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Carbon steel tubes for general structure

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS G 3444** : 2016), which has been technically revised.

However, **JIS G 3444** : 2016 may be applied in the **JIS** mark certification based on the relevant provisions of Article 30, paragraph (1), etc. of the Industrial Standardization Act until 21 February 2022.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, published patent application or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, published patent application or utility model rights.

Carbon steel tubes for general structure

1 Scope

This Japanese Industrial Standard specifies requirements for the carbon steel tubes (hereafter referred to as tubes), used for civil engineering and architecture such as steel towers, scaffoldings, footing piles, foundation piles, piles for landslide suppression.

NOTE The dimensional range covered by this Standard is generally outside diameter 21.7 mm to 1 016.0 mm. In application for foundation piles and piles for landslide suppression, however, this Standard is mainly applicable to tubes of outside diameter under 318.5 mm, and **JIS A 5525** applies mainly to welded steel tubes of outside diameter 318.5 mm or over.

2 Normative references

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

JIS G 0320 *Standard test method for heat analysis of steel products*

JIS G 0321 *Product analysis and its tolerance for wrought steel*

JIS G 0404 *Steel and steel products — General technical delivery requirements*

JIS G 0415 *Steel and steel products — Inspection documents*

JIS G 3302 *Hot-dip zinc-coated steel sheet and strip*

JIS G 3313 *Electrolytic zinc-coated steel sheet and strip*

JIS G 3314 *Hot-dip aluminium-coated steel sheet and strip*

JIS G 3317 *Hot-dip zinc-5 % aluminium alloy-coated steel sheet and strip*

JIS G 3321 *Hot-dip 55 % aluminium-zinc alloy-coated steel sheet and strip*

JIS G 3323 *Hot-dip zinc-aluminium-magnesium alloy-coated steel sheet and strip*

JIS Z 2241 *Metallic materials — Tensile testing — Method of test at room temperature*

JIS Z 3121 *Methods of tensile test for butt welded joints*

JIS Z 8401 *Rounding of numbers*

3 Symbol of grade

The tubes are classified into 5 grades, and the symbol of grade shall be as given in Table 1.

Table 1 Symbol of grade and symbol for manufacturing method

Symbol of grade	Symbol for manufacturing method		
	Tube manufacturing method	Finishing method	Marking
STK290	Seamless : S Electric resistance welded : E Butt welded : B Automatic arc welded : A	Hot finished : H Cold finished : C As electric resistance welded : G	As given in **11 b)**.
STK400			
STK490			
STK500			
STK540			

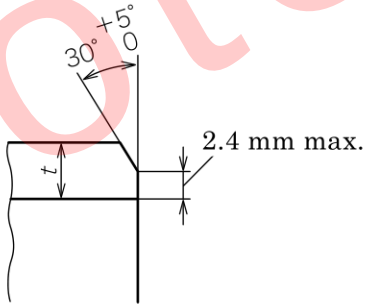
4 Manufacturing method

The manufacturing method shall be as follows.

a) The tubes shall be manufactured by combination of the tube manufacturing method and the finishing method which are indicated in Table 1. The symbol for manufacturing method shall be as specified in Table 1. If required, tubes may be subjected to an appropriate heat treatment.

b) The tubes may be manufactured using coated steel sheet or coated steel strip, if so requested by the purchaser. In this case, the type of coating and coating mass applied should be in accordance with Annex A.

c) The tubes shall be finished with plain ends unless otherwise specified. If the purchaser specifies bevel end finishing, the shape of the bevel end shall be as agreed between the purchaser and the manufacturer. If not specified, the shape of the bevel end shall be in accordance with Figure 1.



t : thickness (mm)

Figure 1 Shape of bevel end

5 Chemical composition

The tubes shall be subjected to the test of **9.1**, and satisfy the heat analysis values given in Table 2. When the product analysis is requested by the purchaser, the test shall be performed according to **9.1**, and the obtained product analysis values shall satisfy the requirements in Table 2 within tolerances given in Table 2 of **JIS G 0321**.

Table 2 Chemical composition [a)]

Unit: %

Symbol of grade	C	Si	Mn	P	S
STK290	—	—	—	0.050 max.	0.050 max.
STK400	0.25 max.	—	—	0.040 max.	0.040 max.
STK490	0.18 max.	0.55 max.	1.65 max.	0.035 max.	0.035 max.
STK500	0.24 max.	0.35 max.	0.30 to 1.30	0.040 max.	0.040 max.
STK540 [b)]	0.23 max.	0.55 max.	1.50 max.	0.040 max.	0.040 max.

Notes [a)] Alloy elements not included in this table and elements indicated with "—" may be added as necessary.
[b)] For STK540, the chemical composition of tubes of wall thickness over 12.5 mm may be as agreed between the purchaser and the manufacturer.

