Steel and Steel Products _ Location and Preparation of Samples and Test Pieces for Mechanical Testing

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Introduction

This Standard has been prepared based on the third edition of ISO 377 published in 2013 with some modifications of the technical contents.

The portions given dotted underlines are the matters in which the contents of the original International Standard have been modified.

1. Scope

This Standard specifies identification marks, location and preparation of samples and test pieces intended for mechanical tests taken from steel sections, bars, rods, sheets (including strips in coil and flats) and tubular products as defined **in JIS G 0203**. If agreed in the order, this Standard may also apply to other metallic products.

Where the requirements of the order or product standard differ from those given in this Standard, then the requirements of the order or product standard apply.

NOTE: The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follow.

ISO 377: 2013 Steel and steel products _ Location and preparation of samples and test pieces for mechanical testing **(MOD)**

In addition, symbol 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 21.1.**

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 0201 Glossary of terms used in iron and steel (Heat treatment)

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

JIS G 0404 Steel and steel products _ General technical delivery requirements.

3. Terms and definitions

For the purposes of this Standard, the following terms and definitions and those given in JIS G 0201 and JIS G 0203 apply.

3.1 Test unit

Number of pieces or the tonnage of products to be accepted or rejected together, on the basis of the tests to be carried out on sample products in accordance with the requirements of the product standard or order (see figure 1)

3.2 Sample Product

Item (e.g., a sheet of steel) selected from test unit for inspection and/ or testing (see figure 1)

3.3 Sample

Sufficient quantity of material taken from the sample product for the purpose of producing one or more test pieces (see figure 1)

NOTE: In certain cases, the sample may be the sample product.

3.4 Rough specimen

Part of a sample having undergone mechanical treatment and, if necessary, heat treatments for the purpose of producing a test piece (see figure 1)

3.5 Teat piece

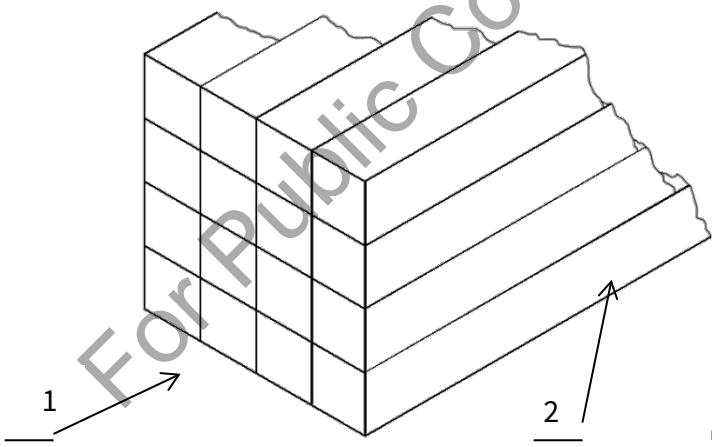
Part of a sample, with specified dimensions, brought to a required condition for submission to a given test (see figure 1)

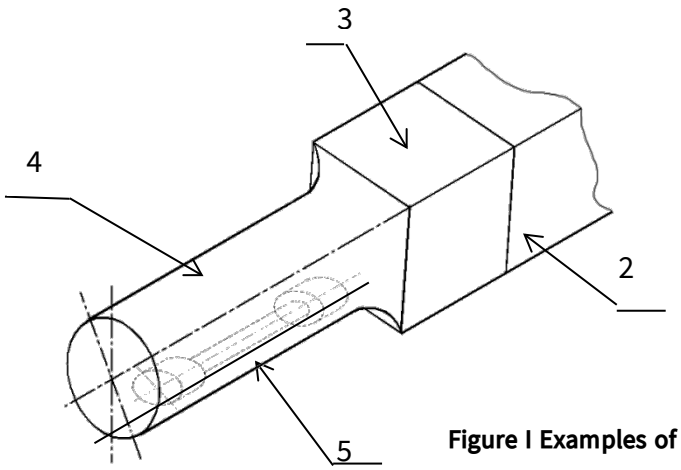
NOTE: In certain cases, the test piece may be the sample or the rough specimen.

