GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(Railway Board)

INDIAN RAILWAY STANDARD SPECIFICATION FOR END FORGING OF THICK WEB ASYMMETRICAL RAILS

SERIAL NO. T- 62

July' 2024

Issued by

RESEARCH DESIGNS & STANDARDS ORGANISATION
(MINISTRY OF RAILWAYS)
MANAK NAGAR, LUCKNOW – 226011

0. FOREWORD

0.1 This specification ~~is being~~ issued ~~for the first time~~ under the fixed serial number as Indian Railway Standards Specification, IRS:T-62; the final number indicates the year of original adoption as standard, or in the case of revision, the year of last revision.
Adopted 2022
Revised 2024

0.2 This standard specification is intended to cover the technical provisions relating to End Forging of Thick Web Asymmetrical Rails at the End Forging plant. The process verification of the End Forging plant shall be carried out by RDSO as per the Inspection Regime for End Forged Asymmetrical Rails of ZU-1-60 /60E1A1& ZU-2-49/49 E1A1 rail profile to 60 kg (UIC)/60E1& IRS 52 Kg rail profile.

1.0 SCOPE

This specification covers technical requirements for end forging of 880/R-260 Grade asymmetric rail into symmetric, 60 kg UIC/60E1 & IRS 52 Kg rail section for making of thick web switches / thick web switch expansion joints.

2.0 MANUFACTURING PROCESS

2.1 The end forging of asymmetric rail shall be carried out by an automatic closed die forging process. Heating for forging purpose shall be done in automatically controlled induction heating furnace with controlled atmosphere. In case of multi stage forging change of dies should be automatic preferably. At the end of the forging, the forgings should require very little or no straightening to avoid introduction of residual stresses in the end forged portion. The forging press shall be of adequate capacity for achieving the designed profiles.

3.0 FORGING OF RAIL-ENDS

3.1 The rails satisfying the stipulations specified above shall only be used for forging minimum length of forged section with desired rail profile shall be 500mm at web and 470 mm at foot and transition length of forging shall be in the range of 150-200mm.

3.2 Drawing of asymmetrical rail along with proposed forging details shall be submitted by supplier and same will be approved by RDSO before forging of rail.

3.3 The end forging shall be done by pressure die forging. The forged portion shall be smooth and variation in cross section in the transition portion shall be uniform without notches, dents, projections or surface flaws. There shall be no internal defects, no cracks or overlaps in the forged portion which shall be tested for internal defects by Ultrasonic Testing and for cracks/flaws by Dye-Penetrant Test (DPT)/Magnetic Particle Test (MPT).

3.4 **Testing on forged rail**

3.4.1 Geometrical Check- 100% on forging and machined end profile.

3.4.2 Ultrasonic Test – 100% forged rail (in the forged area & heat affected area).

3.4.3 DP/Magnetic Particle Test – 100% forged rail (in the forged and heat affected area).

3.5 **Hardness test**

3.5.1 In the initial stage of establishment of a plant, hardness tests shall be conducted on 3 places of end forged rails which have passed the geometrical requirements, Ultrasonic test requirements and other non-destructive tests.

3.5.2 Hardness shall be measured along the center line of the head in the forged portion for the length as per following break up:

a) Entire forged portion of UIC-60/60 E1 & IRS 52 Kg rail section
b) Entire transition portion
c) At least 400mm of length on ZU-1-60/60E1A1& ZU-2-49/49E1A1 rail section from transition zone end of ZU-1-60/60E1A1& IRS 52 Kg

3.5.3 The hardness shall be measured at an interval of 10mm along the center line.

3.5.4 After recording the measurements, the top layer of 5mm thickness shall be removed and the hardness shall be measured again, 5mm below of surface of rail, in a manner described at 3.5.1 to 3.5.3 above.

3.5.5 Hardness in the forged portion shall not be lower than the hardness of the rolled rail portion (ZU-1-60/60E1A1) & ZU-2-49/49E1A1 (260 BHN min). In the transition area and heat affected zone, lower hardness is acceptable but at no point in this area the hardness should go more than 40 BHN lower than the hardness of parent rail. Further, the length of such low hardness zone shall not be more than 50mm. All the 3 samples shall meet the requirements.