6 Mechanical properties

6.1 Tensile strength and yield point or proof stress

The tubes, steel sheets and steel strip used for manufacturing tubes shall be tested in accordance with **9.2**, and the tensile strength and yield point or proof stress as well as the tensile strength at the weld shall satisfy the values specified in Table 3. The tensile strength in weld is applied to automatic arc welded steel tubes. The tensile test in weld may be omitted upon approval of the purchaser.

Table 3 Mechanical properties

Symbol of grade	Tensile strength N/mm²	Yield point or proof stress N/mm²	Tensile strength in weld N/mm²	Flattening resistance	Bendability	
				Distance between flat plates (H)	Bending angle [a)]	Inside radius
STK290	290 min.	—	290 min.	$\frac{2}{3}D$	90°	6 D
STK400	400 min.	235 min.	400 min.	$\frac{2}{3}D$	90°	6 D
STK490	490 min.	315 min.	490 min.	$\frac{7}{8}D$	90°	6 D
STK500	500 min.	355 min.	500 min.	$\frac{7}{8}D$	90°	8 D
STK540	540 min.	390 min.	540 min.	$\frac{7}{8}D$	90°	6 D

NOTE 1 In this table, D stands for the outside diameter of tube.
NOTE 2 1 N/mm² = 1 MPa
Note [1)] The bending angle shall be measured from the starting point of the bend.

6.2 Elongation

The tubes, steel sheets and steel strip used for manufacturing tubes shall be tested in accordance with **9.2**, and elongation corresponding to the tube manufacturing method shall be as given in Table 4. However, when the tensile test is performed on Test piece No. 12 or Test piece No. 5 taken from the tube under 8 mm in wall thickness, the elongation shall be in accordance with Table 5.

Table 4 Elongation

Unit: %

Symbol of grade	Tube manufacturing method				
	Seamless and butt welded	Electric resistance welded and automatic arc welded		All tube manufacturing methods	
	Test piece and direction of test piece				
	Test piece No. 11 Test piece No. 12	Test piece No. 11 [a] Test piece No. 12 [a]	Test piece No. 5 [b]	Test piece No. 4 [c]	
	Direction parallel to tube axis	Direction parallel to tube axis	Direction perpendicular to tube axis	Direction parallel to tube axis	Direction perpendicular to tube axis
STK290	30 min.	30 min.	25 min.	28 min.	23 min.
STK400	23 min.	23 min.	18 min.	21 min.	17 min.
STK490	23 min.	23 min.	18 min.	21 min.	17 min.
STK500	15 min.	15 min.	10 min.	14 min.	9 min.
STK540	20 min.	20 min.	16 min.	19 min.	15 min.

The value of elongation in this table does not apply to tubes whose outside diameter is under 40 mm, but the test results shall be recorded. Upon agreement between the purchaser and the manufacturer, the elongation may be specified.

Notes
[a] Test piece No. 11 and Test piece No. 12 shall be used for tubes of outside diameter 350 mm or under.
[b] Test piece No. 5 shall be used for tubes of outside diameter over 350 mm. Test piece No. 5, instead of Test piece No. 11 and Test piece No. 12, may be used for tubes of outside diameter 200 mm or over up to and including 350 mm, and upon approval by the purchaser, for tubes of outside diameter under 200 mm.
[c] The tensile direction shall be equal to the direction parallel to tube axis. Where feasible, test pieces may be taken in the direction perpendicular to the tube axis instead of the direction parallel to the tube axis.

Table 5 Elongation of tubes with a wall thickness under 8 mm, tested using Test pieces No. 12 (direction parallel to tube axis) and No. 5 (direction perpendicular to tube axis)

Unit: %

Symbol of grade	Test piece	Wall thickness							
		1 mm or under	Over 1 mm up to and incl. 2 mm	Over 2 mm up to and incl. 3 mm	Over 3 mm up to and incl. 4 mm	Over 4 mm up to and incl. 5 mm	Over 5 mm up to and incl. 6 mm	Over 6 mm up to and incl. 7 mm	Over 7 mm to and excl. 8 mm
STK290	Test piece No. 12	20 min.	21 min.	22 min.	24 min.	26 min.	27 min.	28 min.	30 min.
	Test piece No. 5	14 min.	16 min.	18 min.	19 min.	20 min.	22 min.	24 min.	25 min.
STK400	Test piece No. 12	12 min.	14 min.	16 min.	17 min.	18 min.	20 min.	22 min.	23 min.
	Test piece No. 5	8 min.	9 min.	10 min.	12 min.	14 min.	15 min.	16 min.	18 min.
STK490	Test piece No. 12	12 min.	14 min.	16 min.	17 min.	18 min.	20 min.	22 min.	23 min.
	Test piece No. 5	8 min.	9 min.	10 min.	12 min.	14 min.	15 min.	16 min.	18 min.
STK500	Test piece No. 12	4 min.	6 min.	8 min.	9 min.	10 min.	12 min.	14 min.	15 min.
	Test piece No. 5	—	1 min.	2 min.	4 min.	6 min.	7 min.	8 min.	10 min.
STK540	Test piece No. 12	10 min.	11 min.	12 min.	14 min.	16 min.	17 min.	18 min.	20 min.
	Test piece No. 5	6 min.	7 min.	8 min.	10 min.	12 min.	13 min.	14 min.	16 min.