3.6 Reference condition

Condition of a sample, rough specimen or test piece having undergone a heat treatment, separately from the product, to represent the intended final condition of the product.

NOTE: In such cases, the sample, rough specimen or test piece is called the reference sample, reference rough specimen or reference test piece.





1.Test unit (3.1)
2.Sample product (3.2)
3.Sample (3.3)
4.Rough Specimen (3.4)
5.Test piece (3.5)

Figure I Examples of terms defined in clause 3

4 General requirements

4.1 Representative testing

Samples, rough specimens and test pieces selected in accordance with Annex A shall be considered to be representative of the product.

NOTE: As a result of their production sequence (i.e., melting, casting, hot and/or cold forming, heat treatment, etc.) steel products are not homogeneous. The mechanical properties of samples taken from other locations may be different. The manufacturer should pay attention so that acceptability of the mechanical properties of the test pieces obtained in accordance with this Standard represent the test unit as a whole.

4.2 Identification marks of sample products, samples, rough specimens and test pieces.

The identification of sample products, samples, rough specimens and test pieces shall be marked to ensure the traceability to the test unit from which they are taken, and their location and orientation in that product. If, during the preparation of the sample, rough specimen and/or test pieces, removal of the identification marks cannot be avoided, the marks shall be surely retained, for example, by carrying out transfer of these marks before the existing marks are removed or in the case of automatic preparation equipment before the test piece is removed from the equipment. In the case of " Specific inspection" and where requested by the purchaser, the transfer of the identification marks shall be carried out in the presence of the purchaser's representative.

In the case of fully automatic in line preparation and testing systems, marking of samples, rough specimens and test pieces is not necessary if an adequate control system exists, which clearly defines the procedures to be followed in the event of system failure.

5 Preparation of samples and selection of test pieces

5.1 Location of samples and test pieces and dimensions of samples.

The sample shall be selected so that the test piece can be located as indicated in Annex A. The sample shall have sufficient dimensions allowing test pieces required for carrying out specified tests and for any retests which may be necessary.

5.2 Direction of axis of test pieces

The direction of the test piece axis relative to the principle direction of working shall be as specified in the appropriate product standard or order.

5.3 Condition and selection method of samples

5.3.1 General

The product standard shall clarify which property is intended for testing

a) In the product as-delivered condition (Class A in 7.6 of **JIS G 0404**) (see 5.3.2); or

b) In the reference condition (Class B in 7.6 of **JIS G 0404**) (see 5.3.3)

5.3.2 Testing in the product as-delivered condition

A sample intended for testing in the product as-delivered condition shall be taken from the product either.

a) After the forming and heat treatment processes;

b) Before the heat treatment process, in which case the heat treatment of the separated sample shall be carried out under the same conditions as that requested to the product.

Separation of the sample shall be carried out in such a manner so as not to change the characteristics of that part of the sample used to provided the test pieces. Where flattening or straightening of the sample is necessary for the preparation of the test piece, it shall be carried out cold unless otherwise specified in the product standard.

5.3.3 Testing in the reference condition

5.3.3.1 Sample

A sample intended for testing in the reference condition shall be separated from the product at the stage of manufacture specified in the product standard or order. Separation of the sample shall be carried out in such a manner so as not to change the characteristics of that part of the sample used to provide the test pieces. When flattening or straightening is necessary, it may be carried out either hot or cold before any heat treatment. When carried out hot, it shall be at a temperature below the final heat treatment temperature.

5.3.3.2 Rough specimen

A rough specimen intended for testing in the reference condition shall be prepared as follows.

a) Machining prior to heat treatment When the sample is to be made smaller for the process of heat treatment, the product standard shall specify the dimensions to which the rough specimen shall be reduced and the reduction process (e.g., forging, rolling, machining)

b) Heat treatment the heat treatment of the rough specimen shall take place in an environment where the uniformity of the temperature is adequately assured and the temperature is measured by means of a calibrated instrument. The heat treatment shall be in accordance with the requirements of the product standard or of the order.

