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**Carbon steel tyres
for railway rolling stock—
Quality requirements**

ICS 45.060

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of International Trade and Industry and Minister of Transportation through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law: By this Standard, **JIS E 5401 : 1989** is withdrawn. **JIS E 5401-1 : 1998** is intended to conform to the International Standard. The corresponding International Standard, **ISO 1005-1 : 1994** *Railway rolling stock material—Part 1 : Rough-rolled tyres for tractive and trailing stock—Technical delivery conditions* is fully employed in this Standard, while some items or contents of the requirements of the former Standard, **JIS E 5401 : 1989** are supplemented at a minimum range for users' selection, for the purpose of avoiding confusion of users due to full revision of the former Standard which is familiar with users for more than ten years.

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Carbon steel tyres for railway rolling stock—Quality requirements

Introduction This Japanese Industrial Standard has specified the quality requirements of tyres for railway rolling stock as **JIS E 5401-1** *Carbon steel tyres for railway rolling stock—Quality requirements*, upon fully amending the former **JIS E 5401-1989** *Carbon steel tyres for railway rolling stock* on the view-point to contrive the conformity with the corresponding **ISO** Standards.

The former **JIS E 5401-1989** has been arranged of the quality requirements and the dimensional requirements into a single standard, however, since the corresponding **ISO** Standard has been divided into the two standards of **ISO 1005-1 : 1994**, *Railway rolling stock material—Part 1 : Rough-rolled tyres for tractive and trailing stock—Technical delivery conditions* and **ISO 1005-2 : 1994**, *Railway rolling stock material—Part 2 : Tyres, wheel centres and tyred wheels for tractive and trailing stock—Dimensional, balancing and assembly requirements*, the coordination has been proceeded on the basis of the system of the International Standards (adoption of the style of the International Standard, and introduction of branch number system), as the result, the quality requirements have been specified as Part 1, and dimensions and assembling requirements have been specified as Part 2.

The Annex A of this Standard is for informative reference.

At present, the tyres are in the tendency to be used for repairing, and the new wheels are manufactured as the solid wheels.

1 Scope

1.1 This Standard specifies requirements for the manufacture and supply of carbon steel tyres for railway rolling stock based on Table 1-1 or Table 1-2 and 4 (grades).

1.2 In addition to this Standard, the requirements of **ISO 404 : 1992**, *Steel and steel products—General technical delivery requirements* are applicable.

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this part of JIS E 5401. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of JIS E 5401 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

JIS E 5401-2 *Carbon steel tyres for railway rolling stock—Wheel centres and tyred wheels—Dimensional, balancing and assembly requirements*

JIS G 0303 *General rules for inspection of steel*

JIS G 1211 *Iron and steel—Methods for determination of carbon content*

JIS G 1212 *Iron and steel—Methods for determination of silicon content*

JIS G 1213 *Methods for determination of manganese in iron and steel*

JIS G 1214 *Iron and steel—Methods for determination of phosphorus content*

- JIS G 1215 *Iron and steel—Methods for determination of sulfur content (Amendment 1)*
- JIS G 1219 *Iron and steel—Methods for determination of copper content*
- JIS G 1253 *Iron and steel—Method for spark discharge atomic emission spectrometric analysis*
- JIS G 1257 *Iron and steel—Methods for atomic absorption spectrometric analysis*
- JIS Z 2201 *Test pieces for tensile test for metallic materials*
- JIS Z 2241 *Method of tensile test for metallic materials*
- JIS Z 2242 *Method of impact test for metallic materials*
- JIS Z 9901 *Quality systems—Model for quality assurance in design, development, production, installation and servicing*
- JIS Z 9902 *Quality systems—Model for quality assurance in production, installation and servicing*
- ISO 83 : 1976 *Steel—Charpy impact test (U-notch)*
- ISO 377-1 : 1989 *Selection and preparation of samples and test pieces of wrought steels—Part 1 : Samples and test pieces for mechanical test*
- ISO 377-2 : 1989 *Selection and preparation of samples and test pieces of wrought steels—Part 2 : Samples for the determination of the chemical composition*
- ISO 404 : 1992 *Steel and steel products—General technical delivery requirements*
- ISO 5948 : 1994 *Railway rolling stock material—Ultrasonic acceptance testing*
- ISO 6506 : 1981 *Metallic materials—Hardness test—Brinell test*
- ISO 6892 : 1984 *Metallic materials—Tensile testing*
- ISO 10474 : 1991 *Steel and steel products—Inspection documents
(Steel Tyres for Railway Rolling stock—Wheel centres and Tyred wheels Dimensional Balancing and Assembly requirements)*