NOTE The elongation values in this table are given by deducting 1.5, for every 1 mm decrease in wall thickness from 8 mm, from the values given in Table 4 and rounding the results to the whole number according to Rule A in **JIS Z 8401**.

6.3 Flattening resistance

The flattening resistance shall apply to seamless steel tubes, electric resistance welded steel tubes or butt-welded steel tubes. The tube shall be tested in accordance with **9.2**, and the test piece shall be free from cracks when flattened until the distance between the plates *H* reaches the value given in Table 3.

NOTE For the flattening test, see **9.2.4**.

6.4 Bendability

The bendability requirement applies where the purchaser specifies a bend test instead of a flattening test for tubes of outside diameter 50 mm or under. The bendability shall be tested in accordance with **9.2**, and the test piece shall be free from cracks when bent to an angle given in Table 3 with an inside radius given in Table 3.

7 Dimensions, unit mass and dimensional tolerances

7.1 Dimensions and unit mass

The outside diameter, wall thickness and unit mass of the tubes shall be as given in Table 6. Dimensions other than specified in Table 6 may be agreed between the purchaser and the manufacturer. In this case, the unit mass shall be calculated by the following formula assuming that the mass of steel of 1 cm^3 is 7.85 g, and the result shall be rounded off to three significant figures according to Rule A of **JIS Z 8401**.

$$W = 0.024\,66\,t\,(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D: outside diameter of tube (mm)

0.024 66 : unit conversion factor for obtaining W

NOTE The unit mass values in Table 6 are the results of the calculation given above.

For purposes of reference, Table 6 shows the sectional area, geometrical moment of inertia, section modulus and radius of gyration of cross-section.

Table 6 Dimensions and unit mass of tubes

Outside diameter mm	Wall thickness mm	Unit mass kg/m	Reference			
			Sectional area cm^2	Geometrical moment of inertia cm^4	Section modulus cm^3	Radius of gyration of cross-section cm
21.7	2.0	0.972	1.238	0.607	0.560	0.700
27.2	2.0	1.24	1.583	1.26	0.930	0.890
	2.3	1.41	1.799	1.41	1.03	0.880
34.0	2.3	1.80	2.291	2.89	1.70	1.12
42.7	2.3	2.29	2.919	5.97	2.80	1.43
	2.5	2.48	3.157	6.40	3.00	1.42
48.6	2.3	2.63	3.345	8.99	3.70	1.64
	2.5	2.84	3.621	9.65	3.97	1.63
	2.8	3.16	4.029	10.6	4.36	1.62
	3.2	3.58	4.564	11.8	4.86	1.61
60.5	2.3	3.30	4.205	17.8	5.90	2.06
	3.2	4.52	5.760	23.7	7.84	2.03
	4.0	5.57	7.100	28.5	9.41	2.00
76.3	2.8	5.08	6.465	43.7	11.5	2.60
	3.2	5.77	7.349	49.2	12.9	2.59
	4.0	7.13	9.085	59.5	15.6	2.58
89.1	2.8	5.96	7.591	70.7	15.9	3.05
	3.2	6.78	8.636	79.8	17.9	3.04
101.6	3.2	7.76	9.892	120	23.6	3.48
	4.0	9.63	12.26	146	28.8	3.45
	5.0	11.9	15.17	177	34.9	3.42
114.3	3.2	8.77	11.17	172	30.2	3.93
	3.5	9.56	12.18	187	32.7	3.92
	4.5	12.2	15.52	234	41.0	3.89
139.8	3.6	12.1	15.40	357	51.1	4.82
	4.0	13.4	17.07	394	56.3	4.80
	4.5	15.0	19.13	438	62.7	4.79
	6.0	19.8	25.22	566	80.9	4.74
165.2	4.5	17.8	22.72	734	88.9	5.68
	5.0	19.8	25.16	808	97.8	5.67
	6.0	23.6	30.01	952	115	5.63
	7.1	27.7	35.26	110 × 10	134	5.60
190.7	4.5	20.7	26.32	114 × 10	120	6.59
	5.3	24.2	30.87	133 × 10	139	6.56
	6.0	27.3	34.82	149 × 10	156	6.53
	7.0	31.7	40.40	171 × 10	179	6.50
	8.2	36.9	47.01	196 × 10	206	6.46
216.3	4.5	23.5	29.94	168 × 10	155	7.49
	5.8	30.1	38.36	213 × 10	197	7.45
	6.0	31.1	39.64	219 × 10	203	7.44
	7.0	36.1	46.03	252 × 10	233	7.40
	8.0	41.1	52.35	284 × 10	263	7.37
	8.2	42.1	53.61	291 × 10	269	7.36