6 Preparation of test pieces

6.1 Cutting and machining

Cutting and machining of samples and tough specimens for the preparation of test pieces shall be carried out taking such precautions as necessary to avoid superficial work hardening and heating of the material likely to change the mechanical characteristics. After machining, any marks left by the tool which might interfere with the results of the test shall be removed, either by grinding (with ample coolant supply) or by polishing, provided that the chosen method of finishing maintains the dimensions and shape of the test piece within the tolerances specified in the standard for appropriate test.

The tolerances on the dimensions of the test pieces shall be in accordance with specifications concerning the test piece or the test method.

6.2 Reference heat treatment

When the required reference heat treatment is to be carried out on the test piece, the provisions for heat treatment shall be the same as for the rough specimen (see 5.3.3.2 b).

Annex A (normative)

Location of samples and test pieces

A.1 General

This Annex A specifies the location of samples and test pieces for the following product forms:

- Sections;
- Bars and rods;
- Sheets (including strips in coil and flats);
- Tubes.

The location of test pieces for tensile and impact tests shall be in accordance with figure A.1 to figure A.15. When a test piece cannot be taken from the location specified in the figure, it may be sampled at a location as close to that position as possible. For bend tests the width position is as for the tensile test pieces. Where more than on test piece is required, they may be placed adjacent to each other in the location specified.

A.2 Sections

A.2.1 Location of test pieces across the width direction of section

The location of test pieces shall be in accordance with figure A.1. For sections with tapered flanges, H sections with flange width less than 150 mm, or unequal leg angles, the following apply.

a) For sections with tapered flanges, if agreed at the time of enquiry and ordering, the sample may be taken from the web. (See figure A.1 b) or the sample from the tapered flange may be machined.

b) For H sections with flange width less than 150 mm, the sample may be taken from the web and machined (see figure A.1 f).

c) For unequal leg angles, samples may be taken from either leg.

A.2.2 Location of test pieces in thickness direction of section

A 2.2.1 Tensile test pieces

The location of tensile test pieces shall be in accordance with figure A.2. Full thickness test pieces (see figure A.2 a) shall be used whenever machining and test equipment allow. For the round bar test pieces, the location of the test piece may be either under the outside surface or inside surface of the flange.

A.2.2.2 Impact test pieces

The location of impact test pieces shall be in accordance with figure A.3. The location of the test piece may be either under the outside surface or inside surface of the flange. Unless otherwise specified, or in the case where the thickness is over 28 mm, the centre of the test piece shall be located at a quarter thickness from the surface.

A.3 Round bars and rods

A.3.1 Tensile test pieces

The location of tensile test pieces shall be selected in accordance with figure A.4. Full section test pieces (see figure A.4 a) shall be used whenever machining and test equipment allow.

A.3.2 Impact test pieces

The location of impact test pieces shall be in accordance with figure A.5.

A.4 Hexagonal bar

A.4.1 Tensile test pieces

The location of tensile test pieces shall be in accordance with figure A.6. Full section test pieces (see figure A.6 a) shall be used whenever machining and test equipment allow.

A.4.2 Impact test pieces

The location of impact test pieces shall be in accordance with figure A.7.

A.5 Rectangular bar

A.5.1 Tensile test pieces

The location of tensile test pieces shall be in accordance with figure A.8. Full section or full thickness test pieces {(see figure A.8 a), b) of c)} shall be used whenever machining and test equipment allow.

A.5.2 Impact test pieces

The location of impact test pieces shall be in accordance with figure A.9.

A.6 Sheets, strips in coil and flats

A.6.1 Tensile test pieces

The location of tensile test pieces shall be in accordance with figure A.10. There are three types of tensile test pieces: full thickness test pieces {figure A.10 a)}, reduced thickness test pieces {figure A.10 b} and round bar test pieces (figure A.10 C). Full thickness test pieces (see figure A.10 a) shall be used whenever machining and test equipment allow.