3 Designated items by purchaser The purchaser shall designate the following items at the time of inquiry and order.

- a) **The number of this Standard**
- b) **The grade of steel** (4.1, see Table 1-1 or Table 1-2)
- c) **The type of heat treatment** (see 4.2 and 6.5)
- d) **The dimensions of tyre** (see 5.4)
- e) **Required or not of microstructure examination** (see 5.2.2.1 and Table 2-1)
- f) **Chemical composition shall be verified by the ladle analysis** (see 5.1)
- g) **Required or not of the macrostructure examination and macrograph (sulfur print) examination** (see 5.2.2.2, 5.2.2.3 and Table 2-1)
- h) **Required or not of ultrasonic examination** (see 5.2.2.4 and Table 2-1)

- i) **Required or not of application of the Brinell hardness range (uniformity of hardness)** (see 5.2.3 and Table 2-1)
- j) **Required or not of special marking** (see 5.5)
- k) **Required or not of special production process** (see 6)
- l) **Required or not of special inspection** (see 7)
- m) **Required or not of special preparation of test pieces and sampling** (see 7.7.2 and 7.7.3.1)
- n) **Required or not of protection against corrosion** (see clause 8)
- o) **Required or not of agreement on guarantee conditions** (see clause 9)

4 Grades The tyres shall be specified by the grades of steel, heat treatment conditions of delivery and required additional tests or inspections according to the order sheets or its appended documents (see the second columns, third columns of Table 2-1 or the second columns of Table 2-2).

4.1 Steel grades This Standard specifies the following steel grades in accordance with the properties given in Table 1-1 or Table 1-2.

- a) In the case of Table 1-1, C46GT-N, C55GT-N, C57GT-N, C57GT-E, C67GT-N, C65GT-E and C77GT-E
- b) In the case of Table 1-2, STY-R1, STY-R2, STY-N and STY-Q

4.2 Heat treatment conditions on delivery The tyres shall be supplied by one of the following.

Irrespective of the heat treatment condition ordered, where no effective degassing has been carried out, for example, suitable precautions such as slow cooling shall be taken to avoid the formation of flaking (hydrogen cracking).

4.2.1 In the case of Table 1-1

- a) Normalized or normalized and tempered (symbol N) Grades C46GT-N, C55GT-N, C57GT-N, C67GT-N
- b) Immersion quenched and tempered (symbol E) Grades C57GT-E, C67GT-E, C77GT-E

4.2.2 In the case of Table 1-2

- a) No heat treatment (no symbol) Grades STY-R1, STY-R2
- b) Normalized (symbol N) Grade STY-N
- c) Normalized and tempered (symbol Q) Grade STY-Q

4.3 Degree of finish The degree of finish at the time of delivery shall be as rolled or the degree of finish as required on the order sheets, and drawings (see JIS E 5401-2 : 1998).

Table 1-1 Grade of steel, chemical composition, heat treatment condition at time of delivery and mechanical properties

Steel grade symbol	Chemical composition ^{1) 2)} by ladle analysis (product analysis) % (m/m)						Heat treatment condition at time of delivery ³⁾	Mechanical properties ⁴⁾				
	C max	Si max	Mn max	P max	S max	Oth-ers ⁵⁾		R_{eH} or $R_{p0.2}$ ⁶⁾ N/mm ² min	R_m N/mm ²	A % min	KU J min ⁸⁾	HB ⁷⁾
C46GT-N	0.46 (0.48)	0.38 (0.40)	1.15 (1.20)	0.035 (0.040)	0.035 (0.040)		N	For documentary purposes	600 to 720	18	15	
C55GT-N	0.55 (0.58)	0.38 (0.40)	0.86 (0.90)	0.035 (0.040)	0.035 (0.040)		N		700 to 820	14	10	
C57GT-N	0.57 (0.60)	0.38 (0.40)	1.05 (1.10)	0.035 (0.040)	0.035 (0.040)		N		750 to 880	12	10	
C57GT-E	0.57 (0.60)	0.38 (0.40)	0.76 (0.80)	0.035 (0.040)	0.035 (0.040)		E		800 to 920	14	15	
C67GT-N	0.67 (0.70)	0.38 (0.40)	0.86 (0.90)	0.035 (0.040)	0.035 (0.040)		N		800 to 940	14	15	
C67GT-E							E		940 to 1 090	11	10	
C77GT-E	0.77 (0.80)	0.38 (0.40)	0.86 (0.90)	0.035 (0.040)	0.035 (0.040)		E		1 050 to 1 200	10	8	

Notes ¹⁾ When a steel grade is selected from Table 1-1, an important factor may be the risk of thermal crack caused from the slip of tread brake or wheel.

When braking is repeated at relatively high speed, the purchaser should take into consideration that the steel of higher carbon content could liable to cause thermal crack than the steel of lower carbon content. Viewed from a different angle, it should be noted that steels with higher carbon content have a greater strength and wear resistance. When the investigation on standard value is to be carried out placing the priority on the wear resistance, it may be considerably different from this Standard.

²⁾ Unless otherwise agreed between the parties concerned, the conditions of chemical analysis shall be verified by the ladle analysis. However, in cases of dispute, the composition values (the values in brackets) according to product analysis shall be the deciding criteria.