Table 6 (continued)

Outside diameter mm	Wall thickness mm	Unit mass kg/m	Reference			
			Sectional area cm^2	Geometrical moment of inertia cm^4	Section modulus cm^3	Radius of gyration of cross-section cm
267.4	6.0	38.7	49.27	421 × 10	315	9.24
	6.6	42.4	54.08	460 × 10	344	9.22
	7.0	45.0	57.26	486 × 10	363	9.21
	8.0	51.2	65.19	549 × 10	411	9.18
	9.0	57.3	73.06	611 × 10	457	9.14
	9.3	59.2	75.41	629 × 10	470	9.13
318.5	6.0	46.2	58.91	719 × 10	452	11.1
	6.9	53.0	67.55	820 × 10	515	11.0
	8.0	61.3	78.04	941 × 10	591	11.0
	9.0	68.7	87.51	105 × 10^2	659	10.9
	10.3	78.3	99.73	119 × 10^2	744	10.9
355.6	6.4	55.1	70.21	107 × 10^2	602	12.3
	7.9	67.7	86.29	130 × 10^2	734	12.3
	9.0	76.9	98.00	147 × 10^2	828	12.3
	9.5	81.1	103.3	155 × 10^2	871	12.2
	12.0	102	129.5	191 × 10^2	108 × 10	12.2
	12.7	107	136.8	201 × 10^2	113 × 10	12.1
406.4	7.9	77.6	98.90	196 × 10^2	967	14.1
	9.0	88.2	112.4	222 × 10^2	109 × 10	14.1
	9.5	93.0	118.5	233 × 10^2	115 × 10	14.0
	12.0	117	148.7	289 × 10^2	142 × 10	14.0
	12.7	123	157.1	305 × 10^2	150 × 10	13.9
	16.0	154	196.2	374 × 10^2	184 × 10	13.8
	19.0	182	231.2	435 × 10^2	214 × 10	13.7
457.2	9.0	99.5	126.7	318 × 10^2	140 × 10	15.8
	9.5	105	133.6	335 × 10^2	147 × 10	15.8
	12.0	132	167.8	416 × 10^2	182 × 10	15.7
	12.7	139	177.3	438 × 10^2	192 × 10	15.7
	16.0	174	221.8	540 × 10^2	236 × 10	15.6
	19.0	205	261.6	629 × 10^2	275 × 10	15.5
500.0	9.0	109	138.8	418 × 10^2	167 × 10	17.4
	12.0	144	184.0	548 × 10^2	219 × 10	17.3
	14.0	168	213.8	632 × 10^2	253 × 10	17.2
508.0	7.9	97.4	124.1	388 × 10^2	153 × 10	17.7
	9.0	111	141.1	439 × 10^2	173 × 10	17.6
	9.5	117	148.8	462 × 10^2	182 × 10	17.6
	12.0	147	187.0	575 × 10^2	227 × 10	17.5
	12.7	155	197.6	606 × 10^2	239 × 10	17.5
	14.0	171	217.3	663 × 10^2	261 × 10	17.5
	16.0	194	247.3	749 × 10^2	295 × 10	17.4
	19.0	229	291.9	874 × 10^2	344 × 10	17.3
	22.0	264	335.9	994 × 10^2	391 × 10	17.2
558.8	9.0	122	155.5	588 × 10^2	210 × 10	19.4
	12.0	162	206.1	771 × 10^2	276 × 10	19.3
	16.0	214	272.8	101 × 10^3	360 × 10	19.2
	19.0	253	322.2	118 × 10^3	421 × 10	19.1
	22.0	291	371.0	134 × 10^3	479 × 10	19.0

Table 6 (concluded)