Reduced- thickness test pieces can be used when the product thickness is 30 mm or over and the test piece thickness is 30 mm or over (see figure A.10b). However, for quenched and tempered or thermo mechanically rolled plates, the product thickness shall be 30 mm or over and the test piece thickness shall be half the product thickness on either side of the product. In this case, the requirement for the test piece thickness of 30 mm or over does not apply.

Round bar test pieces in figure A.10 c) may be applied to the thickness of 20 mm or over to and excluding 25 mm in accordance with the specification in the product standard or in the order. In this case, for the location, the test piece shall be taken so that the axis centre becomes the centre of the thickness.

Although the location of the transverse test pieces is specified to be at w/4, where the width is not sufficient to take the test piece from the location, then the centre of the test piece shall be as near to w/4 as possible.

A.6.2 Impact test pieces

The location of impact test pieces shall be in accordance with figure A.11. Unless otherwise specified in the product standard or in the order, the location shall be as shown in figure A.11 a) for products whose thickness is 28 mm or under, and shall be as shown in figure A.11 b) for products whose thickness is over 28 mm.

A.7 Tubular products

A.7.1 Tubes and circular hollow sections

A.7.1.1 Tensile test pieces

The location of tensile test pieces shall be in accordance with figure A.12. Full section test pieces (see figure A. 12 a) shall be used whenever machining and test equipment allow. For welded tubes, when testing the weld using strip test pieces, the weld shall be at the centre of the test piece. Unless otherwise specified in the product standard or in the order, the sampling position is at the discretion of the manufacturer.

NOTE 1 The full section test piece as shown in figure A.12 a) is also applicable for the following tests:

- flattening test;
- expanding test;
- flanging test;
- bend test in full section

NOTE 2 Test pieces shown in figure A.12.b) are used for the strip bend test.

A.7.1.2 Impact test pieces

The location of impact test pieces shall be in accordance with figure A.13. The locations apply to both seamless and welded tubes. Unless otherwise specified in the product standard or in the order, the sampling position is at the discretion of the manufacturer. The orientation of test pieces is determined by the dimensions of the tube. Where a test piece is required in the transverse position, the widest possible size of test piece width between 2.5 mm and 10 mm shall be produced.

The minimum diameter D_{min} of the tube necessary to obtain such a test piece is given as follows.

$$D_{min} = (T - 2.5) + \frac{756.25}{T - 2.5} \quad \text{(A.1)}$$

Where, T: the thickness of tube

Where the smallest (2.5 mm) permitted transverse test piece is not obtainable, the widest possible longitudinal size of test piece width between 2.5 mm and 10 mm shall be used.