³⁾ N = normalized or normalized and tempered, E = immersion quenched and tempered

⁴⁾ R_{eH} = upper yield stress, $R_{p0.2}$ = 0.2 % proof stress (non-proportional elongation), R_m = tensile strength, A = percentage elongation after fracture ($L_0 = 5.65 \sqrt{S_0}$), KU = impact strength for ISO U-notch test piece at 23 °C, 1 N/mm² = 1 MPa

⁵⁾ Cr ≤ 0.28 (≤ 0.30 %); Cu ≤ 0.28 % (≤ 0.30 %); Mo ≤ 0.08 % (≤ 0.08 %); Ni ≤ 0.28 % (≤ 0.30 %); V ≤ 0.05 % (≤ 0.05 %); Cr + Mo + Ni shall be max. 0.60 % for all grades.

⁶⁾ If the 0.5 % proof stress $R_{t0.5}$ is not greater than 600 N/mm², $R_{t0.5}$ may be used instead of R_{eH} , $R_{p0.2}$.

⁷⁾ Hardness values are not specified. However, the variation of Brinell hardness shall not exceed 30 HB.

⁸⁾ Mean value of three tests shall be given. When the lowest value among the three pieces is not less than 70 % of the specified value, it may be allowed to be lower than the specified value.

Table 1-2 Grade of steel, chemical composition, heat treatment condition, mechanical properties

Steel grade symbol			Chemical composition by ladle analysis ¹⁾ % (m/m)						Heat treatment		Mechanical properties			
Type	Symbol	Abbreviation	C	Si	Mn	Cu max	P max	S max	Sym-bol	Summary	Tensile strength N/mm ²	Elongation ²⁾ %	Restriction ²⁾ %	Value of impact J min ³⁾
Class 1	STY-R1 ⁴⁾	R1	0.60 to 0.75	0.15 to 0.35	0.50 to 0.90	0.30	0.045	0.050	—	That of as rolled	770 min	8 min	—	—
	STY-R2 ⁴⁾	R2	(0.57) to (0.80)	(0.13) to (0.38)	(0.46) to (0.94)	(0.33)	(0.055)	(0.060)	—	That of as rolled	770 min	8 min	—	10
Class 2	STY-N	N							N	That of normalized	730 min 960 max	14 max 9 min	18 max 13 min	15
Class 3	STY-Q	Q							Q	That of quenched and tempered	860 min 1 080 max	16 max 12 min	32 max 24 min	15

Notes ¹⁾ Unless otherwise agreed between the parties concerned, the conditions of chemical analysis shall be verified by the ladle analysis. However, in cases of dispute, the composition values according to product analysis [the value (in brackets)] shall be the deciding criteria.

²⁾ As regards the steel grade symbols STY-N and STY-Q respectively, the minimum values of elongation and restriction against the tensile strength shall be obtained by the proportional calculation.

³⁾ The mean value of three pieces shall be indicated. When the lowest value of the three pieces is not less than 70 % the specified value, it may be allowed to be smaller than the specified value.

⁴⁾ R1 and R2 of the tyres of class 1 shall be discriminated by the testing method. R1 shall be that of conducting tension test on the test ingot. R2 shall be that of conducting tension test on the product body.

Table 2-1 Types and number of tests

1		2	3	4	5	6	7	8
Test inspection		Test inspection ^{1) 2)} on each heat treatment condition		Note ^{3) 4)}	Test lots ⁵⁾	Number of tyres to be subjected to test inspection on each test lot		Number of test on one piece of tyre
		N	E			≤ 100 tyres	> 100 tyres	
Chemical analysis	Ladle analysis ⁶⁾	m	m	—	c	1	1	1
	Product analysis ⁶⁾	o	o	—	c	1	2	1
Mechanical test	Tension test	m	m	h	c, h	1	2	1
	Impact test	m	m	h	c, h	1	2	3
Microstructure		—	o	h	c, h	1	2	1
Microstructure observation—microphotograph		o	o	—	c	1	2	1
Brinell hardness (uniformity)		o	m	h	c, h	10 % (N) 100 % (E)		1 1
Ultrasonic flaw detection inspection		o	o	h	t	100 %		1
Dimensional inspection		m	m	f	t	100 %		1
Notes ¹⁾ N = normalized or normalized and tempered, E = immersion quenched and tempered ²⁾ m = mandatory test, o = optional test i.e. needs only to be carried out if specified in the order sheet or its appended documents. ³⁾ Unless otherwise agreed between the parties concerned (see 7.1), the test inspection except the ladle analysis shall be carried out under attendance of manufacturer's qualified department. ⁴⁾ h = the test shall not be carried out before the heat treatment, f = the acceptance test shall be carried out in the final delivery condition. ⁵⁾ c = tyres from the same cast, c, h = tyres from the cast and the same heat treatment cycle, t = each one piece of tyre is the test unit. ⁶⁾ When no product analysis is designated, at the first submission for inspection, the manufacturer shall provide a certificate of the ladle analysis results.								