

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

🌐 JIS E 1101 : 2001

**Flat bottom railway rails and
special rails for switches and
crossings of non-treated steel**

ICS 45.080

Descriptors : plain track, railway rails, point work

Reference number : JIS E 1101 : 2001 (E)

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS E 1101 : 1993** is replaced with **JIS E 1101 : 2001**.

In this revision, for striving after conformity to the corresponding International Standard it adopts **ISO 5003** *Flat bottom railway rails and special rail section for switches and crossings of non-treated steel—Technical delivery requirements* as the basis.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 1953-02-27

Date of Revision: 2001-03-20

Date of Public Notice in Official Gazette: 2001-03-21

Investigated by: Japanese Industrial Standards Committee
Divisional Council on Railways and Rolling
Stock

JIS E 1101 : 2001, First English edition published in 2002-03

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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the original JIS is to be the final authority.

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Printed in Japan

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Flat bottom railway rails and special rails for switches and crossings of non-treated steel

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO 5003** *Flat bottom railway rails and special rail section for switches and crossings of non-treated steel—Technical delivery requirements* published in 1980 without modifying the technical contents of the corresponding International Standard, excepting supplement of the following clauses and technical contents not specified in the corresponding International Standard and deletion of some requirements in that Standard.

- a) Giving consideration to the confusion by overall and drastic revision, such provisions in the former **JIS** as classification, shape and dimensions are set together, in a minimum of necessity, by way of supplementary clause or technical contents to extend the user's choice.
- b) In the classification, S rails, which had been specified in Annex 2 of **JIS E 1303**, are added as well as the rails of the former **JIS E 1101**, while the 50 kg rail and 90 S rail, which have become to be no product results, are deleted.

The portions sidlined or underlined with dots in this Standard show the matters not specified in the corresponding International Standard.

1 Scope This Standard specifies the quality and the tests for flat bottom railway rails of non-treated steel with a calculated mass of 30 kg/m or more and special rails for those railway switches and crossings (hereafter, where generically termed for both, referred to as "rails").

Remarks 1 The purchaser's attention is drawn to the fact that an invitation to tender should normally be accompanied by a definition of the conditions of use and other relevant documents for carrying out the order, and in particular those concerning the application of the clauses in this Standard.

2 The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 5003 *Flat bottom railway rails and special rail section for switches and crossings of non-treated steel—Technical delivery requirements* (MOD)

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 0202 *Glossary of terms used in iron and steel (testing)*

JIS G 0203 *Glossary of terms used in iron and steel (Products and quality)*

JIS G 0303	<i>General rules for inspection of steel</i>
JIS G 0560	<i>Method of sulphur print test for steel</i>
JIS G 1211	<i>Iron and steel—Methods for determination of carbon content</i>
JIS G 1212	<i>Iron and steel—Methods for determination of silicon content</i>
JIS G 1213	<i>Methods for determination of manganese in iron and steel</i>
JIS G 1214	<i>Iron and steel—Methods for determination of phosphorus content</i>
JIS G 1215	<i>Iron and steel—Methods for determination of sulfur content</i>
JIS G 1253	<i>Iron and steel—Method for spark discharge atomic emission spectrometric analysis</i>
JIS G 1256	<i>Iron and steel—Method for X-ray fluorescence spectrometric analysis</i>
JIS G 1257	<i>Iron and steel—Methods for atomic absorption spectrometric analysis (Amendment 2)</i>
JIS G 1258	<i>Iron and steel—Methods for inductively coupled plasma atomic emission spectrometry (Amendment 1)</i>
JIS G 4801	<i>Spring steels</i>
JIS Z 2201	<i>Test pieces for tensile test for metallic materials</i>
JIS Z 2241	<i>Method of tensile test for metallic materials</i>
JIS Z 2243	<i>Brinell hardness test—Test method</i>

3 Definitions For the main terms used in this Standard the definitions in **JIS G 0202** and **JIS G 0203** apply, and the rest of the terms shall be as follows:

- a) **continuous casting** Casting of manufacturing a long and gross steel cast bloom through solidifying a cast of molten steel continuously as pouring.
- b) **sequence continuous casting** Continuous casting in which two or more casts are poured successively without any interval.
- c) **strand** Generic name of a set of mold, bloom supporting roll, drawing roll and cutting device in continuous casting.

