Carbon Steel Square Pipes for General Structural Purposes

1. Scope

This Japanese Industrial Standard specifies the carbon steel square pipes, hereinafter referred to as the "square tubes", used for civil engineering, architecture and other structures.

Remark: The units and numerical values given in { } in this Standard are based on the International System of Units (SI) and are appended for informative reference.

Further, the traditional units accompanied by numerical values in this Standard shall be converted, January 1, 1991, to the SI units and numerical values.

2. Grade and Designation

Square tubes shall be classified into 2 grades, and their designation shall be as given in Table 1-1 or Table 1-2.

Table 1-1. Designation of Grade
(Applicable till the end of 1990)

Designation of grade
STKR 41
STKR 50

Table 1-2. Designation of Grade
(Applicable on and after Jan. 1, 1991)

Designation of grade	(Informative reference) Traditional designation
STKR 400	STKR 41
STKR 490	STKR 50

3. Chemical Composition

The pipe shall be tested in accordance with 8.1 and the resulting ladle analysis values shall conform to Table 2-1 or Table 2-2.

Table 2-1. Chemical Composition

(Applicable till the end of 1990)

Unit: %

Designation of grade	C	Si	Mn	P	S
STKR 41	0.25 max.	—	— [a]	0.040 max.	0.040 max.
STKR 50	0.18 max.	0.55 max.	1.50 max.	0.040 max.	0.040 max.

Remark: When a pipe is made from killed steel and the purchaser requires product analysis, the tolerances on the values given in the above table shall be as specified in Table 1 in JIS G 0321.

Table 2-2. Chemical Composition

(Applicable on and after Jan. 1, 1991)

Unit: %

Designation of grade	C	Si	Mn	P	S
STKR 400	0.25 max.	—	—	0.040 max.	0.040 max.
STKR 490	0.18 max.	0.55 max.	1.50 max.	0.040 max.	0.040 max.

Remark: When a pipe is made from killed steel and the purchaser requires product analysis, the tolerances on the values given in the above table shall be as specified in Table 1 in JIS G 0321.

4. Mechanical Properties

4.1 Tensile Strength, Yield Point or Proof Stress and Elongation The tube shall be tested in accordance with 8.2 and the resulting tensile strength, yield point or proof stress and elongation shall conform to Table 3-1 or Table 3-2.

Table 3-1. Mechanical Properties

(Applicable till the end of 1990)

Designation of grade	Tensile strength kgf/mm² {N/mm²}	Yield point or proof stress kgf/mm² {N/mm²}	Elongation %
			No. 5 test piece
STKR 41	41 min. {402} min.	25 min. {245} min.	23 min.
STKR 50	50 min. {490} min.	33 min. {324} min.	23 min.

Remarks 1. When the tube under 8 mm in thickness is subjected to tensile test, the minimum value of elongation shall be calculated by subtracting 1.5 % from the value of elongation given in Table 3-1 for each decrease of 1 mm and rounding off the result to a whole number according to JIS Z 8401.

2. When a tensile test piece is to be taken from the welded steel square tube, one shall be taken from a seamless portion.

Table 3-2. Mechanical Properties

(Applicable on and after Jan. 1, 1991)

Designation of grade	Tensile strength N/mm²	Yield point or proof stress N/mm²	Elongation %
			No. 5 test piece
STKR 400	400 min.	245 min.	23 min.
STKR 490	490 min.	325 min.	23 min.

Remarks 1. When the tube under 8 mm in thickness is subjected to tensile test, the minimum value of elongation shall be calculated by subtracting 1.5 % from the value of elongation given in Table 3-2 for each decrease of 1 mm and rounding off the result to a whole number according to JIS Z 8401.

2. When a tensile test piece is to be taken from the welded steel square tube, one shall be taken from a seamless portion.

4.2 Bendability For a square tube manufactured by welding, a bending test on welded zone shall be made as required by the purchaser. In this case, the specified values, test method and sampling method shall be agreed upon by the purchaser and the manufacturer.