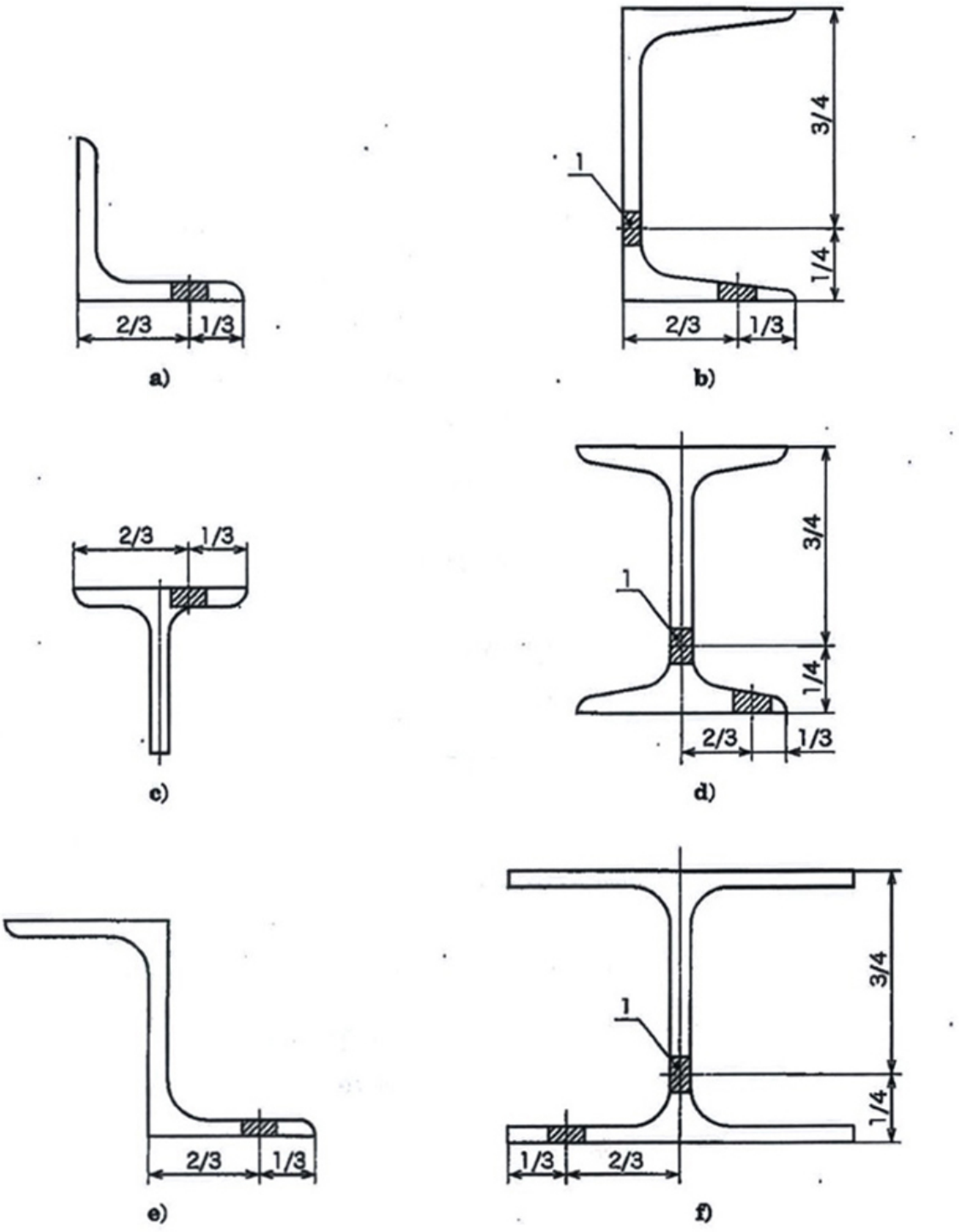
A.7.2 Rectangular hollow sections

A.7.2.1 Tensile test pieces

The location of tensile test pieces shall be in accordance with figure A.14. Full section test pieces (see figure A.14 a) shall be used whenever machining and test equipment allow.

A.7.2.2 Impact test pieces

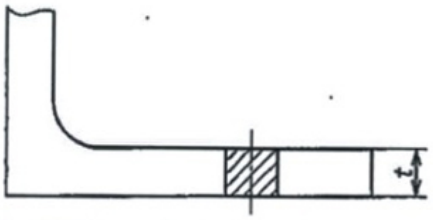
The location of impact test pieces shall be in accordance with figure A.15.



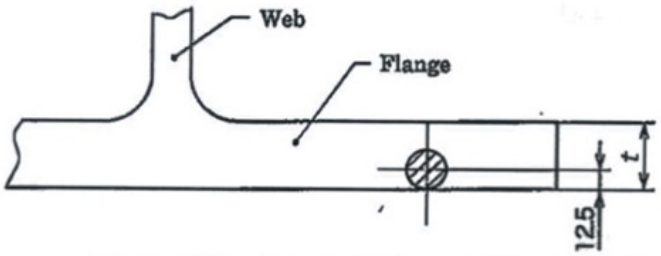
1 See A.2.1 a) and b).