3.5.6 In case the criteria stated at 3.5.5 above is not met, the forging process shall be reviewed, improvements be carried out and fresh tests for hardness be conducted as per Para 3.5.1 to 3.5.5 above.

3.5.7 The data generated as per 3.5.1 above shall be used to identify the spots that are critical from hardness consideration, 3 such spots will be identified for measurement of hardness on each and every piece at surface of the rail table.

3.5.8 Once the process is established, one sample out of every 500 forgings will be tested for hardness in the manner described at Para-3.5.1 to 3.5.5 above.

3.5.9 At this stage, only one sample needs to be drawn as against 3 stipulated for the initial stage.

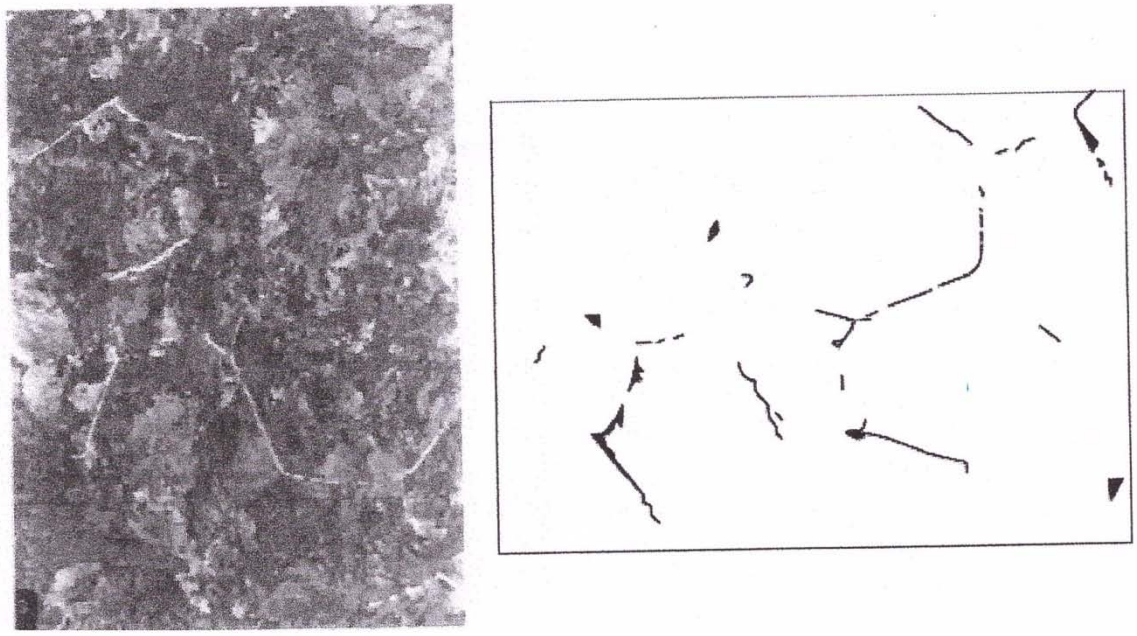
3.5.10 In case the sample fails to meet the criteria stipulated at 3.5.5 above, the forging process shall be reviewed, improvements be carried out and fresh tests for hardness be conducted as per Para 3.5.1 to 3.5.5 above.

3.5.11 Every forging shall be subjected to hardness tests on the surface of rail table at 3 points identified as per Para 3.5.7 above.

3.5.12 Hardness of forged section shall not be lower than the hardness of the rolled rail portion ~~(ZU—60/60E1A1).~~ (ZU-1-60/60E1A1 & ZU-2-49/49E1A1) In the transition area lower hardness is acceptable but at no point in this area the hardness should go more than 40 BHN lower than the hardness of parent rail. In case these requirements are not met, the forging shall be rejected.

3.6 Micro Structure

3.6.1 The micro structure shall be pearlitic but grain boundary ferrite may occur in these grades. The maximum grain boundary ferrite permitted is shown in the Figure shown below (Ref : EN 13674-2: 2006). There shall be no martensite, bainite or grain boundary cementite.