4 Classification Rails shall be classified as given in Table 1.

Table 1 Classification of rails

Rail type	Symbol	Summary	
		Calculated mass (informative) kg/m	Existence of fishing holes
30 kg rail	30A	30.1	With
			Without
37 kg rail	37A	37.2	With
			Without
40 kgN rail	40N	40.9	With
			Without
50 kgN rail	50N	50.4	With
			Without
60 kg rail	60	60.8	With
			Without
50 S rail	50S	51.7	—
70 S rail	70S	69.5	—
80 S rail	80S	79.9	—

Table 2 Chemical composition and mechanical properties of rails

Division	Steel grade	Rail type	Chemical composition (%)				Mechanical properties				
			C	Si	Mn	P	S	Tensile strength N/mm ²	Test piece	Elongation %	Hardness HB
Class 1	AR	30A	0.50 to 0.70	0.15 to 0.35	0.60 to 0.90	0.045 max.	0.050 max.	690 min.	No. 4	9 min.	—
		37A	0.55 to 0.70	0.15 to 0.35	0.60 to 0.90	0.045 max.	0.050 max.	690 min.	No. 4	9 min.	—
		40N	0.63 to 0.75	0.15 to 0.30	0.70 to 1.10	0.030 max.	0.025 max.	800 min.	No. 4	10 min.	235 min.
		50N	0.63 to 0.75	0.15 to 0.30	0.70 to 1.10	0.030 max.	0.025 max.	800 min.	No. 4	10 min.	235 min.
		60	0.63 to 0.75	0.15 to 0.30	0.70 to 1.10	0.030 max.	0.025 max.	800 min.	No. 4	10 min.	235 min.
		50S	0.63 to 0.75	0.15 to 0.30	0.70 to 1.10	0.030 max.	0.025 max.	800 min.	No. 4	10 min.	235 min.
		70S	0.63 to 0.75	0.15 to 0.30	0.70 to 1.10	0.030 max.	0.025 max.	800 min.	No. 4	10 min.	235 min.
		80S	0.63 to 0.75	0.15 to 0.30	0.70 to 1.10	0.030 max.	0.025 max.	800 min.	No. 4	10 min.	235 min.
Class 2	1A	All the type	0.50 to 0.70	0.07 to 0.35	0.60 to 1.00	0.05 max.	0.05 max.	680 min.	No. 14A	10 min.	—
	1B	All the type	0.40 to 0.60	0.05 to 0.35	0.80 to 1.25	0.05 max.	0.05 max.	680 min.	No. 14A	14 min.	—
	2A	All the type	0.62 to 0.82	0.10 to 0.35	0.60 to 1.10	0.05 max.	0.05 max.	780 min.	No. 14A	9 min.	—
	2B	All the type	0.50 to 0.70	0.10 to 0.35	0.95 to 1.25	0.05 max.	0.05 max.	780 min.	No. 14A	12 min.	—
	3A	All the type	0.60 to 0.80	0.10 to 0.50	0.80 to 1.30	0.05 max.	0.05 max.	880 min.	No. 14A	8 min.	—
	3B	All the type	0.55 to 0.75	0.10 to 0.50	1.30 to 1.70	0.05 max.	0.05 max.	880 min.	No. 14A	10 min.	—

Remarks 1 In case of no designation of steel grade, class 1 applies. If it is designated particularly, class 2 applies.

2 For No. 14A test pieces, the gauge length, $L = 5d$.

3 The chemical composition and mechanical properties of heat treated S rails should be designated by the purchaser. Otherwise these shall be as follows.

C: 0.70 % to 0.82 %, Tensile strength: 890 N/mm² min, Elongation: 8 % min, Hardness: 255 HB min.

5 Chemical composition and mechanical properties The chemical composition of rails, when tested by 9.5, shall meet the requirements in Table 2. Further the tensile strength, elongation and hardness of rails, when tested by the methods of 9.6 and 9.7, shall meet the requirements given in Table 2.

6 Shape, dimensions and dimensional and geometrical tolerances The shape, dimensions and dimensional and geometrical tolerances of rails shall be as given in sub-clauses 6.1 to 6.3 for class 1 rails and in Annex 1 for class 2 rails.

6.1 Shape and dimensions Attached Figs. 1 to 8 give the shape and dimensions.

6.2 Standard length The standard length of rails shall be as given in Table 3.

Table 3 Standard length

Unit : mm

Rail type	Standard length
30 kg rail	10
37 kg rail	25
40 kgN rail	
50 kgN rail	25, 50
60 kg rail	
50 S rail 70 S rail 80 S rail	—

6.3 Dimensional and geometrical tolerances The dimensional and geometrical tolerances on rails, at an ambient temperature of 20 °C, shall be as given in Tables 4.1 and 4.2.