Figure A.1 Sections—Locations of test pieces for tensile and impact testing in width direction of flange (see A.2.1)

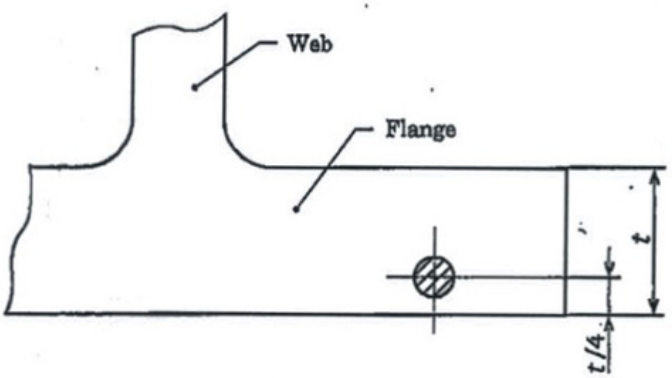
Unit: mm



a) Full thickness test piece where $t \leq 50$ mm



b) Round bar test piece where $t \leq 50$ mm

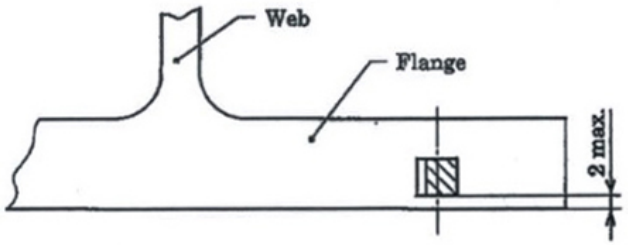


c) Round bar test piece where $t > 50$ mm

NOTE: For round bar test pieces shown in b) and c), the location of the test piece may be either under the outside surface or inside surface of the flange (see A.2.2.1).

Figure A.2 Sections—Location of test pieces for tensile testing in thickness direction of flange (see A.2.2.1)

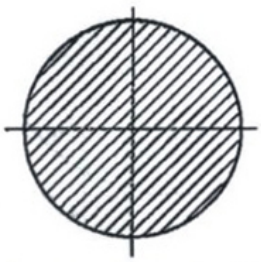
Unit: mm



NOTE : The location of the test piece may be either under the outside surface or inside surface of the flange. Unless otherwise specified, or in the case where the thickness is over 28 mm, the centre of the test piece shall be located at a quarter thickness from the surface (see A.2.2.2).

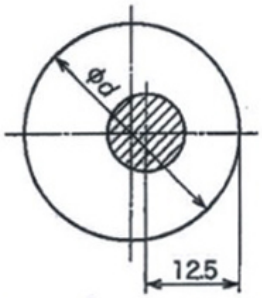
Figure A.3 Sections—Location of test pieces for impact testing in thickness direction of flange (see A.2.2.2)

Unit: mm

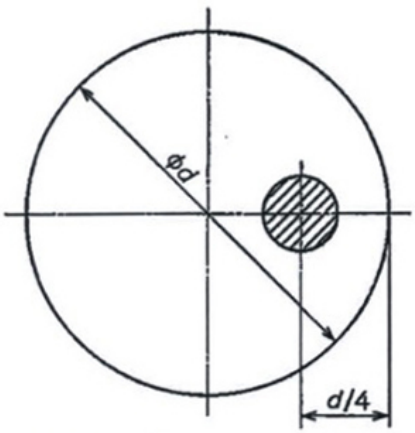


a) Full section test piece (preferred, see A.3.1)