Photomicrograph x 500

Figure: Photomicrograph and diagram showing maximum allowable ferrite at theGrain boundaries

3.6.2 Microstructure analysis should be carried out for one forging per 500 forgings done.

3.6.3 For the purpose, end of tensile test piece shall be used and structure will be seen on the transverse section.

3.7 **Tensile Test**

Tensile test shall be done on the symmetrical portion of the forged rail, if straightening operation is carried out, tensile test will be done after straightening.

This test shall be conducted as per clause 17 of IRS-T-12-2009, as amended from time to time. The frequency of the test shall be 1 in 500.

3.8 All the above, mentioned tests in forged portion of rail will be carried out in manufacturers premises in the presence of ~~purchasers~~ purchaser's representative.

3.9 **Tolerances**

The tolerances on dimensions and end straightening of end forged rail shall comply with relevant clauses of IRS:T-12-2009 (clause 9),as amended from time to time. Forged rail shall pass at least in 'B' class category as mentioned in Clause 9.4.1 & 9.4.2 of IRS T-12-2009, as amended from time to time.

4.0 IDENTIFICATION

Each and every rail shall be given an identification heat number which shall be painted on the non-forged area of the rail. Record shall be maintained to link the rail, by its identification number to the cast number of the rail given by the rail manufacturer. The identification number shall be used for the traceability of the rail for all internal quality records and operations. ~~The identification number shall be so painted that it remains legible during further processing of the rail and its transportation to site.~~ Further, for easy identification, each TWA rail End Forged to 60E1 profile rail shall have legible unique identification, punched at the foot of end forged length.

The Unique Identification shall to be given as ABCMMYYXXXXX,
where,

ABC = first, second & third character will denote "Firm's Initial"
MM = fourth & fifth character will denote "Month of forging"
YY = sixth & seventh character will denote "Year of forging"
XXXXX = eighth, ninth, tenth, eleventh & twelfth character will denote "Serial number of forging", starting from 00001 every calendar year.

5.0 FINAL FINISHING

The area of cross section on the entire forged portion shall be adjusted to the required measurements by machining. Final finishing of the forged transition shall be performed by CNC Milling Machine. The manufacturer shall submit gauges for checking the cross sectional dimensions for approval to RDSO. Complete decarburized surface created due to heating and forging process to be removed up to 60Kg UIC/60E1& ZU-2-49/49E1A1 rail profile and beyond that only on head table by milling operation. No black spots etc. will be seen after machining operation.

6.0 Inspection Regime for End Forged Thick Web Asymmetrical (TWA) Rail of ZU-1-60/60E1A1& ZU-2-49/49E1A1 Rail Profile (Grade 880/R260), arranged by Thick Web Switch /Thick web switch expansion joints manufacturer, shall be as detailed in Annexure-A of this specification.

Annexure-A

Inspection Regime for End Forged Thick Web Asymmetrical (TWA) Rail of ZU-1-60/60E1A1 & ZU-2-49/49E1A1 Rail Profile (Grade 880/R260)

Following are the different inspection stages as per which the inspection is to be done

1. Inspection of TWA Rail of ZU-1-60/60E1A1 **& ZU-2-49/49E1A1** rail profile on receipt at End Forging Plant.
2. Inspection at End Forging Plant of process approval to be done generally once for a particular plant (03 samples for initial 500 forgings).
3. Inspection of End of TWA Rail of ZU-1-60/60E1A1 **& ZU-2-49/49E1A1** rail profile into 60kg UIC/60E1 & IRS 52 Kg rail section respectively process approval (at End Forging Plant)
4. Inspection of End Forged TWA Rail at the works premises of Thick Web Manufacturer

These inspections stages detailed below.