**Table 4.1 Dimensional and geometrical tolerances on rails
(for 30 kg, 37 kg, 40 kgN, 50 kgN and 60 kg rails)**

Unit : mm

Item		Rail type			
		30 kg rail	37 kg rail	40 kgN rail 50 kgN rail	60 kg rail
Length	≤ 12.5 m	±7.0		—	—
	> 12.5 m but ≤ 25 m	—	±10.0	—	—
	> 25 m but ≤ 50 m	—	±10.0	+10.0 -5.0	+10.0 -3.0
	> 50 m	—		+25.0 0	+25.0 0
Height		+1.0 -0.5			
Width of head		+1.0 -0.5			+0.8 -0.5
Thickness of web		+1.0 -0.5			
Overall and side width of flange		±1.0			±0.8
Deviation of vertical axis to base at head top		1.0			0.5
Squareness of cut surfaces		1.0			0.5
Diameter of fishing holes		±0.5			
Position of fishing holes		±0.8		±0.5	
Clearance between rail and reference fishplate attached	Outward ⁽¹⁾	2.0		1.5	
	Inward ⁽¹⁾	1.0		0.5	
Straightness of rail (per 10 m)	Upward ⁽²⁾ , lateral	15.0	10.0		
	Downward ⁽²⁾	—	10.0		
Straightness of rail ends (per 1.5 m)	Lateral	1.0			0.5
	Upward ⁽²⁾	1.2		1.0	0.7
	Downward ⁽²⁾	0.8		0.3	0.0
Twist of rail		—		2.0	1.0
Discrepancy in upper fillet curvature R19 on template		—			0.3
Flatness of rail base		—			0.4

Notes (1) Outward means a state of being pushed out from the normal position, and inward means a state of entering inside.

(2) Upward means a state of rail head bent in depression like, and downward, in swell like.

Table 4.2 Dimensional and geometrical tolerances on rails
(for 50 S, 70 S and 80 S rails)

Unit : mm

Item			Rail type		
			50 S rail	70 S rail	80 S rail
Length	Up to 10 m		+10 −5		
	Above and including 10 m		+15 −5		
Height			+1.0 −0.5		
Width of head			+1.0 −0.5		
Thickness of web			+1.0 −0.5		
Overall and side width of flange			±1.5		
Deviation of vertical axis to flange base at head centre			1.0	0.5	
Squareness of cut surfaces			1.0	0.5	
Straightness of rail	Lateral Upward ⁽²⁾ Downward ⁽²⁾	≥ 10 m in length	10		
		≥ 9 m but < 10 m	9		
		≥ 8 m but < 9 m	7		
		≥ 7 m but < 8 m	6		
		≥ 6 m but < 7 m	5		
		≥ 5 m but < 6 m	4		
Straightness of rail ends		Lateral	1.0	0.5	
		Upward ⁽²⁾	1.2	0.5	
		Downward ⁽²⁾	0.3		
Flatness of rail base			—	0.4	
Twist of rail			1.0		

Note ⁽²⁾ See Note ⁽²⁾ of Table 4.1.**7 Appearance and internal soundness****7.1 Appearance** The appearance of rails shall be as follows:

- Rails shall be shaped uniformly for all over the length without harmful twist and the like.
- The surface of rails shall be free from such detrimental defects as cracks and flaws.

- c) Tolerances on the surface flaw of rails are given in Table 5. Excepting that for 30 kg rails the depth and fin height of surface flaws shall be up to 0.6 mm.
- d) Where any defect detrimental to service is found on the rail surface, the manufacturer may remove it by grinding treatment. In this case the following conditions shall be satisfied.
 - 1) The dimensions after completion of the rail treatment shall meet the requirements in clause 6.
 - 2) The treated portion of the rail shall be finished well and the boundary to the surfaces as rolled shall be smooth.
- e) The inspector may examine surface defects by means of a chipping tool and shall decide whether such defects will have any adverse effect on the behaviour of the rail in service.
- f) Any operation carried out, either in the hot or cold state with the object of hiding a defect, is strictly forbidden.

Table 5 Tolerances on surface defects

Kind of defect	Portion	Tolerance
Seam	Head and base	$D < 0.4 \text{ mm}$
	Others	$D < 0.6 \text{ mm}$
Spill and roll-in substance	Head	$D < 0.4 \text{ mm}$, however, $0.4 \text{ mm} \leq D < 0.6 \text{ mm}$ is permitted providing $S < 150 \text{ mm}^2$.
	Others	$D < 0.4 \text{ mm}$, however, $0.4 \text{ mm} \leq D < 0.6 \text{ mm}$ is permitted providing $S < 200 \text{ mm}^2$.
Overlap flaw and scratch	Head and base	$D < 0.4 \text{ mm}$
	Others	$D < 0.6 \text{ mm}$
Roll mark	Head and base	$H < 0.4 \text{ mm}$
	Upper and lower fillet	$H < 0.6 \text{ mm}$

Remarks : Symbols in this Table, D is the depth, S is the surface area and H is the fin height.