5. Dimensions, Mass and Dimensional Tolerances

5.1 Dimension and Weight The dimensions and mass of square tubes shall be as given in Attached Table. However, the standard radius of curvature at corner shall be 1.5 t of wall thickness on the center line of the wall thickness.

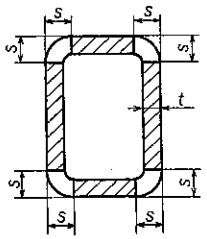
The standard lengths of the tube shall be 6 m, 8 m, 10 m and 12 m.

5.2 Dimensional Tolerances The tolerances on side length, unevenness of flat plate portion for each side, angularity made between adjacent flat plate portions, dimension at corner, length, unstraightness and wall thickness for square tubes shall be as given in Table 4. In this case, the measurement of dimensions of sectional profile and angle at corner shall be made at any point except both ends of the square tube.

Table 4. Dimensional Tolerances

Specified item and dimension			Dimensional tolerances
Length of side	100 mm or under		± 1.5 mm
	Over 100 mm		± 1.5 %
Unevenness of flat plate portion of each side	Side length 100 mm or under		0.5 mm max.
	Side length over 100 mm		Within 0.5 % of side length
Angularity made by adjacent flat plate portions			± 1.5°
Dimension at corner: S			3 t max.
Length			+ not specified 0
Unstraightness			Within 0.3 % of whole length
Wall thickness	Square steel tube manufactured by welding	Under 3 mm	± 0.3 mm
		3 mm or over	± 10 %
	Seamless square steel tube	Under 4 mm	± 0.6 mm
		4 mm or over	± 15 %

Remarks 1. The "flat plate portion" is defined as the hatched portion shown in the figure below.



t : wall thickness of flat plate portion

S : dimension at corner

2. The tolerances on the dimensions at corner may be altered by agreement between the purchaser and the manufacturer.

3. The tolerances on unstraightness shall be applied to the upper to lower bend and the right to left bend with a long pitch.

4. The tolerances on wall thickness shall be applied to the flat plate portion.

6. Appearance

(1) Square tubes shall be free from defects that are detrimental to practical use.

(2) The surface finishing of square tubes and plating, if particularly required by the purchaser, shall be agreed upon between the purchaser and the manufacturer.

7. Method of Manufacture

(1) Square tubes shall be manufactured by forming welded steel tubes (by means of electric resistance welding, forging welding or automatic arc welding) or seamless steel tubes into square section, or manufactured by forming a steel sheet in coil into square section or into one pair of channel section followed by a continuous electric resistance welding or automatic arc welding process.

(2) Square tubes shall be furnished as manufactured condition and, as a rule, not heat-treated.

8. Test

8.1 Chemical Analysis

8.1.1 Chemical Analysis General matters of chemical analysis and method of sampling specimens for analysis shall be in accordance with 3. in JIS G 0303.

8.1.2 Analytical Method The analytical method shall be in accordance with one of the following Standards:

JIS G 1211
JIS G 1212
JIS G 1213
JIS G 1214
JIS G 1215
JIS G 1253
JIS G 1256
JIS G 1257

8.2 Tensile Test

8.2.1 Test Piece The test piece shall be No. 5 test piece specified in JIS Z 2201 to be cut from the flat plate portion of the square tube along its longitudinal axis.

8.2.2 Test Method The test method shall be in accordance with JIS Z 2241.

9. Inspection

9.1 Inspection Inspection shall be as follows:

(1) General matters of inspection shall be in accordance with JIS G 0303.

(2) The chemical composition, mechanical properties, appearance and dimensions for square tubes shall conform to the requirements specified in 3., 4., 5. and 6.

(3) The method of sampling test specimens and the number of test pieces for tensile test shall be as given in Table 5.

Table 5. Method of Sampling Test Specimens and Number of Test Pieces

Length of longer side	Sampling method of test specimen and number of test piece
100 mm or under	Take one test specimen from each 5000 m or its fraction of square tubes of the same grade and dimension, and from the specimen take one tensile test piece.
Over 100 mm up to and incl. 200 mm	To take one test specimen from each 2500 m or its fraction of square tubes of the same grade and dimension, and from the specimen take one tensile test piece.
Over 200 mm	To take one test specimen from each 1250 m or its fraction of square tubes of the same grade and dimension, and from the specimen take one tensile test piece.