1. Inspection of TWA Rail of ZU-1-60 /60E1A1 & ZU-2-49/49E1A1 rail profile of receipt at End Forging Plant

SL No.	Stage	Process (Inspection Parameters)	Acceptance standards & Reference document	Sample size and frequency of inspection/testing wherever applicable	Inspection by	Rejection details
1.1	Scrutiny of Test Results submitted by manufacturer of Asymmetrical rail of ZU-1-60/60E1A1 **& ZU-2-49/49E1A1** rail profile	Test Result for Qualifying Criteria Test as prescribed in IRS-T-12-2009: 1. Residual Stress measurement 2. Fracture Toughness measurement 3. Fatigue Test 4. Fatigue Crack Growth Rate Test	As per IRS-T-12-2009 amended from time to time	100%	Before taking up end forging – QC organization of End forging plant. QC organization of Thick Web Switch/Thick Web Switch expansion joints Manufacturer may also do	End Forging not to be taken up for TWA rail not conforming to IRS-T-12-2009 amended from time to time
		Test Result for Acceptance tests as	As per IRS-T-12-2009	100%		

		prescribed in IRS-T-12-2009: amended from time to time: 1. Chemical Analysis 2. Tensile Test 3. Sulphur Print 4. Hardness Test 5. Falling Weight Test 6. Hydrogen Content 7. Inclusion Rating Level 8. Decarburisation Test (For R260) 9. Determination of total oxygen content (for R260)	amended from time to time		the inspection.	
		Test Results for freedom from defects including surface defects, defects as per UFSD Testing, eddy current testing etc.	As per para 10 of IRS-T-12-2009 amended from time to time	100%		
		Test Result for Sections & Dimensions	As per para 9 of IRS-T-12-2009 amended from time to time	100%		
1.2	Inspection of marking provided for Rail Identification	All Information mentioned at para 8 of IRS-T-12-2009 amended from time to time should preferably be included in the marking at TWA	As per IRS-T-12-2009 amended from time to time and/or as per manufacturer's specification	100%	Before taking up end forging – QC organization of End forging plant. QC organization of Thick Web Switch / Thick Web Switch	End Forging not to be taken up for TWA rail not conforming to IRS-T-12-2009 amended from time to time

					expansion joints Manufacturer may also do the inspection.	
1.3	Any test mentioned above or any other test deemed fit by End forging Plant/Thick Web Switch /Thick Web Switch expansion joints manufacturer for confirmation of test results submitted by TWA Rail manufacturer.					

2. Inspection at End Forging Plant of process approval to be done generally once for a particular plant (03 samples for initial 500 forgings)						
SL No.	**Stage**	**Process (Inspection Parameters)**	**Acceptance standards & Reference document**	**Sample size and frequency of inspection/testing wherever applicable**	**Inspection by**	**Rejection details**
2.1	Visual Inspection & Final Finishing	Surface Defects (The forged portion shall be smooth and variation in cross section in the transition portion shall be uniform without notches, dents, projections or surface flaws)	IRS Specification for end forging of thick web asymmetric rails. (IRS:T-62)	All 03 samples	QC organization of End forging plant	End forgings not conforming to specification shall be rejected. Another sample should be produced and tests carried out.
		Milling of forged portion (Complete decarburized surface created due to heating and forging process to be removed up to 60 Kg UIC/60E1 & ZU-2-49/49E1A1 rail profile				

		and beyond that only on head table by milling operation. No black spots etc. will be seen after machining operation)				
2.2	Geometrical Check	Minimum forged length 500 mm at web and 470 mm at foot of 60 kg/60E1 profile and transition length 150-200 mm	IRS Specification for end forging of thick web asymmetric rails. (IRS:T-62)	All 03 samples		
		Dimensional check of 60 kg profile (Class B) & IRS 52 Kg (Class B)	IRS-T-12/2009 amended from time to time	All 03 samples		
2.3	Ultrasonic Testing in the end forged portion, transition portion and heat affected area	Internal defects	Ultrasonic Testing shall be done as per Chapter 10 of Manual for Ultrasonic Testing of rails and Weld, revised 2012 issued by RDSO.	All 03 samples		
2.4	Dye-Penetrant Test (DPT) or Magnetic Particle Test (MPT)	No cracks or overlaps in the forged area	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62)	All 03 samples	QC organization of End forging plant	End forgings not conforming to specification shall be rejected Another sample should be produced and tests carried out
2.5	Hardness Test	Measurement of hardness at rail top and 5 mm below rail top to identify 3 spots critical from hardness consideration for measurement of hardness on each	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62)	All 03 samples		

		forging at surface of rail table				
2.6	Tensile Test	UTS, Yield Strength & Elongation	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62) & as per IRS-T-12-2009 amended from time to time	1 Sample randomly selected out of 03 samples		
2.7	Micro-structure	Microstructure	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62)	1 Sample randomly selected out of 03 samples (End of tensile test piece may also be used)		
2.8	Identification mark of forging	Identification no. etc	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62) or as per specification end forging plant	All 03 samples	QC organization of End forging plant	Not Applicable

2.9 The test report for tests/checks made as described above should be submitted to the inspecting agency for scrutiny and approval.