7.2 Internal soundness The internal soundness of rails shall be as follows:

- a) Rails having no fishing holes shall be free from any filiform piping.
- b) Rails having fishing holes shall be free from harmful pipings. Those dotted in the rail web are not considered as harmful providing these have a length not exceeding $2/15$ the rail height at the surface sawn off or not exceeding $4/15$ at the surface polished and are not opened.
- c) Rails shall be free from such internal defect as causing abnormality of fracture, cracking, chipping or the like after subjected to the test of 9.8.

- d) For rails, the test of 9.9 shall not reveal such internal defect as segregation of impurities. Annex 2 shows the limit of such harmful defects.
- e) Rails, when tested by 9.10, shall not show any defect of laminations, piping, gross non-metallic inclusions or the like.
- f) When agreed between the manufacturer and the purchaser, at the time of tender and order, continuous non-destructive testing, appropriate to the manufacturing process and the grade of steel, for example ultrasonic testing, shall be applied. This testing shall be carried out under the sole responsibility of the manufacturer.

8 Steelmaking, manufacture, master templates and working gauges

8.1 Steelmaking process Steel ingots and continuously cast blooms (hereafter referred to as “cast blooms”) used for manufacturing rails shall be produced by means of pure oxygen converter or electric furnace process.

The purchaser may request the manufacturer to state, in his tender, the nature and principal characteristics of the process used; the manufacturer shall not alter these without informing the purchaser’s representative.

8.2 Manufacture of rails The manufacture of rails shall be as follows:

- a) Throughout the production process the manufacturer shall use the best techniques available so that the rails meet the requirements of this Standard.
- b) Steel ingots shall be rolled after being solidified completely. Such solidification is not allowed as these are tumbled.
- c) The original sectional area of steel ingots shall be at least 25 times the sectional area of the rail to be rolled.
- d) The original sectional area of cast blooms shall be at least 8 times the sectional area of the rail to be rolled. For 30 kg rail it may be at least 7 times.
- e) The ends of steel ingots and cast blooms shall be cropped for a length sufficient to remain no detrimental defects inside the rail.
- f) For rails any adequate treatment of pour steel degassing, gradually rail cooling and the like shall be applied to avoid occurrence of hydrogen flakes.
- g) If requested, the manufacturer shall inform the purchaser of the procedure used in order to avoid the presence of hydrogen flakes in rails of the grades of steel in question.
- h) For rails, such deviations after rolling and cooling shall be reduced as far as possible. Further both ends shall be prevented from downward deflection.
- i) For correcting the straightness such processing as may affect the intrinsic quality of the rail shall not be applied.
- j) Both ends of the rail shall be cut at right angles to the lengthwise direction, and burrs remained on the cut edges shall be removed.

- k) For rails with fishing holes, all the end edges and periphery of the holes, being pierced accurately, shall be chamfered as shown in Attached Figs. 1 to 8.

8.3 Master templates and working gauges The master templates and working gauges shall be as follows:

- a) As purchaser's request, the standard section of the rail and all master templates and working gauges required for particular tests shall be provided by the manufacturer, at his own expense, and shall be submitted, for approval, to the purchaser.
- b) Before manufacture, the manufacturer shall submit two sets of master templates, male and female, conforming to the theoretical outline of the rail section to be manufactured, together with two sets of go and no go limit working gauges incorporating the tolerances on the specified dimensions.
- c) The master template and the working gauges shall be stamped after approval by the purchaser (or his representative).
- d) One set of the master templates and working gauges shall remain in the possession of the purchaser or the inspector receiving purchaser's trust (hereafter referred to as "inspector", simply) for the period of acceptance testing.
- e) Only these master templates and working gauges shall be valid for checking purposes.
- f) When the master templates and the working gauges have been approved by a purchaser, or by an outside testing agency, these shall be used for the requirements of other purchasers wherever possible.
- g) Annex 3 shows examples of the master templates and working gauges.

9 Tests

9.1 Supervision The inspector shall be entitled to observe, at all reasonable times, the method of manufacture and to be present at all the tests relating to the casts intended for his railway. He shall be entitled to carry out all necessary checks to ensure that the manufacture is strictly in accordance with the stipulated conditions. The supervision shall be carried out in such a way as not to interfere with the operation of the works.