9.2 Reinspection The tube is entitled to a retest in accordance with 4.4 in JIS G 0303 for final acceptance.

10. Marking

Each square tube having passed the inspection shall be legibly marked with the following items. The order of arranging the items is not specified. However, smaller square tubes may be bundled together and be marked for each bundle by suitable means.

When approved by the purchaser, part of the items may be omitted.

(1) Designation of grade

(2) Dimensions

(3) Manufacturer's name or its identifying brand

11. Report

The manufacturer shall submit a test report if previously required by the purchaser.

Attached Table. Dimension and Mass of Carbon Steel Square Pipes for General Structural Purposes

1. Square

Side length $A \times B$ mm	Wall thickness t mm	Unit mass kg/m	Informative reference: Cross sectional area cm²	Geometrical moment of inertia cm⁴ I_X, I_Y	Modulus of section cm³ Z_X, Z_Y	Radius of gyration of area cm i_X, i_Y
40×40	1.6	1.88	2.392	5.79	2.90	1.56
40×40	2.3	2.62	3.332	7.73	3.86	1.52
50×50	1.6	2.38	3.032	11.7	4.68	1.96
50×50	2.3	3.34	4.252	15.9	6.34	1.93
50×50	3.2	4.50	5.727	20.4	8.16	1.89
60×60	1.6	2.88	3.672	20.7	6.89	2.37
60×60	2.3	4.06	5.172	28.3	9.44	2.34
60×60	3.2	5.50	7.007	36.9	12.3	2.30
75×75	1.6	3.64	4.632	41.3	11.0	2.99
75×75	2.3	5.14	6.552	57.1	15.2	2.95
75×75	3.2	7.01	8.927	75.5	20.1	2.91
75×75	4.5	9.55	12.17	98.6	26.3	2.85
80×80	2.3	5.50	7.012	69.9	17.5	3.16
80×80	3.2	7.51	9.567	92.7	23.2	3.11
80×80	4.5	10.3	13.07	122	30.4	3.05
90×90	2.3	6.23	7.932	101	22.4	3.56
90×90	3.2	8.51	10.85	135	29.9	3.52
100×100	2.3	6.95	8.852	140	27.9	3.97
100×100	3.2	9.52	12.13	187	37.5	3.93
100×100	4.0	11.7	14.95	226	45.3	3.89
100×100	4.5	13.1	16.67	249	49.9	3.87
100×100	6.0	17.0	21.63	311	62.3	3.79
100×100	9.0	24.1	30.67	408	81.6	3.65
100×100	12.0	30.2	38.53	471	94.3	3.50
125×125	3.2	12.0	15.33	376	60.1	4.95
125×125	4.5	16.6	21.17	506	80.9	4.89
125×125	5.0	18.3	23.36	553	88.4	4.86
125×125	6.0	21.7	27.63	641	103	4.82
125×125	9.0	31.1	39.67	865	138	4.67
125×125	12.0	39.7	50.53	103×10	165	4.52
150×150	4.5	20.1	25.67	896	120	5.91
150×150	5.0	22.3	28.36	982	131	5.89
150×150	6.0	26.4	33.63	115×10	153	5.84
150×150	9.0	38.2	48.67	158×10	210	5.69
175×175	4.5	23.7	30.17	145×10	166	6.93
175×175	5.0	26.2	33.36	159×10	182	6.91
175×175	6.0	31.1	39.63	186×10	213	6.86

Attached Table (Continued)

