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**Hot-rolled atmospheric corrosion
resisting steels for welded structure**



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Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Classification and symbols	1
4 Chemical composition	1
5 Carbon equivalent or weld cracking susceptibility of material	2
5.1 Carbon equivalent and weld cracking susceptibility of material of SMA570W and SMA570P	2
5.2 Carbon equivalent and weld cracking susceptibility of material of steel plates having undergone thermo-mechanical process control	3
6 Mechanical property	4
6.1 Yield point or proof stress, tensile strength, and elongation	4
6.2 Charpy absorption energy	4
7 Shapes, dimensions, mass, and tolerances	5
8 Appearance	5
9 Heat treatment and symbols	5
9.1 Heat treatment	5
9.2 Symbols for heat treatment	5
10 Tests	6
10.1 Chemical analysis	6
10.2 Mechanical test	6
11 Inspection	7
11.1 Inspection	8
11.2 Reinspection	8
12 Marking	8
13 Report	8
Attached Table 1 Normative references	9
Annex (normative) Sampling position of the test piece	10

Hot-rolled atmospheric corrosion resisting steels for welded structure

Introduction Since this Standard was specified in 1968, the revisions have been made in 1983, 1988 and 1998 up to the present time.

In this revision, carbon equivalent and weld cracking susceptibility of material for SMA570 have been specified.

1 Scope This Standard specifies the hot-hot rolled atmospheric corrosion resisting steels particularly imparted with a high weldability (hereafter referred to as "plates and sections") to be used for bridges, building and other structures.

Remarks : The term "atmospheric corrosion resistance" means the protective characteristics impervious to corrosion when exposed to the atmosphere.

2 Normative references The standards listed in attached table 1 contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) shall be applied.

3 Classification and symbols

Table 1 Symbols of classification

Symbol	Applicable thickness mm
SMA400AW SMA400AP	The plates, steel strip in coil, sections and flat steel with atmospheric corrosion resistance; 200 max.
SMA400BW SMA400BP	The plates, steel strip in coil, sections and flat steel with atmospheric corrosion resistance; 200 max.
SMA400CW SMA400CP	The plates, steel strip in coil, and sections with atmospheric corrosion resistance; 100 max.
SMA490AW SMA490AP	The plates, steel strip in coil, sections and flat steel with atmospheric corrosion resistance; 200 max.
SMA490BW SMA490BP	The plates, steel strip in coil, sections and flat steel with atmospheric corrosion resistance; 200 max.
SMA490CW SMA490CP	The plates, steel strip in coil, and sections with atmospheric corrosion resistance; 100 max.
SMA570W SMA570P	The plates, steel strip in coil, and sections with atmospheric corrosion resistance; 100 max.

Remarks : The letter symbol "W" denotes that the plates and sections are usually used with nothing on it or only chemically treated against rusting, while "P" denotes that they are usually used after being coated.

4 Chemical composition The plates and sections shall be tested in accordance with 10.1, and the ladle analysis values shall conform to table 2.

Table 2 Chemical composition

Designation	C %	Si %	Mn %	P %	S %	Cu %	Cr %	Ni %
SMA400AW SMA400BW SMA400CW	0.18 max.	0.15 to 0.65	1.25 max.	0.035 max.	0.035 max.	0.30 to 0.50	0.45 to 0.75	0.05 to 0.30
SMA400AP SMA400BP SMA400CP	0.18 max.	0.55 max.	1.25 max.	0.035 max.	0.035 max.	0.20 to 0.35	0.30 to 0.55	—
SMA490AW SMA490BW SMA490CW	0.18 max.	0.15 to 0.65	1.40 max.	0.035 max.	0.035 max.	0.30 to 0.50	0.45 to 0.75	0.05 to 0.30
SMA490AP SMA490BP SMA490CP	0.18 max.	0.55 max.	1.40 max.	0.035 max.	0.035 max.	0.20 to 0.35	0.30 to 0.55	—
SMA570W	0.18 max.	0.15 to 0.65	1.40 max.	0.035 max.	0.035 max.	0.30 to 0.50	0.45 to 0.75	0.05 to 0.30
SMA570P	0.18 max.	0.55 max.	1.40 max.	0.035 max.	0.035 max.	0.20 to 0.35	0.30 to 0.55	—

Remarks : The elements effective for the atmospheric corrosion resistance, such as Mo, Nb, Ti, V and Zr may be added to any grade of plates and sections. The total content of these elements shall not be over 0.15 %.