Outside diameter mm	Wall thickness mm	Unit mass kg/m	Reference			
			Sectional area cm^2	Geometrical moment of inertia cm^4	Section modulus cm^3	Radius of gyration of cross-section cm
600.0	9.0	131	167.1	730×10^2	243×10	20.9
	12.0	174	221.7	958×10^2	320×10	20.8
	14.0	202	257.7	111×10^3	369×10	20.7
	16.0	230	293.6	125×10^3	418×10	20.7
609.6	9.0	133	169.8	766×10^2	251×10	21.2
	9.5	141	179.1	806×10^2	265×10	21.2
	12.0	177	225.3	101×10^3	330×10	21.1
	12.7	187	238.2	106×10^3	348×10	21.1
	14.0	206	262.0	116×10^3	381×10	21.1
	16.0	234	298.4	132×10^3	431×10	21.0
	19.0	277	352.5	154×10^3	505×10	20.9
	22.0	319	406.1	176×10^3	576×10	20.8
700.0	9.0	153	195.4	117×10^3	333×10	24.4
	12.0	204	259.4	154×10^3	439×10	24.3
	14.0	237	301.7	178×10^3	507×10	24.3
	16.0	270	343.8	201×10^3	575×10	24.2
711.2	9.0	156	198.5	122×10^3	344×10	24.8
	12.0	207	263.6	161×10^3	453×10	24.7
	14.0	241	306.6	186×10^3	524×10	24.7
	16.0	274	349.4	211×10^3	594×10	24.6
	19.0	324	413.2	248×10^3	696×10	24.5
	22.0	374	476.3	283×10^3	796×10	24.4
812.8	9.0	178	227.3	184×10^3	452×10	28.4
	12.0	237	301.9	242×10^3	596×10	28.3
	14.0	276	351.3	280×10^3	690×10	28.2
	16.0	314	400.5	318×10^3	782×10	28.2
	19.0	372	473.8	373×10^3	919×10	28.1
	22.0	429	546.6	428×10^3	105×10^2	28.0
914.4	12.0	267	340.2	348×10^3	758×10	31.9
	14.0	311	396.0	401×10^3	878×10	31.8
	16.0	354	451.6	456×10^3	997×10	31.8
	19.0	420	534.5	536×10^3	117×10^2	31.7
	22.0	484	616.5	614×10^3	134×10^2	31.5
1 016.0	12.0	297	378.5	477×10^3	939×10	35.5
	14.0	346	440.7	553×10^3	109×10^2	35.4
	16.0	395	502.7	628×10^3	124×10^2	35.4
	19.0	467	595.1	740×10^3	146×10^2	35.2
	22.0	539	687.0	849×10^3	167×10^2	35.2

7.2 Dimensional tolerances

The dimensional tolerances shall be as follows.

a) The tolerance on outside diameter of tubes shall be as given in Table 7.

b) The tolerance on wall thickness of tubes shall be as given in Table 8.

The tolerance on outside diameter and wall thickness for tubes manufactured from coated steel sheet or coated steel strip shall be as given in Tables 7 and 8. The plus tolerance shall apply to the outside diameter and wall thickness including the coating layer, and the minus tolerance shall apply to the outside diameter and wall thickness values reduced by the equivalent or actually measured coating thickness.

Equivalent coating thickness shall be as specified in **JIS G 3302** in the case of hot-dip zinc coating, as specified in **JIS G 3313** in the case of electrolytic zinc coating, as specified in **JIS G 3314** in the case of hot-dip aluminium coating, as specified in **JIS G 3317** in the case of hot-dip zinc-5 % aluminium alloy coating, as specified in **JIS G 3321** in the case of hot-dip 55 % aluminium-zinc alloy coating and as specified in **JIS G 3323** in the case of hot-dip zinc-aluminium-magnesium alloy coating.

c) The length of tubes shall be in accordance with the specified length. For the tolerance on length of tubes, the minus side shall be zero, and the plus side not specified. The tolerance on length of tubes may be agreed between the purchaser and the manufacturer.

Table 7 Tolerances on outside diameter [a)]

Category	Outside diameter [b)]	Tolerance on outside diameter [c)]	Applicable category
Class 1	Under 50 mm	±0.5 mm	Applicable to hot finished seamless steel tubes, unless otherwise specified.
	50 mm or over	±1 %	
Class 2	Under 50 mm	±0.25 mm	Applicable when specified, but not applicable to hot finished seamless steel tubes.
	50 mm or over	±0.5 %	

Notes
a) For local repaired parts, the tolerances on outside diameter in this table shall not apply.
b) The measurement of tubes with an outside diameter over 350 mm may be based on measurement of the circumference. The conversion between the outside diameter (D) and the circumferential length (l) is obtained by the following formula.

$$D = l / \pi$$

where, D : outside diameter (mm)
l : circumferential length (mm)
π : 3.141 6

c) Class 1 is applicable to electric resistance welded steel tubes and automatic arc welded steel tubes of outside diameter over 350 mm. The tolerance on outside diameter at the end of tubes is ±0.5 %.

Table 8 Tolerance on wall thickness [a)]

Category	Seamless steel tubes		Other tubes than seamless steel tubes		Applicable category
	Wall thickness	Tolerances on wall thickness	Wall thickness	Tolerances on wall thickness	
Class 1	Under 4 mm	+0.6 mm –0.5 mm	Under 4 mm	+0.6 mm –0.5 mm	Applicable to hot finished seamless steel tubes, unless otherwise specified.
	4 mm or over	+15 % –12.5 %	4 mm or over to and excl. 12 mm	+15 % –12.5 %	
			12 mm or over	+15 % –1.5 mm	
Class 2	Under 3 mm	±0.3 mm	Under 3 mm	±0.3 mm	Applicable when specified, but not applicable to hot finished seamless steel tubes.
	3 mm or over	±10 %	3 mm or over to and excl. 12 mm	±10 %	
			12 mm or over	+10 % –1.2 mm	
Note [a)]	The tolerances on wall thickness of tubes of outside diameter over 1 016.0 mm may be as agreed between the purchaser and the manufacturer.				

