qualification of testing personnel shall be min level-II from ISNT/ASNT. Probing surface shall be from curved surface and not from the end surface. Rods duly passed in Magnetic Particle Testing (MPT) and UT shall only be supplied by the manufacturers.

6.2.1.3 Proper record of rods failed in Magnetic Particle Testing (MPT) /UT and further disposal should be recorded.

6.2.1.4 The surface quality of the rod shall be as per Clause 5.3.2.1 of EN 13298. The maximum R_a value of the surface of the bar before coiling shall not exceed 2.5 μm .

6.2.2 Shape & Dimensions:

6.2.2.1 The limit for out of straightness of rods shall be within 1mm/m length maximum.

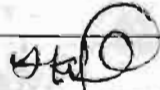

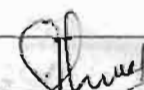
6.2.2.2 The diameter of straight rods must be within the following limits:

Diameter of Rods in mm	Tolerance in mm
18 - 30	± 0.10
30 - 50	± 0.12
50 - 80	± 0.15

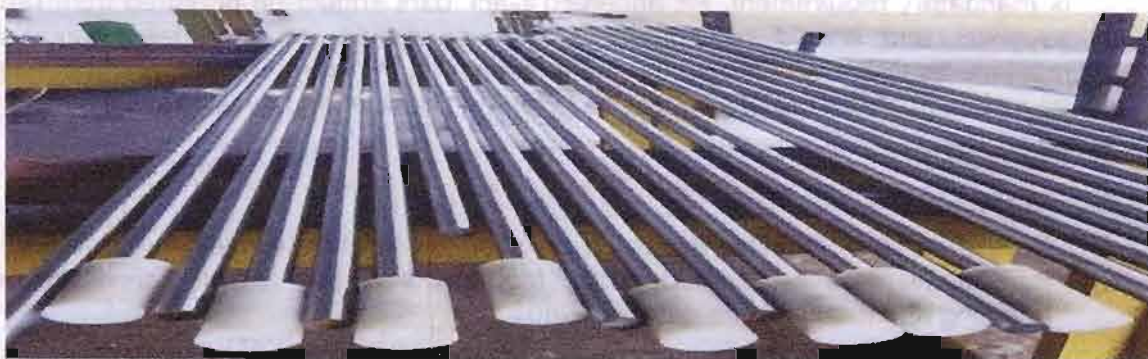
6.3 CORROSION PROTECTION OF BARS/RODS:

6.3.1 A thin corrosion protection layer shall be provided on the bars/rods before dispatch. Corrosion protection of the bars/rods shall be as per Clause 3.0 of ICF/MD/Spec-155 issue 01, Rev.01 (or latest). The bars/rods shall be coated with Lacquer, cellulose, pigmented, finishing, glossy to IS:5691-1970 (or latest) to a Dry Film Thickness of 3-5 microns. After the application, coating is dried up, bio-degradable material shall be used for packing. If any plastic material is used for packing, necessary government guidelines should be followed.

6.3.2 Corrosion protection shall be adequate to last for period of two months under storage in covered place. This shall not be in the form of oil/grease to prevent rods slippage during end tapering operation. The chemical used be such as to burn off or vaporize during heating at a temperature of 150 °C & above leaving no residue. To avoid metal to metal contact, plastic

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spiral rings (for 25 mm to 40 mm rod dia.) and plastic caps (above 40 mm rod dia.) shall be provided on each bars/rods as shown in Figure below:



- 6.3.3 Sample check of bars/rods should be carried out for checking of rusting and straightness of bars/rods before manufacturing process. The stacking of bars/rods may be done according to the production schedule. The long storage of bars/rods should be avoided as it leads to loss of straightness and initiation of rusting.

6.4 PACKAGING & TRANSPORTATION OF BARS/RODS:

The bars/rods are very sensitive item and need to be packed and transported very carefully. The following guidelines to be followed while packaging & transportation of bars/rods:

- 6.4.1 Spread the bars/rods on the inspection table before packaging & transportation. Check for any process defects in the bars/rods like lobbing, pitting, bend, tool marks, scratch lines, chips or dent marks etc. and segregate them with proper identification. If the segregated defective bars/rods are in recovery condition, recover them by passing through centerless grinding or cutting operations. Ensure that bars/rods ends are free from burrs.
- 6.4.2 Ensure proper coating of corrosion protection layer on full face of bars/rods as per Para 6.3 of this specification.
- 6.4.3 Weigh the bundles and identify them with tags detailing size, grade, length, heat no., P.O. no., weight etc. Bundle weight should be approximate in between 1200 Kg to 1300 Kg. Pack the bars/rods in the bundle so that bars/rods are in the center of the bundle as shown in the figure.