5 Carbon equivalent or weld cracking susceptibility of material

5.1 Carbon equivalent and weld cracking susceptibility of material of SMA570W and SMA570P Carbon equivalent or weld cracking susceptibility of material of SMA570W and SMA570P shall be as follows:

Carbon equivalent shall be applied to the plates and sections having undergone quenching and tempering.

- a) **Carbon equivalent** The carbon equivalent shall be calculated from the following formula by using the result of the ladle analysis obtained in 10.1 and the values shall conform to table 3.

Carbon equivalent (%) =

$$C + \frac{Mn}{6} + \frac{Si}{24} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{V}{14} \dots\dots\dots (1)$$

Table 3 Carbon equivalent

Thickness of the plates and sections mm	50 max.	Over 50 up to and incl. 100
Carbon equivalent %	0.44 max.	0.47 max.

- b) **Weld cracking susceptibility of material** In accordance with the agreement between the purchaser and the supplier, weld cracking susceptibility of material may be applied instead of carbon equivalent. In this case, weld cracking susceptibility is calculated from the following formula by using the result of the ladle analysis obtained in 10.1 and the values shall conform to table 4.

Weld cracking susceptibility of material (%) =

$$C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B \dots\dots\dots (2)$$

Table 4 Weld cracking susceptibility of materials for steel plates and sections

Thickness of the plates and sections mm	50 max.	Over 50 up to and incl. 100
Weld cracking susceptibility of material %	0.28 max.	0.30 max.

5.2 Carbon equivalent and weld cracking susceptibility of material of steel plates having undergone thermo-mechanical process control Carbon equivalent of steel plates having undergone thermo-mechanical process control in accordance with the agreement between the purchaser and the supplier, and having undergone weld cracking susceptibility of material applied instead of carbon equivalent in accordance with the agreement between the purchaser and the supplier, shall be as follows:

- a) **Carbon equivalent** The carbon equivalent shall be calculated from the formula (1) of 5.1 with using the result of the ladle analysis obtained in 10.1 and the values shall conform to table 5.

Table 5 Carbon equivalent

Symbol of classification		SMA490AW, SMA490BW, SMA490CW	SMA490AP, SMA490BP, SMA490CP
Applicable thickness	500 mm max.	0.41 % max.	0.40 % max.
	Over 50 mm up to and incl. 100 mm	0.43 % max.	0.42 % max.

Remarks : Carbon equivalent of plates more than 100 mm in thickness shall be in accordance with the agreement between the purchaser and the supplier.

- b) **Weld cracking susceptibility of material** Weld cracking susceptibility is calculated from the formula (2) of 5.1 by using the result of the ladle analysis obtained in 10.1 and the values shall conform to table 6.

Table 6 Weld cracking susceptibility of material

Symbol of classification		SMA490AW, SMA490BW, SMA490CW	SMA490AP, SMA490BP, SMA490CP
Applicable thickness	500 mm max.	0.24 % max.	0.24 % max.
	Over 50 mm up to and incl. 100 mm	0.26 % max.	0.26 % max.

Remarks : Weld cracking susceptibility of material of plates more than 100 mm in thickness shall be in accordance with the agreement between the purchaser and the supplier.

6 Mechanical property

6.1 Yield point or proof stress, tensile strength, and elongation The steel plates and sections shall be tested in accordance with 10.2, and the resulting yield point or proof stress, tensile strength, and elongation shall conform to table 7.

Table 7 Yield point or proof stress, tensile strength and elongation

Designation	Yield point or proof stress N/mm ²						Tensile strength N/mm ²	Elongation		
	Thickness of plates and sections ⁽¹⁾ mm							Application of plates and sections and test piece		
	16 or under	Over 16 up to and incl. 40	Over 40 up to and incl. 75	Over 75 up to and incl. 100	Over 100 up to and incl. 160	Over 160 up to and incl. 200		Thick-ness mm	Test piece	Elonga-tion %
SMA400AW SMA400AP SMA400BW SMA400BP	245 min.	235 min.	215 min.	215 min.	205 min.	195 min.	400 to 540	5 or under	No. 5	22 min.
								16 or under	No. 1A	17 min.
SMA400CW SMA400CP	245 min.	235 min.	215 min.	215 min.	—	—		Over 16	No. 1A	21 min.
								Over 40	No. 4	23 min.
SMA490AW SMA490AP SMA490BW SMA490BP	365 min.	355 min.	335 min.	325 min.	305 min.	295 min.	490 to 610	5 or under	No. 5	19 min.
								16 or under	No. 1A	15 min.
SMA490CW SMA490CP	365 min.	355 min.	335 min.	325 min.	—	—		Over 16	No. 1A	19 min.
								Over 40	No. 4	21 min.
SMA570W SMA570P	460 min.	450 min.	430 min.	420 min.	—	—	570 to 720	16 or under	No. 5	19 min.
								Over 16	No. 5	26 min.
								Over 20	No. 4	20 min.