8 Appearance

The appearance shall be as follows.

a) The tubes shall be straight for practical purposes, and the both ends shall be at right angles to the tube axis.

b) Both internal and external surfaces of tubes shall be finished smoothly and free from defects detrimental to use. If any detrimental defects exist, the tubes may be repaired by grinding, machining or other methods, or repaired by welding. In this case, the following conditions shall be satisfied.

1) When tubes are repaired by grinding, machining or other methods, the following shall be met :

— wall thickness after repair shall be within tolerances on wall thickness;

— the surface of the repaired part shall be smooth along the contour of the tube.

2) When tubes are repaired by welding, the following shall be met :

— only the base metal of automatic arc welded steel tubes, electric resistance welded steel tubes and butt-welded steel tubes, and the weld of automatic arc welded steel tubes shall be subjected to the repair by welding;

— the detrimental defects of tubes shall be completely eliminated by chipping, grinding or other suitable methods prior to welding. The depth of base metal removed shall be 20 % or less of nominal wall thickness of tubes. The to-

tal area repaired on the surface shall be 2 % or less of the surface area of the tube;

— the repair by welding shall be performed by an appropriate method according to the type of steel material, and for the weld, by an appropriate method according to characteristics of the weld;

— the area repaired by welding shall not have undercuts or overlaps at the edges. The weld reinforcement shall be as high as or above the rolling surface and shall be removed by chipping, grinding or other methods. The repaired areas shall blend smoothly with adjacent parts and, in the case of the weld, with the weld beads;

— for heat-treated tubes, the tube body shall be subjected to another heat treatment after repair by welding.

c) The surface finishing of tubes and coating, when especially requested, shall be as agreed between the purchaser and the manufacturer.

d) Upon the agreement between the purchaser and the manufacturer, tubes may be coated (e.g. zinc rich painting, epoxy coating, primer coating) on the external and/or internal surface.

e) When specified by the purchaser, hanging fixtures may be installed on the tubes, provided that strength and safety are considered. In this case, the specification and inspection of the fixtures shall be as agreed between the purchaser and the manufacturer.

9 Tests

9.1 Chemical analysis

9.1.1 General requirements and sampling method

General requirements for chemical analysis and sampling method for heat analysis shall be in accordance with Clause **8** of **JIS G 0404**. When the product analysis is requested by the purchaser, the sampling method shall be in accordance with Clause **4** of **JIS G 0321**.

9.1.2 Analytical method

The heat analysis method shall be in accordance with **JIS G 0320**. The product analysis method shall be in accordance with **JIS G 0321**.

9.2 Mechanical tests

9.2.1 General

General requirements for mechanical tests shall be in accordance with Clauses **7** and **9** of **JIS G 0404**. However, the sampling method for mechanical tests shall be in accordance with Class A in **7.6** of **JIS G 0404**.

The mechanical tests for tubes manufactured from coated steel sheets or coated steel strip shall be performed on tubes with the coating applied.

9.2.2 Sampling method and number of test pieces

The sampling method and the number of test pieces shall be as given in Table 9. When sampling tensile test piece of weld for automatic arc welded steel tubes, take one sample from every 1 250 m length or its fraction of tubes of the same dimensions and the same heat treatment batch, and from the sample take one test piece.

Table 9 Sampling method and number of test pieces

Outside diameter	Sampling method	Number of test pieces
≤ 65 mm	Take one sample from each 10 000 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c].	The number of test pieces to be taken from the sample is as follows. The applicable test piece shall be in accordance with Clause **6**. Tensile test piece : one Flattening test piece : one Bend test piece : one
> 65 mm ≤ 100 mm	Take one sample from each 5 000 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c].	
> 100 mm ≤ 200 mm	Take one sample from each 2 500 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c].	
> 200 mm ≤ 350 mm	Take one sample from each 1 250 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c].	
> 350	a) When taking samples from a tube : Take one sample from each 1 250 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c]. b) When taking samples for tensile test piece from steel strip or steel sheets : Steel strip : Take one sample from one lot of steel strip which belongs to the same heat and be of the same thickness. For steel strip of mass over 50 t, take two samples. Steel sheet : Take one sample from one lot of steel sheet which belongs to the same heat and whose maximum thickness is within two times the minimum thickness. For steel sheet of mass over 50 t, take two samples.	
Notes [a] "Same dimensions" refer to the same outside diameter and the same wall thickness. [b] Applicable to heat-treated tubes. The "same heat treatment batch" in the case of using continuous furnace refers to a unit of tubes from continuous furnace operation under the same heat treatment conditions, and tubes which are heat treated after any stop of furnace operation do not belong to the same heat treatment batch. [c] In the case of sampling from a unit of tubes from the same cast, the tubes in the unit may be of the same heat treatment condition, instead of being from the same heat treatment batch.		