9.2 Submission for acceptance In the case of ingots, where agreed with the manufacturer, the inspector may indicate, prior to rolling, those ingots from which samples are to be taken for acceptance testing in accordance with the previously agreed number of tests. These samples shall be grouped according to cast and shall remain available until completion of the acceptance testing operations of the rails from the corresponding casts.

In the case of continuously cast material, where agreed between the parties concerning with delivery the manufacturer shall advise the inspector of the positions in the casts and strands from which test samples have been taken.

The acceptance procedures shall not interfere with the normal operation of the works.

9.3 Test items Rails shall be ensured the quality on the items given in Table 6.**Table 6 Test items**

Class	Steel grade	Rail type	Chemical ladle analysis	Tensile test	Hardness test	Falling weight test		Sulphur print test	Nick and break test	Shape and dimensions	Appearance
						Class 1	Class 2				
Class 1	AR	30A	Mandatory	Mandatory	No need	Mandatory	No need	No need	Agreement	Mandatory	Mandatory
		37A	Mandatory	Mandatory	No need	Mandatory	No need	No need	Agreement	Mandatory	Mandatory
		40N	Mandatory	Mandatory	Mandatory	Mandatory	No need	Mandatory	Agreement	Mandatory	Mandatory
		50N	Mandatory	Mandatory	Mandatory	Mandatory	No need	Mandatory	Agreement	Mandatory	Mandatory
		60	Mandatory	Mandatory	Mandatory	Mandatory	No need	Mandatory	Agreement	Mandatory	Mandatory
		50S	Mandatory	Mandatory	Mandatory	Mandatory	No need	Mandatory	Agreement	Mandatory	Mandatory
		70S	Mandatory	Mandatory	Mandatory	Mandatory	No need	Mandatory	Agreement	Mandatory	Mandatory
		80S	Mandatory	Mandatory	Mandatory	Mandatory	No need	Mandatory	Agreement	Mandatory	Mandatory
Class 2	1A	All the type	Mandatory	Mandatory	Agreement	No need	Agreement	Agreement	Agreement	Mandatory	Mandatory
	1B	All the type	Mandatory	Mandatory	Agreement	No need	Agreement	Agreement	Agreement	Mandatory	Mandatory
	2A	All the type	Mandatory	Mandatory	Agreement	No need	Agreement	Agreement	Agreement	Mandatory	Mandatory
	2B	All the type	Mandatory	Mandatory	Agreement	No need	Agreement	Agreement	Agreement	Mandatory	Mandatory
	3A	All the type	Mandatory	Mandatory	Agreement	No need	Agreement	Agreement	Agreement	Mandatory	Mandatory
	3B	All the type	Mandatory	Mandatory	Agreement	No need	Agreement	Agreement	Agreement	Mandatory	Mandatory

Remarks 1 "Agreement" applies where agreed between the parties concerning with the delivery.

2 The hardness test of class 2 does not subject to the acceptance decision.

3 The nick and break test applies for rails produced from ingots.

9.4 Sampling and specimens

- a) **Batch** All the ingots or cast blooms of all the strands belonging to the same cast are regarded as a batch.
- b) **Sampling of chemical analysis** For the sampling of chemical analysis test, clause 3 (chemical composition) of JIS G 0303 applies. Where a batch of the cast is 150 t or over, the number of ladle samples may be increased to 2, if agreed.
- c) **Sampling for mechanical tests and microscopic tests** For class 1 rails Table 7 shall be applied. In the case of sequence continuous casting, the test pieces shall not be selected from the portion where the two casts are intermingled. For class 2 rails the test pieces shall be taken from the cast rolled initially, unless otherwise agreed particularly.

Table 7 Sampling of specimens (for class 1)

Item	In the case of ingot	In the case of continuous casting
Tensile test	To take one specimen from rear crop end of a part of the rail rolled from an optional ingot	To take one specimen from an optional location of a rail rolled from a cast bloom in an optional strand.
Hardness test	Same as the sampling of tensile test.	Same as the sampling of tensile test.
Falling weight test	To take one specimen from rear end of top-end crop of an optional rail.	To take one specimen from an optional part of a rail rolled from an optional cast.
Sulphur print test	To take one specimen from rear end of top-end crop of an optional rail.	To take one specimen from an optional part of a rail rolled from an optional cast.
Nick and break test	To take one specimen from rear end of top-end crop of the rail rolled initially in the batch. To take with a minimum of one per 500 t and a maximum of one per 50 t.	Do not apply.

Remarks 1 The specimen for the falling weight test should be taken from another ingot or strand cast than that from which the specimen for tensile test has been taken.