Note (1) For the section, thickness shall be those of the test piece given in figure 1.

Remarks : The upper limits of tensile strength shall apply only to the plates and those for the sections shall be in accordance with agreement between the purchaser and the supplier.

6.2 Charpy absorption energy The steel plate and section more than 12 mm in thickness shall be tested in accordance with 10.2, and the resulting Charpy absorption energy shall conform to table 8. In this case, the value of Charpy absorption energy shall be taken from the mean of the three test pieces and shall be judged by 9.6 of JIS G 0404.

Table 8 Charpy absorption energy

Designation	Test temperature °C	Charpy absorption energy J	Test piece
SMA400BW SMA400BP	0	27 min.	V-notch test piece, rolling direction
SMA400CW SMA400CP	0	47 min.	
SMA490BW SMA490BP	0	27 min.	
SMA490CW SMA490CP	0	47 min.	
SMA570W SMA570P	-5	47 min.	

Remarks : The purchaser is permitted to specify the Charpy absorption energy values which are higher than those in the above table 8.

7 Shapes, dimensions, mass, and tolerances The shapes, dimensions, mass, and the tolerances of the steel plates and sections shall be as specified in the following:

JIS G 3192, JIS G 3193, JIS G 3194

The tolerances on the length of the steel plates and the width of cut edged plates, unless otherwise especially specified, shall be in accordance with tolerance A specified in **JIS G 3193**.

8 Appearance Appearance of the steel plates and sections shall be in accordance with clause 9 of **JIS G 3192**, clause 6 of **JIS G 3193** and clause 10 of **JIS G 3194**.

Repairing by welding for SMA570W and SMA570P steel plates shall be applied when the purchaser has agreed to it previously.

9 Heat treatment and symbols

9.1 Heat treatment The plates and sections may undergo heat treatment such as normalizing, quenching and tempering, or tempering as required. For all designations, suitable heat treatment such as thermal processing control may be performed in accordance with the agreement between the purchaser and the supplier.

9.2 Symbols for heat treatment In case that heat treatment has been performed on the steel plates and sections, the symbol for the respective heat treatment shall be as follows:

When the symbol for the heat treatment has been added according to the following items, it shall be attached to the end of the symbol of classification in table 1.

- a) For normalizing carried out on the plates and sections in accordance with the agreement: N

- b) For tempering carried out on the plates and sections in accordance with the agreement: T
- c) For quenching and tempering carried out on the plates and sections: Q
- d) For thermal processing control carried out on the plates and sections: TMC
- e) For some other suitable heat treatments carried out on the plates and sections: In accordance with the agreement

Example of symbols : SMA400BWN, SMA570WTMC

10 Tests

10.1 Chemical analysis

Chemical analysis shall be as follows:

- a) **General matters for chemical tests** Chemical components of plates and sections shall be determined by ladle analysis and general matters for chemical analysis and sampling method of specimen for analysis shall be in accordance with clause 8 in JIS G 0404.
- b) **Analytical method** Analytical method shall be in accordance with one of the following Standard.

JIS G 1211, JIS G 1212, JIS G 1213, JIS G 1214, JIS G 1215, JIS G 1216, JIS G 1217, JIS G 1218, JIS G 1219, JIS G 1221, JIS G 1223, JIS G 1227, JIS G 1232, JIS G 1237, JIS G 1238, JIS G 1253, JIS G 1256, JIS G 1257, JIS G 1258

10.2 Mechanical test

10.2.1 Test in general General matters of the mechanical test shall be in accordance with clause 9 of JIS G 0404. However, the sampling method of specimens shall follow class A, and the number of test pieces and sampling position shall be as follows:

- a) **Number of test pieces for tensile test** Number of test pieces shall be as follows:
 - 1) **Steel plate and steel flat** One test piece for tensile test shall be taken from each lot of the steel plates grouped together under the same heat and the dimensional condition that the maximum thickness is not more than twice the minimum thickness. However, in the case of a lot exceeding 50 t, two test pieces shall be taken. In the case of a steel plate exceeding 50 t, one test pieces shall be taken from one steel plate.
 - 2) **Steel strip and cutting sheet from steel strip** One test piece for tensile test shall be taken from each lot of the steel plates grouped together under the same heat and the same thickness. However, in the case of a lot exceeding 50 t, two test pieces shall be taken.
 - 3) **Steel sections** One test piece for tensile test shall be taken from each lot of the steel sections grouped together under the same heat and shape of the cross section, of which the largest thickness is not more than twice the smallest thickness. However, in the case of a lot exceeding 50 t, two test pieces shall be taken.

- 4) **Number of test pieces for heat-treated steel plates and sections** The number of test pieces to be taken from the heat treated steel plates and sections shall be in accordance with either 1), 2) or 3) on the basis of each lot of the same heat, same shape of the cross section and heat treatment conditions.
- b) **Number of test pieces for impact test** One specimen of the plates and section of the maximum thickness from each lot of the non heat-treated plates and sections of the same heat and the shape of the cross section shall be taken. Also, from each lot of the heat-treated ones of the same heat the same shape of cross section, and heat treating conditions shall be taken. And the three test pieces shall be taken from the specimen in the rolling direction.
- c) **Sampling position of the test piece for tensile tests** Sampling position of the test piece for tensile tests shall be in accordance with **JIS G 0416**. However, annex specification may be applied. Test pieces of steel strips shall be sampled from the position adjacent to the material section to be evaluated.
- d) **Sampling position of the test piece for impact tests** Sampling position of the test piece for impact tests shall be in accordance with **JIS G 0416**. For the thickness of 40 mm or less, annex A figure A.11 a) of **JIS G 0416** shall apply, and for the thickness of over 40 mm, annex A figure A.11 b) of **JIS G 0416** shall apply.

Annex may be applied.

Test pieces of steel strips shall be sampled from the position adjacent to the material section to be evaluated.

10.2.2 Test piece Test pieces for tensile test and impact test shall be as follows:

- a) No. 1A, No. 4 or No. 5 test piece specified in **JIS Z 2201**.
- b) The V-notch test piece specified in **JIS Z 2201**. In this case, the longitudinal direction of the notch of the test piece shall be perpendicular to the rolled surface.

10.2.3 Test method Test method for tensile test and impact test shall conform to the following:

- a) **JIS Z 2241**
- b) **JIS Z 2242**

10.2.4 Tensile test in case test piece of specified dimension is not available When a test piece of specified dimensions cannot be taken, the execution and resulting values of the tensile test shall be in accordance with an agreement between the purchaser and the supplier.

10.2.5 Omission for tensile test and impact test Tensile test and impact test may be omitted when the purchaser has agreed to it previously.

11 Inspection

11.1 Inspection Inspection shall be as follows:

- a) General matters of inspection shall be in accordance with **JIS G 0404**.
- b) Chemical composition shall conform to the requirements of clause 4.
- c) Carbon equivalent or weld cracking sensitivity of material shall conform to the requirements of clause 5.
- d) Mechanical properties shall conform to the requirements of clause 6.
- e) Shapes, dimensions, and mass shall conform to the requirements of clause 7.
- f) Appearance shall conform to the requirements of clause 8.
- g) The purchaser may request the ultrasonic test specified in **JIS G 0801** or **JIS G 0901**. In this case, test methods and criteria for judging either acceptance or rejection etc. shall be agreed between the purchaser and the supplier previously.

11.2 Reinspection Reinspection shall be as follows:

- a) The steel plate and section which have failed in the tensile test shall have reinspection carried out in accordance with 9.8 in **JIS G 0404** and may be determined whether it shall be accepted.
- b) The plates and sections which have failed in the impact test specified in 9.6 of **JIS G 0404** may be retested in accordance with 9.8 of **JIS G 0404** and determined to be acceptable or not.
- c) The plates and sections having failed in the mechanical test are eligible for a retest for final acceptance after undergoing heat treatment or reheat treatment.

12 Marking The plates and sections having passed the inspection shall be legibly marked with the following items on each piece or on each bundle by suitable means. However, they may be partially omitted with agreement between purchaser and the supplier.