2.10 After identification of 03 spots critical from hardness consideration during process approval which is valid for initial 500 forgings, one sample out of every 500 forgings (against 03 stipulated for initial testing) shall be tested for hardness as given in para 3.5.8 to 3.5.10 of specification for end forging of thick web asymmetric rails(IRS:T-62) and test result communicated to inspecting agency.

3. Inspection of End Forging of TWA Rail of ZU-1-60/60E1A1 & ZU-2-49/49E1A1 rail profile into 60kg UIC /60E1 & IRS 52 Kg Rail section respectively after process approval (at End Forging Plant)						
SL No.	**Stage**	**Process (Inspection Parameters)**	**Acceptance standards & Reference document**	**Sample size and frequency of inspection/testing wherever applicable**	**Inspection by**	**Rejection details**
3.1	Visual inspection & Final Finishing	Surface Defects Milling of forged portion	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62).	100%	QC organization of End Forging Plant	End forgings not conforming to specification shall be rejected.
3.2	Geometrical check	Minimum forged length 500 mm at web and 470 mm at foot of 60 kg/60E1& IRS 52 Kg profile and transition length 150-200 mm	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62).	100%		
		Dimensional check of 60kg/60E1 profile (class B) & IRS 52 Kg (Class B)	IRS-T-12/2009 amended from time to time	100%		
3.3	Ultrasonic Testing in the end forged portion, transition portion and heat affected area	Internal defects	Ultrasonic Testing shall be done as per chapter 10 of Manual for ultrasonic testing of rails and weld revised 2012 issued by RDSO.	100%		
3.4	Dye-Penetrant Test (DPT) or Magnetic Particle Test (MPT)	No Cracks or overlaps in the forged area	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62).	100%		

3.5	Hardness Test	Measurement of hardness at three locations identified during process approval using portable tester (also refer 2.10 for measurement of hardness after initial 500 forgings as stipulated in para 3.5.8 to 3.5.10 of RDSO specification for end forging)	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62).	100%	QC organization of End Forging Plant	End forgings not conforming to specification shall be rejected.
3.6	Tensile Test	UTS, Yield Strength & Elongation	IRS Specification for end forging of thick web asymmetric rails(IRS:T-62) and as per IRS-T-12-2009 amended from time to time	1 per 500 forgings	QC organization of End Forging plant	In case test piece fails, two more test pieces shall be made from same end forged rail, Both the test pieces should pass the test otherwise entire lot shall be rejected
3.7	Micro-structure	Microstructure	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62).	1 per 500 forgings (End of tensile test piece may be used as para 3.6.3 of this specification)		
3.8	Identification mark of forging	Identification no. etc	IRS Specification for end forging of thick web asymmetric rails (IRS:T-62).~~or as per specification of end forging plant~~	100%	QC organization of End Forging plant	Marking to be done

4. Inspection of End Forging of TWA Rail at the premises of Thick Web Switch / Thick web switch expansion joints Manufacturer							
SL No.	**Stage**	**Process (Inspection Parameters)**	**Acceptance standards & Reference document**	**Sample size and frequency of inspection/testing wherever applicable**	**Inspection by**		**Rejection details**
					Internal	**RDSO**	
4.1	Scrutiny of Test Results submitted by manufacturer of Asymmetrical rail of ZU-1-60/60E1A1 & ZU-2-49/49E1A1 rail profile	All parameters mentioned at Sl. No. 1.1 & 1.2	As per IRS-T-12-2009 amended from time to time	100%	QC organization of Thick Web Switch /Thick Web Switch expansion joint manufacturing of thick web switches/ Thick Web Switch expansion joints	100%	Rejected if not conforming to specification
4.2	Scrutiny of Test Results of end forging of TWA rail of ZU-1-60/60E1A1&ZU-2-49/49E1A1 rail profile to 60 kg UIC /60 E1A1 & IRS 52 Kg rail section respectively	All parameters mentioned at Sl. No. 3.1 & 3.8	IRS specification for end forging of thick web asymmetric rails (IRS:T-62)& as per IRS-T-12-2009 amended from time to time	100%			
4.3	Tests on TWA Rail of ZU-1-60 rail profile	Chemical Test Tensile Test	As per IRS-T-12-2009 amended from time to time	1 rail sample out of every 10 heats or TWA rail or part thereof	QC organization of Thick Web Switch /Thick Web Switch expansion joint manufacturing of thick web	100% witnessing by RDSO	In case, test of the rail sample fails, the more test pieces shall be made from same rail