9.2.3 Tensile test

The tensile test shall be performed on the parent metal of tube, or steel sheet or steel

strip for manufacturing tubes, and the weld of automatic arc welded steel tube. The tensile test piece and the test method shall be as follows.

a) **Test piece** The test piece shall be as follows.

1) Tensile test pieces shall be one of No. 11, No. 12 (No. 12 A, No. 12 B and No. 12 C), No. 4 or No. 5 specified in **JIS Z 2241**. Test piece No. 4 shall be of diameter 14 mm (gauge length 50 mm). In the case of electric resistance welded steel tubes and automatic arc welded steel tubes, Test piece No. 11 and Test piece No. 12 shall be used for tubes of outside diameter 350 mm or under, and Test piece No. 5 shall be used for tubes of outside diameter over 350 mm. Test piece No. 5, instead of Test piece No. 11 and Test piece No. 12, may be used for tubes of outside diameter 200 mm or over up to and including 350 mm, and upon approval by the purchaser, for tubes of outside diameter under 200 mm. Test piece No. 5, when taken from the tube, shall be cut in the direction perpendicular to the tube axis, then be flattened to make into the test piece.

2) Test piece No. 5 specified in **JIS Z 2241**, when taken from electric resistance welded steel tubes and automatic arc welded steel tubes of outside diameter over 350 mm, shall be taken by one of the following methods.

— For expanded tubes, a test piece shall be taken directly from the tube.

— For non-expanded tubes, a test piece shall be taken directly from the tube, or from steel strip or steel sheet used for manufacturing tubes.

A test piece, when taken from the steel strip or steel sheet, shall be taken in the direction parallel to or perpendicular to the rolling direction.

3) When a tensile test piece is taken from butt-welded steel tube, electric resistance welded steel tube and automatic arc welded steel tube, Test piece No. 12 or No. 5 shall be taken from a portion not containing the weld.

4) For tensile test piece of weld for automatic arc welded steel tubes, a sample shall be cut off either from the tube or the part of tube end that is welded under the same condition as the tube, then be flattened to take as Test piece No.1 as given in **JIS Z 3121**.

5) The wall thickness used to calculate the yield point or proof stress, and tensile strength for tubes manufactured from coated steel sheet or coated steel strip shall be one of the following.

— Actually measured wall thickness after removal of coating

— Actually measured wall thickness including the coating layer, from which the equivalent coating thickness has been deducted

— Actually measured wall thickness including the coating layer, from which the coating thickness obtained through conversion of the actually measured coating mass has been deducted

b) **Test method** The tensile test method shall be as specified in **JIS Z 2241**.

9.2.4 Flattening test

The flattening test piece and the test method shall be as follows.

The flattening test of seamless steel tubes may be omitted unless otherwise specified by the purchaser [1)].

Note [1)] It means that although the test may be omitted according to the judgement of the manufacturer, the tubes shall satisfy the specified flattening resistance.

a) **Test piece** The length of the test piece shall be 50 mm or greater.

b) **Test method** Place the test piece at ordinary temperature (5 °C to 35 °C) between two flat plates and compress to flatten until the distance between the plates *H* becomes equal to or smaller than the value specified in Table 3, then examine for cracks on the test piece. In this case, place the weld of electric resistance welded steel tube and butt-welded steel tube, as shown in Figure 2, such that the line connecting the centre of the tube and the weld is perpendicular to the direction of compression.

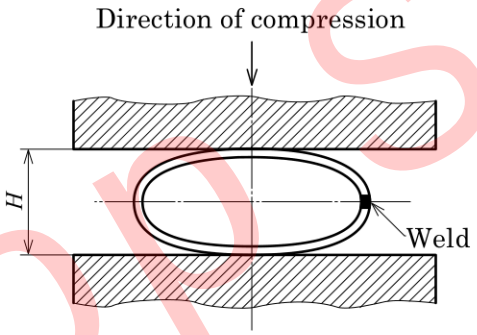


Figure 2 Flattening test

9.2.5 Bend test

The bend test piece and the test method shall be as follows.

a) **Test piece** The test piece shall be of the proper length for the bend test.

b) **Test method** Bend the test piece around a cylinder at ordinary temperature (5 °C to 35 °C) at a bending angle not less than the minimum bending angle specified in Table 3, and with an inside radius not more than the maximum inside radius specified in Table 3, and examine the test piece for cracks. For testing the electric resistance welded steel tube and butt-welded steel tube, place the test piece such that the weld is 90 °C from the outermost position of the bend.