- a) Designation (including the symbol for heat treatment specified in 9.2)
- b) Heat number or inspection number
- c) Dimensions
- d) Number of pieces in a single bundle or its mass (in the case of the plate and strip)
- e) Manufacturer's name or its abbreviation

13 Report The test report shall be in accordance with clause 13 in **JIS G 0404**. In case required, the manufacturer shall submit the symbol 2.3 or 3.1.B specified in table 1 of **JIS G 0415** to the purchaser.

Where the provision in remarks of table 2 is applied, the content of alloying elements added shall be noted in the test report.

Attached Table 1 Normative references

- JIS G 0404 *Steel and steel products—General technical delivery requirements*
- JIS G 0415 *Steel and steel products—Inspection documents*
- JIS G 0416 *Steel and steel products—Location and preparation of samples and test pieces for mechanical testing*
- JIS G 0801 *Ultrasonic examination of steel plates for pressure vessels*
- JIS G 0901 *Classification of structural rolled steel plate and wide flat for building by ultrasonic test*
- 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 *Iron and steel—Methods for determination of manganese content*
- JIS G 1214 *Iron and steel—Methods for determination of phosphorus content*
- JIS G 1215 *Iron and steel—Methods for determination of sulfur content*
- JIS G 1216 *Iron and steel—Methods for determination of nickel content*
- JIS G 1217 *Methods for determination of chromium in iron and steel*
- JIS G 1218 *Iron and steel—Methods for determination of molybdenum content*
- JIS G 1219 *Iron and steel—Methods for determination of copper content*
- JIS G 1221 *Iron and steel—Methods for determination of vanadium content*
- JIS G 1223 *Iron and steel—Methods for determination of titanium content*
- JIS G 1227 *Iron and steel—Methods for determination of boron content*
- JIS G 1232 *Methods for determination of zirconium in steel*
- JIS G 1237 *Iron and steel—Methods for determination of niobium content*
- JIS G 1238 *Steel and iron—Determination of chromium content—Potentiometric or visual titration method*
- JIS G 1253 *Iron and steel—Method for spark discharge atomic emission spectrometric analysis*
- JIS G 1256 *Iron and steel—Method for X-ray fluorescence spectrometric analysis*
- JIS G 1257 *Iron and steel—Methods for atomic absorption spectrometric analysis*
- JIS G 1258 *Iron and steel—Methods for inductively coupled plasma atomic emission spectrometry*
- JIS G 3192 *Dimensions, mass and permissible variations of hot rolled steel sections*
- JIS G 3193 *Dimensions, mass and permissible variations of hot rolled steel plates, sheets and strip*
- JIS G 3194 *Dimensions, mass and permissible variations of hot rolled flat steel*
- JIS Z 2201 *Test pieces for tensile test for metallic materials*
- JIS Z 2202 *Test pieces for impact test for metallic materials*
- JIS Z 2241 *Method of tensile test for metallic materials*
- JIS Z 2242 *Method of impact test for metallic materials*