2 The specimen for the sulphur print test should be taken from the rail rolled from another ingot or strand cast than that from which the specimen for the tensile test or falling weight test has been taken.

- d) **Tensile test piece** Among the tensile test pieces, that for class 1 rails, which shall be No. 4 test piece defined in JIS Z 2201, shall be cut when cold at a point of its centre shown in Fig. 1, and that for class 2, which shall be No. 14A test piece defined in JIS Z 2201, with a diameter of 10 mm and gauge length of 50 mm, shall be cut when cold at a point of its centre shown in Fig. 2.
- e) **Falling weight test piece** The falling weight test piece shall be a rail specimen, having the section as it is, cut into a length of approximate 1 500 mm for class 1 or 1 300 mm for class 2.
- f) **Sulphur print test piece** The sulphur print test piece shall be a rail specimen, having its section as it is, cut into a length of 10 mm minimum.

- g) **Nick and break test piece** The nick and break test piece shall have the rail section as it is. A short length of rail may be taken in the hot condition to be allowed either to air cool completely, or air cool to approximately 600 °C (i.e. below the lower transformation point) and then rapidly cooled. Alternatively the test sample may be obtained from a cold rail.

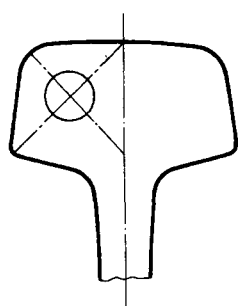


Fig. 1 Location of tensile test piece (for class 1)

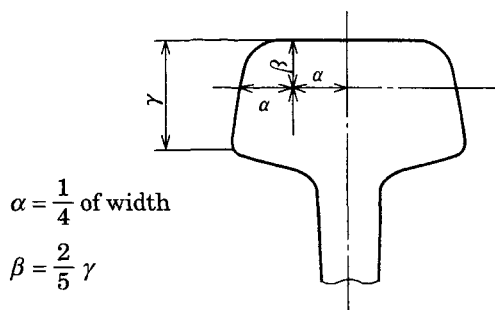


Fig. 2 Location of tensile test piece (for class 2)

9.5 Chemical analysis The chemical analysis test shall be according with **JIS G 1211, JIS G 1212, JIS G 1213, JIS G 1214 and JIS G 1215** or any of **JIS G 1253, JIS G 1256, JIS G 1257 and JIS G 1258**.

9.6 Tensile test For the tensile test method of rails **JIS Z 2241** applies.

9.7 Hardness test For the hardness test method of rails **JIS Z 2243** applies.

9.8 Falling weight test The falling weight test of rails shall be as follows.

9.8.1 Falling weight test (for class 1) The test shall be made by using the testing device specified in Annex 4. Such test conditions are given in Table 8. For the rails rolled from cast bloom, the falling weight test may be eliminated, by the agreement between the parties concerning with delivery.

9.8.2 Falling weight test (for class 2) For the test method, the testing device of Annex 4 shall be used. The test conditions shall be as given in Table 9.

Table 8 Falling weight test (for class 1)

Unit : m

Rail type	Supporting of test piece	Height of drop	Distance between bearers	Number of striking
30 kg rail	To place with rail head to upside	4.0	0.914	Once
37 kg rail		5.0		
40 kgN rail	To place with rail head to lower side	5.1		
50 kgN rail		7.0		
60 kg rail		10.6		
50 S rail		6.1		
70 S rail		10.0		
80 S rail				

Table 9 Falling weight test (for class 2)

Unit : m

Rail type	Supporting of test piece	Height of drop	Distance between bearers	Number of striking
30 kg rail	To place with rail head to upside	To be by formula (1)	1.000	Once
37 kg rail				
40 kgN rail				
50 kgN rail				
60 kg rail				
50 S rail		To be by formula (2)		
70 S rail				
80 S rail				

$$H^{(3)} \times M_n = 150M_r \dots\dots\dots (1)$$

$$H^{(3)} = 0.24I_x/V^2 \dots\dots\dots (2)$$

where, H : height of fall measured from top level of the rail head (m)

M_n : mass of the rail per unit length (kg/m)

M_r : mass of the falling weight (kg)

I_x : moment of inertia about the horizontal neutral axis X (cm⁴)

V : distance between the neutral axis and the furthest fibre (cm)

Note ⁽³⁾ If the height calculated as above is incompatible with the available equipment, the mass of the falling weight should be increased.