NOTE In addition to the tests specified in this Standard, a hydrostatic test, non-destructive test at the weld and other tests are in some cases carried out upon agreement between the purchaser and the manufacturer. In this case, the test item, sampling method, test method, acceptance criteria, or any other test requirements shall be previously agreed between

the purchaser and the manufacturer.

10 Inspection and reinspection

10.1 Inspection

The inspection shall be as follows.

a) General requirements for inspection shall be in accordance with **JIS G 0404**.

b) Chemical composition shall conform to the requirements of Clause **5**.

c) Mechanical properties shall conform to the requirements of Clause **6**.

d) Dimensions shall conform to the requirements of Clause **7**.

e) Appearance shall conform to the requirements of Clause **8**.

10.2 Reinspection

The tubes having failed in the mechanical tests may be subjected to the retest according to **9.8** of **JIS G 0404** for further acceptance judgement.

11 Marking

Each tube having passed the inspection shall be marked with the following information. When the marking on tube is difficult because its outside diameter is small or when so requested by the purchaser, the marking may be given on each bundle of tubes by a suitable means. In this case, the order of marking is not specified. Any information among the following not essential for identification of the product may be omitted upon agreement between the purchaser and the manufacturer.

a) Symbol of grade

b) Symbol for manufacturing method The symbol for manufacturing method shall be as follows. A dash may be replaced with a blank.

1) Hot finished seamless steel tube : –S–H

2) Cold finished seamless steel tube : –S–C

3) As electric resistance welded steel tube : –E–G

4) Hot-finished electric resistance welded steel tube : –E–H

5) Cold-finished electric resistance welded steel tube : –E–C

6) Butt-welded steel tubes –B

7) Automatic arc welded steel tubes –A

c) Dimensions The outside diameter and wall thickness shall be marked.

d) Manufacturer's name or abbreviation

e) Symbol indicating the type of coating (in the case of using coated steel sheet or coated steel strip). This symbol shall be as agreed between the purchaser and the manufacturer.

Example STK290–E–G– (symbol of coating type : PZ)

12 Report

Unless otherwise specified, the manufacturer shall submit an inspection document to the purchaser. The report shall be in accordance with Clause **13** of **JIS G 0404**. Unless otherwise specified in the order, the type of the inspection document to be submitted shall be in accordance with **5.1** of **JIS G 0415**.

Annex A (normative)

Type of coating and coating mass for tubes manufactured from coated steel sheet or coated steel strip

A.1 Type of coating and coating mass

The type of coating and coating mass applied should be as follows.

a) The types of coating that can be applied are : hot-dip zinc coating, electrolytic zinc coating, hot-dip aluminium coating, hot-dip zinc-5 % aluminium alloy coating, hot-dip 55 % aluminium-zinc alloy coating or hot-dip zinc-aluminium-magnesium alloy coating. Upon agreement between the purchaser and the manufacturer, other types of coating than these may be applied [see **c**)]. When applying equivalent thickness coating, the coating mass as specified in **JIS G 3302**, **JIS G 3313**, **JIS G 3314**, **JIS G 3317**, **JIS G 3321** and **JIS G 3323** is applied.

b) In the case of applying hot-dip zinc coating and hot-dip 55 % aluminium-zinc alloy coating, the coating mass may be different between the front and rear surfaces of the steel sheet or steel strip (differential thickness coating). In this case, the following conditions should be satisfied.

1) The coating mass on the outer surface of the tube for hot-dip zinc coating should meet the minimum triple-spot average value [1)] and minimum single-spot value [1)] of 30 g/m^2 and 26 g/m^2, respectively, and for hot-dip 55 % aluminium-zinc alloy coating, 35 g/m^2 and 30 g/m^2, respectively.

Note [1)] See **5.3.2** of **JIS G 3302**.

2) The coating mass on the inner surface of the tube for both hot-dip zinc coating and hot-dip 55 % aluminium-zinc alloy coating should meet the minimum triple-spot average value and minimum single-spot value of 30 g/m^2 and 26 g/m^2, respectively.

c) Upon agreement between the purchaser and the manufacturer, other type of hot-dip coating or electrolytic coating than stated in **a**) may be applied. In this case, the following conditions should be satisfied.

1) For hot-dip coating, the total coating mass of both surfaces should meet the minimum triple-spot average value and minimum single-spot value of 60 g/m^2 and 51 g/m^2, respectively.

2) For electrolytic coating, the coating mass on one surface should meet the minimum value of 8.5 g/m^2 in the case of equal thickness coating and 8 g/m^2 in the case of differential thickness coating.

Errata for **JIS** (English edition) can be downloaded in PDF format at Webdesk (purchase information page) of our website (https://www.jsa.or.jp/).

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