Side length $A \times B$ mm	Wall thickness t mm	Unit mass kg/m	Informative reference: Cross sectional area cm²	Geometrical moment of inertia cm⁴ I_X, I_Y	Modulus of section cm³ Z_X, Z_Y	Radius of gyration of area cm i_X, i_Y
200×200	4.5	27.2	34.67	219×10	219	7.95
200×200	6.0	35.8	45.63	283×10	283	7.88
200×200	8.0	46.9	59.79	362×10	362	7.78
200×200	9.0	52.3	66.67	399×10	399	7.73
200×200	12.0	67.9	86.53	498×10	498	7.59
250×250	5.0	38.0	48.36	481×10	384	9.97
250×250	6.0	45.2	57.63	567×10	454	9.92
250×250	8.0	59.5	75.79	732×10	585	9.82
250×250	9.0	66.5	84.67	809×10	647	9.78
250×250	12.0	86.8	110.5	103×10²	820	9.63
300×300	4.5	41.3	52.67	763×10	508	12.0
300×300	6.0	54.7	69.63	996×10	664	12.0
300×300	9.0	80.6	102.7	143×10²	956	11.8
300×300	12.0	106	134.5	183×10²	122×10	11.7
350×350	9.0	94.7	120.7	232×10²	132×10	13.9
350×350	12.0	124	158.5	298×10²	170×10	13.7

Attached Table (Continued)

2. Rectangle

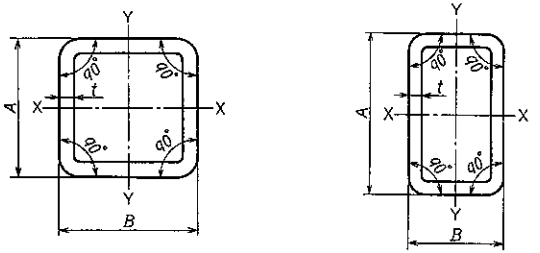
Side length $A \times B$ mm	Wall thickness t mm	Unit mass kg/m	Informative reference: Cross sectional area cm²	Geometrical moment of inertia cm⁴ I_X	I_Y	Modulus of section cm³ Z_X	Z_Y	Radius of gyration of area cm i_X	i_Y
50×20	1.6	1.63	2.072	6.08	1.42	2.43	1.42	1.71	0.829
50×20	2.3	2.25	2.872	8.00	1.83	3.20	1.83	1.67	0.798
50×30	1.6	1.88	2.392	7.96	3.60	3.18	2.40	1.82	1.23
50×30	2.3	2.62	3.332	10.6	4.76	4.25	3.17	1.79	1.20
60×30	1.6	2.13	2.712	12.5	4.25	4.16	2.83	2.15	1.25
60×30	2.3	2.98	3.792	16.8	5.65	5.61	3.76	2.11	1.22
60×30	3.2	3.99	5.087	21.4	7.08	7.15	4.72	2.05	1.18
75×20	1.6	2.25	2.872	17.6	2.10	4.69	2.10	2.47	0.855
75×20	2.3	3.16	4.022	23.7	2.73	6.31	2.73	2.43	0.824
75×45	1.6	2.88	3.672	28.4	12.9	7.56	5.75	2.78	1.88
75×45	2.3	4.06	5.172	38.9	17.6	10.4	7.82	2.74	1.84
75×45	3.2	5.50	7.007	50.8	22.8	13.5	10.1	2.69	1.80
80×40	1.6	2.88	3.672	30.7	10.5	7.68	5.26	2.89	1.69
80×40	2.3	4.06	5.172	42.1	14.3	10.5	7.14	2.85	1.66
80×40	3.2	5.50	7.007	54.9	18.4	13.7	9.21	2.80	1.62
90×45	2.3	4.60	5.862	61.0	20.8	13.6	9.22	3.23	1.88
90×45	3.2	6.25	7.967	80.2	27.0	17.8	12.0	3.17	1.84
100×20	1.6	2.88	3.672	38.1	2.78	7.61	2.78	3.22	0.870
100×20	2.3	4.06	5.172	51.9	3.64	10.4	3.64	3.17	0.839
100×40	1.6	3.38	4.312	53.5	12.9	10.7	6.44	3.52	1.73
100×40	2.3	4.78	6.092	73.9	17.5	14.8	8.77	3.48	1.70
100×40	4.2	8.32	10.60	120	27.6	24.0	10.6	3.36	1.61
100×50	1.6	3.64	4.632	61.3	21.1	12.3	8.43	3.64	2.13
100×50	2.3	5.14	6.552	84.8	29.0	17.0	11.6	3.60	2.10
100×50	3.2	7.01	8.927	112	38.0	22.5	15.2	3.55	2.06
100×50	4.5	9.55	12.17	147	48.9	29.3	19.5	3.47	2.00
125×40	1.6	4.01	5.112	94.4	15.8	15.1	7.91	4.30	1.76
125×40	2.3	5.69	7.242	131	21.6	20.9	10.8	4.25	1.73
125×75	2.3	6.95	8.852	192	87.5	30.6	23.3	4.65	3.14
125×75	3.2	9.52	12.13	257	117	41.1	31.1	4.60	3.10
125×75	4.0	11.7	14.95	311	141	49.7	37.5	4.56	3.07
125×75	4.5	13.1	16.67	342	155	54.8	41.2	4.53	3.04
125×75	6.0	17.0	21.63	428	192	68.5	51.1	4.45	2.98
150×75	3.2	10.8	13.73	402	137	53.6	36.6	5.41	3.16
150×80	4.5	15.2	19.37	563	211	75.0	52.9	5.39	3.30
150×80	5.0	16.8	21.36	614	230	81.9	57.5	5.36	3.28
150×80	6.0	19.8	25.23	710	264	94.7	66.1	5.31	3.24