Annex (normative)
Sampling position of the test piece

1 Scope This annex specifies the sampling position of the test piece for tensile tests and impact tests.

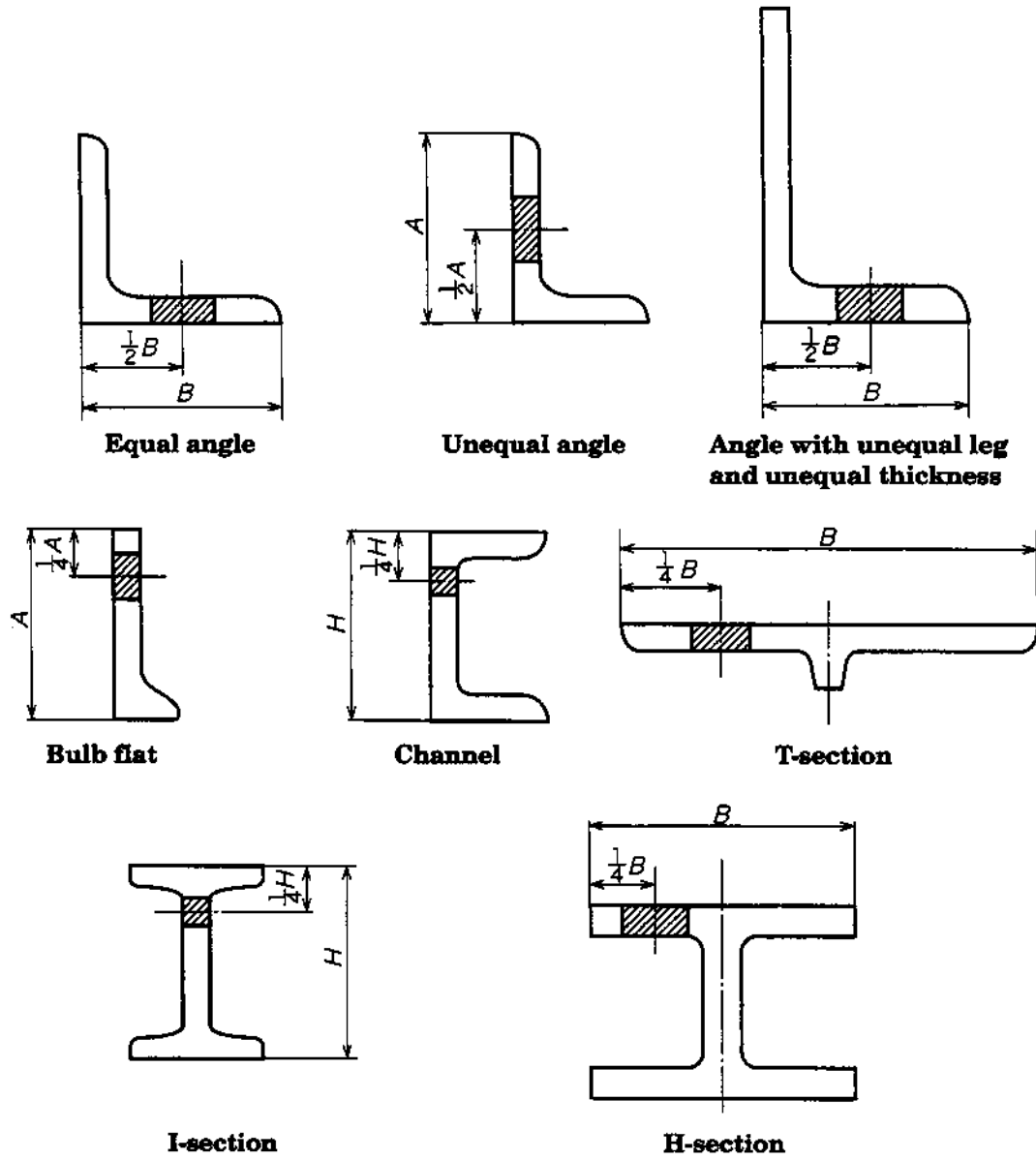
2 Applicable date This annex applies until Dec. 31, 2008.

3 Sampling position of the test piece for tensile tests Sampling position of the test piece for tensile tests shall be as follows:

- a) **Steel plate, steel strip in coil, and flat steel** The centre of the test piece shall be at a quarter-width position from a side edge, and further in the case of No. 4 test piece, it shall be at a quarter-thickness position from a surface as well as a quarter-width position from a side edge. When it is infeasible to allow the centre of the test piece to be at a quarter-width position from a side edge or at a quarter-thickness position from a surface, the sampling should be performed as close to the aforementioned position as possible.
- b) **Steel section** The sampling position shall be as shown in annex figure 1. When it is infeasible to take a specimen as shown in annex figure 1, the sampling position should be as close to the aforementioned position as possible. In the case of the steel H section from which a specimen is unable to be taken in the same manner as shown in annex figure 1, the sampling position for the I section should be applied mutatis mutandis. For other steel sections, it should be agreed upon between the purchaser and the supplier.

4 Sampling position of the test piece for impact tests Sampling position of the test piece for impact tests shall be as follows:

- a) **Steel plate, steel strip in coil and flat** The centre of the test piece shall be at a quarter-thickness position from a surface, and it shall be at a quarter-width position from a side edge as well as a quarter-thickness position from a surface. When it is infeasible to allow the centre of the test piece to be at a quarter-thickness position from a surface and at a quarter-width position from a side edge, the sampling should be performed as close to the aforementioned position as possible.
- b) **Steel section** The centre of the test piece shall be at a quarter-thickness position from a surface (see annex figure 1). When it is infeasible to allow the centre of the test piece to be at a quarter-thickness position from a surface, the sampling should be performed as close to the aforementioned position as possible. In the case of the steel H section from which a specimen is unable to be taken in the same manner as shown in annex figure 1, the sampling position for the I section should be applied mutatis mutandis. For other steel sections, it should be agreed upon between the purchaser and the supplier.



Annex Figure 1 Sampling position of the test piece for tensile tests and bend tests for steel section

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