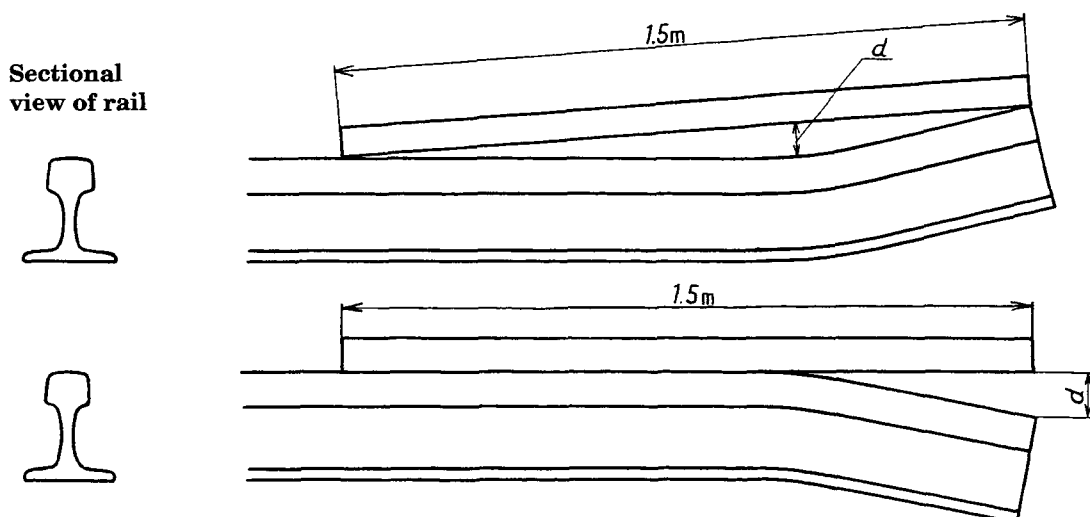
9.9 Sulphur print test For the sulphur print test for rails **JIS G 0560** shall be applied.

9.10 Nick and break test For the nick and break test, in order to break the test sample, a sharp notch shall be made in the centre of the test sample; with a suitable press or impact testing machine, a force shall then be applied, with the notch on the tension side.

9.11 Tests for shape and dimensions The tests for shape and dimensions shall be made by visual observation, directly measuring, working limit gauging or other means.

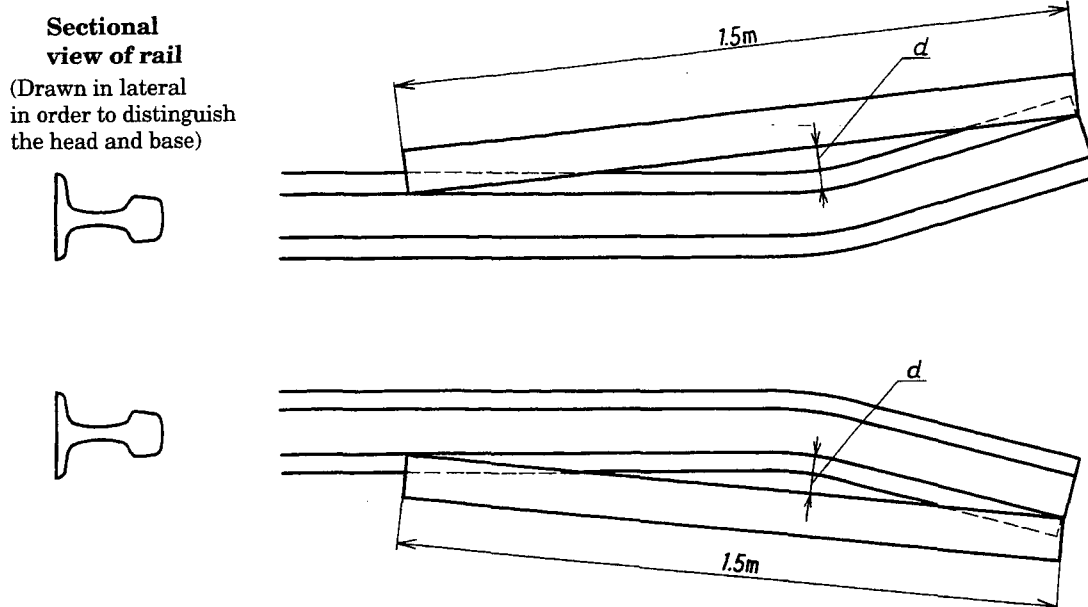
The check of straightness deviations and twist, where any device is used, shall be as follows:

- For checking the vertical deviation of rails, with the rail laid in lateral, to measure the maximum clearance between the head central line for upward deviation, or base top for downward deviation, and a chord of length 10 m strung on the relative position.
- For checking the lateral deviation of rails, with the rail being the head to upside, to measure the maximum clearance between the rail side surface and a 10 m chord strung on that surface in the deviation side.
- For checking the vertical deviation of rail ends, with the rail being the head to upside, to measure the maximum clearance between the upper rail surface and a chord of length 1.5 m on the rail end, as shown in Fig. 3.
- For checking the lateral deviation of rail ends, with the rail being the head to upside, to measure the maximum clearance between the side surface of rail head and a 1.5 m chord strung on the head side face in the side of deviated rail end, as shown in Fig. 4.
- For checking the twist of rails, with the rail being the head to upside, to measure the maximum amount of deviation at the flange base.