					switches/ Thick Web Switch expansion joints		sample. Both the test pieces should pass the test otherwise rails of that particular heat shall be rejected. In addition a sample each of the balance heats shall be tested.
		Sections & Dimensions		100%	100% by QC organization of Thick Web Switch / Thick Web Switch expansion joints Manufacturer before taking up manufacturing of thick web switches/ Thick Web Switch expansion joints	Witnessing /cross verification : 20% by RDSO (In case of discrepancies , 100% witnessing/cross-verification shall be done by RDSO	Rejected if not conforming to specification
4.4	Ultrasonic Test of TWA rail of ZU-1-60/60E1A1 & ZU-2-49/49E1A1 Rail profile along with end forged portion	Internal defect	Ultrasonic Testing shall be done as per Chapter 10 of Manual for Ultrasonic Testing of rails and welds, revised 2012 issued by RDSO	100%			
4.5	Visual Inspection & Final Finishing of end forging portion	Surface Defects Milling of forged portion	IRS specification for end forging of thick web asymmetric rails (IRS:T-62)	100%			
4.6	Geometrical check of end forged portion	Minimum forged length 500mm at web and 470 mm at foot of 60 kg/60E1 profile	IRS-T-12/2009 amended from time to time &IRS specification for end forging of	100%			

		and transition length 150-200mm	thick web asymmetric rails (IRS:T-62)				
		Minimum forged length 380 mm at web and 350 mm at foot of IRS 52 kg profile and transition length 175 mm-200 mm					
		Dimensional check of 60kg/60E1 profile (class B) & IRS 52 kg profile (class B)					
4.7	Dye-Penetrant Test (DPT) or Magnetic Particle Test (MPT)	No Cracks or overlaps in the forged area	IRS specification for end forging of thick web asymmetric rails (IRS:T-62)	100%			
4.8	Hardness Test of end forged portion	Measurement of hardness at three locations identified during process approval using portable hardness tester	IRS specification for end forging of thick web asymmetric rails (IRS:T-62)	100%			
4.9	Tensile Test of end forged portion	UTS, Yield Strength & Elongation	IRS specification for end forging of thick web asymmetric rails (IRS:T-62)	1 per 500 forgings (Minimum 1 per lot if lot size<= 500 forgings)	100% by QC organization of Thick Web Switch / Thick Web Switch expansion joints	100% witnessing shall be done by RDSO	In case test piece fails, two more test pieces shall be made from

4.10	Micro-structure of end forged portion	Microstructure	IRS specification for end forging of thick web asymmetric rails (IRS:T-62)	1 per 500 forgings (Minimum 1 per lot if lot size <= 500 forging) End of tensile test piece may be used as para 3.6.3 of this specification	Manufacturer before taking up manufacturing of thick web switches/ Thick Web Switch expansion joints		same end forged rail, Both the test pieces should pass the test otherwise entire lot shall be rejected
4.11	Identification mark on TWA rail and at end forging portion	Identification no. etc	IRS-T-12/2009, amended from time to time, TWA Rail Manufacturer's specification &IRS specification for end forging of thick web asymmetric rails (IRS:T-62)	100%	100% by QC organization of Thick Web Switch Manufacturer before taking up manufacturing of thick web switches	Witnessing /cross verification : 20% by RDSO (In case of discrepancies , 100% witnessing/cross-verification shall be done by RDSO	Making to be done

Note:- Section/s of Thick web Asymmetrical rails not covered in IRS /T-12 Should conform to UIC/EN standard.