Attached Table (Continued)

Side length $A \times B$ mm	Wall thickness t mm	Unit mass kg/m	Informative reference: Cross sectional area cm²	Geometrical moment of inertia cm⁴ I_X	I_Y	Modulus of section cm³ Z_X	Z_Y	Radius of gyration of area cm i_X	i_Y
150×100	3.2	12.0	15.33	488	262	65.1	52.5	5.64	4.14
150×100	4.5	16.6	21.17	658	352	87.7	70.4	5.58	4.08
150×100	6.0	21.7	27.63	835	444	111	88.8	5.50	4.01
150×100	9.0	31.1	39.67	113×10	595	151	119	5.33	3.87
200×100	4.5	20.1	25.67	133×10	455	133	90.9	7.20	4.21
200×100	6.0	26.4	33.63	170×10	577	170	115	7.12	4.14
200×100	9.0	38.2	48.67	235×10	782	235	156	6.94	4.01
200×150	4.5	23.7	30.17	176×10	113×10	176	151	7.64	6.13
200×150	6.0	31.1	39.63	227×10	146×10	227	194	7.56	6.06
200×150	9.0	45.3	57.67	317×10	202×10	317	270	7.41	5.93
250×150	6.0	35.8	45.63	389×10	177×10	311	236	9.23	6.23
250×150	9.0	52.3	66.67	548×10	247×10	438	330	9.06	6.09
250×150	12.0	67.9	86.53	685×10	307×10	548	409	8.90	5.95
300×200	6.0	45.2	57.63	737×10	396×10	491	396	11.3	8.29
300×200	9.0	66.5	84.67	105×10²	563×10	702	563	11.2	8.16
300×200	12.0	86.8	110.5	134×10²	711×10	890	711	11.0	8.02
350×150	6.0	45.2	57.63	891×10	239×10	509	319	12.4	6.44
350×150	9.0	66.5	84.67	127×10²	337×10	726	449	12.3	6.31
350×150	12.0	86.8	110.5	161×10²	421×10	921	562	12.1	6.17
400×200	6.0	54.7	69.63	148×10²	509×10	739	509	14.6	8.55
400×200	9.0	80.6	102.7	213×10²	727×10	107×10	727	14.4	8.42
400×200	12.0	106	134.5	273×10²	923×10	136×10	923	14.2	8.23

Remarks 1. Dimensions other than those listed in the above table if particularly required shall be agreed upon by the purchaser and the manufacturer.

2. The symbols given in Attached Table are arranged in the figures below.



3. Calculate the values of mass from the following formula assuming 1 cm^3 of steel to be 7.85 g and round off the result to three significant figures in accordance with JIS Z 8401.

$$W = 0.0157\,t\,(A+B-3.287\,t)$$

where W : unit mass of the square tube kg/m

t : wall thickness of the square tube mm

A, B : side length of the square tube mm