Remarks : The dimension d in this figure indicates the maximum value of clearance

Fig. 3 Check on the vertical deviation of rail ends



Remarks : The dimension d in this figure indicates the maximum value of clearance

Fig. 4 Check on the lateral deviation of rail ends

10 Checks

10.1 Checks Checks shall be as follows.

- The chemical composition of rails shall meet the requirements given in clause 5.
- The mechanical properties of rails shall meet the requirements given in clause 5.
- The shape, dimensions, and dimensional and geometrical deviations shall meet the requirements given in clause 6.
- The appearance and internal soundness shall meet the requirements given in clause 7.

10.2 Re-checks If a requirement in 10.1 is not satisfied, re-tests may be carried out according to the following methods to decide the acceptance or rejection.

10.2.1 Chemical analysis When it is established, after verification, that a result of a check ladle analysis differs from the specified requirements, two new check analyses shall be carried out. These shall be made on the specimens taken from two rail bars, originating in the top end ingot (or cast bloom) or part ingot (or cast bloom) corresponding to the ladle sample checked.

If the results of these two new analyses are in agreement with the values given in Table 2 for class 1, or Table 10 for class 2, the ingot (or cast bloom) or part ingot (or cast ingot) is accepted. Otherwise, the ingot (or cast bloom) or part ingot (or cast bloom) is rejected.

For sequence continuous castings, if a cast fails to meet the requirements, the part material intermingled with the previous cast shall either be subjected to re-test or scrapped.

Table 10 Chemical composition (re-test for class 2)

Unit : %

Type	C	Mn	Si	P	S
1A	0.47 to 0.73	0.55 to 1.05	0.04 to 0.38	0.06 max.	0.06 max.
1B	0.37 to 0.63	0.75 to 1.30	0.04 to 0.38	0.06 max.	0.06 max.
2A	0.59 to 0.85	0.55 to 1.15	0.07 to 0.38	0.06 max.	0.06 max.
2B	0.47 to 0.73	0.90 to 1.30	0.07 to 0.38	0.06 max.	0.06 max.
3A	0.57 to 0.83	0.75 to 1.35	0.07 to 0.38	0.06 max.	0.06 max.
3B	0.52 to 0.78	1.25 to 1.75	0.07 to 0.38	0.06 max.	0.06 max.

10.2.2 Tensile test The tensile re-test shall be as follows:

- a) If the tensile test gives unsatisfactory result to the requirement of Table 2, with breaking the test piece at a position beyond the 1/4 gauge length from the centre of gauge marks, this check shall be invalidated and a check shall further be made on the part rail from which the initial test piece has been taken.
- b) **In the case of ingots** In the event of a test failure, two further re-tests shall be made on samples selected at the discretion of the manufacturer. The samples shall be taken from the bottom end crop of two rails rolled from the same bottom cast as the initial test, unless otherwise agreed between the manufacturer and purchaser.

If any one of the tests is not satisfactory, all the rails of the cast shall be rejected.

- c) **In the case of continuously cast material** In the event of an unsatisfactory result, two re-tests may be made.

The first re-test shall be made on rails from the same strand, and the second re-test on rails from another strand of the same cast.

The re-tests shall not be made on rails rolled from changeover blooms of sequence continuous casting.

If the two re-tests are satisfactory the cast shall be accepted. In the event of failure of one or both re-tests, the reasons for failure may be investigated by the manufacturer. When the reason for failure is established to the satisfaction of the inspector then further re-tests may be carried out by agreement between the manufacturer and the purchaser for acceptance of the remainder of the material.

10.2.3 Falling weight test According to the result of the falling weight re-test, the check shall be treated as follows:

10.2.3.1 In the case of ingots If both of the two re-tests satisfy the requirement in the results, all the rails shall be accepted, if one or both of the re-tests is/are unsatisfactory, all the rails shall be rejected.

- a) Cutting off at least 300 kg of rail from another part in the same rail from which the initial test piece has been taken, to take two samples.