Put at least four straps on the bundle with strapping clips. Put two straps each at approximately 600 mm from the end of both sides of bundle. The other two straps shall be placed by proper spacing from the end straps. Tight the straps by a manual/pneumatic tensioner and tight the clip to clamp the bundle.

- 6.4.4 Tie the Tag on the Tag Wire and ensure that the following:

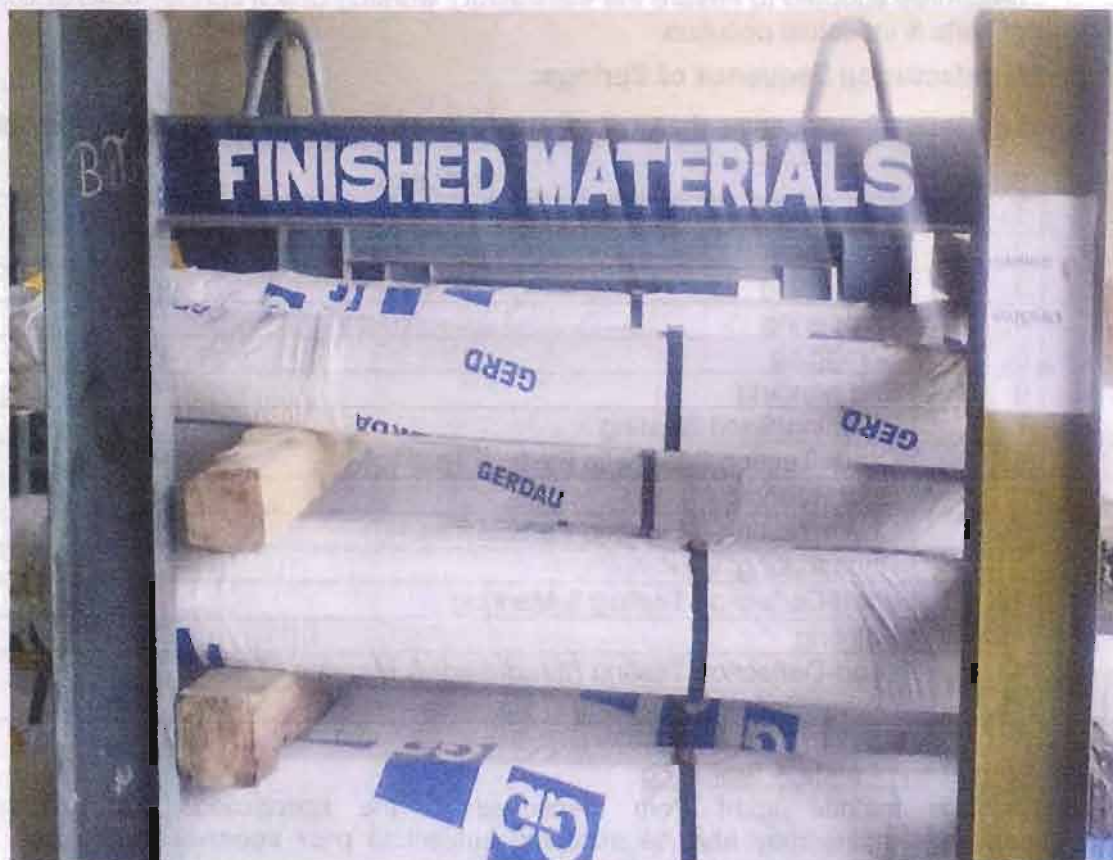
- Colour Code is matching with bundle.
- Heat No. is matching with bundle.
- Stamping details of bars/rods are matching with Tag details (Heat No., Grade & Size).

Signature			
Name & designation	Akil Haider, SSE/Design/Carriage Prepared by:	Satyendra Kumar, ADE/VDG/ Carriage Checked by:	Prabhat Ranjan Shukla Director/VDG/Carriage Approved by:

- 6.4.5 Insert the Hollow Polyurethane tube to cover the entire bundle so that moisture should not enter inside the packed bundle. Thereafter, wrap with HDPE cloth and strap with steel straps on 5 locations for 6-meter material.



- 6.4.6 Weigh the bundles and identify them with tags detailing the size, grade, length, heat no., P.O. no., weight etc. record the readings in the Internal inspection format/job card with the details of P.O. no., heat no., grade, quantity etc. Stack the packed bundles (prime & reject) in the designated location and handover to Logistic for dispatch. Non-conforming bars/rods, if any generated during the operation shall be kept separately with identification.



Any other packing arrangement of bars/rods better than above may be approved by RDSO depending on case to case basis.

- 6.4.7 Any other precaution in packing as may be deemed fit for safe transportation shall be taken by the bars/rods suppliers to avoid damage during transportation.

Signature			
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