b) Round bar test piece where $d \leq 25$ mm



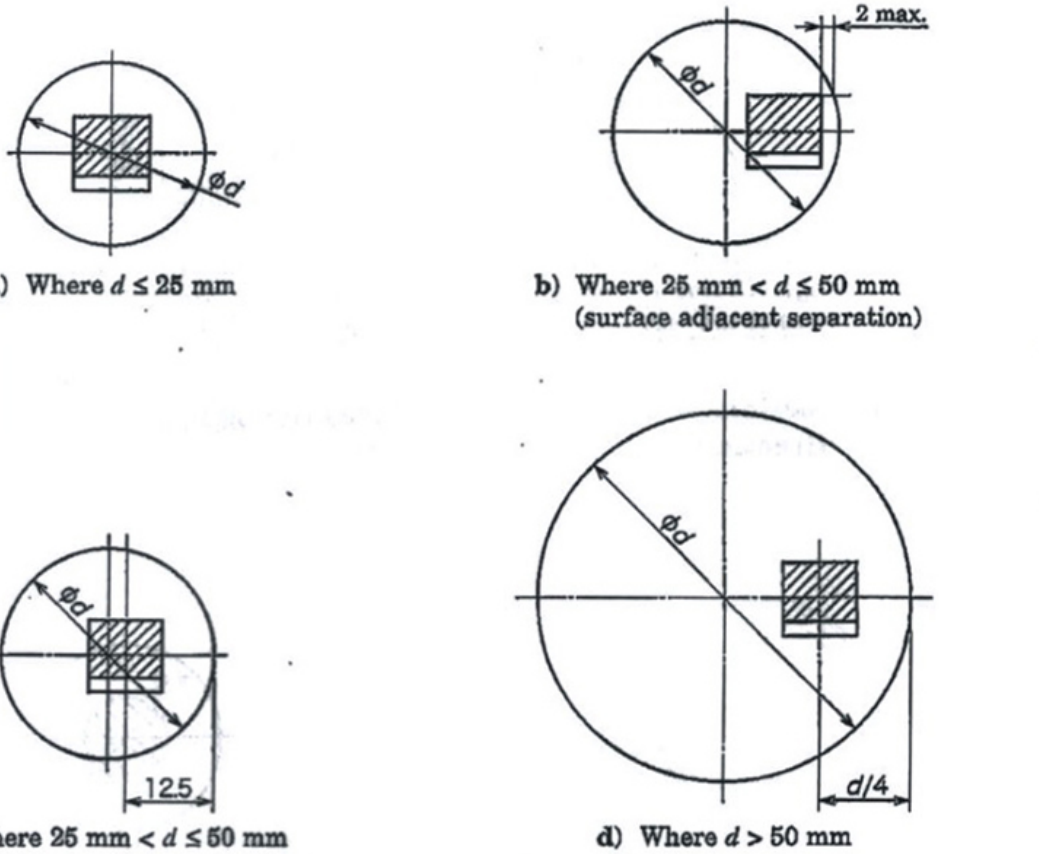
c) Round bar test piece where $25 \text{ mm} < d \leq 50$ mm



d) Round bar test piece where $d > 50$ mm

Figure A.4 Round bar and rod—Location of test pieces for tensile testing (see A.3.1)

Unit: mm



a) Where $d \leq 25$ mm

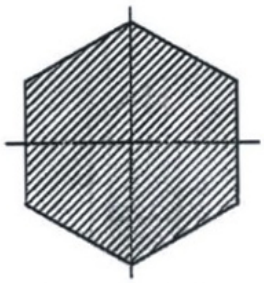
b) Where 25 mm < $d \leq 50$ mm (surface adjacent separation)

c) Where 25 mm < $d \leq 50$ mm

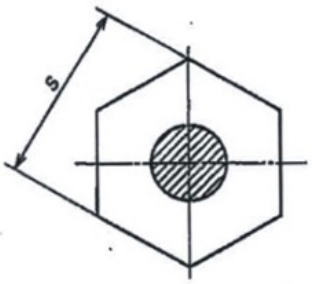
d) Where $d > 50$ mm

Figure A.5 Round bar and rod—Location of test pieces for impact testing (see A.3.2)

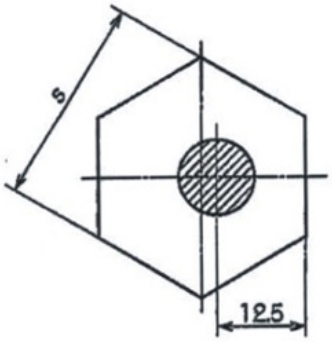
Unit: mm



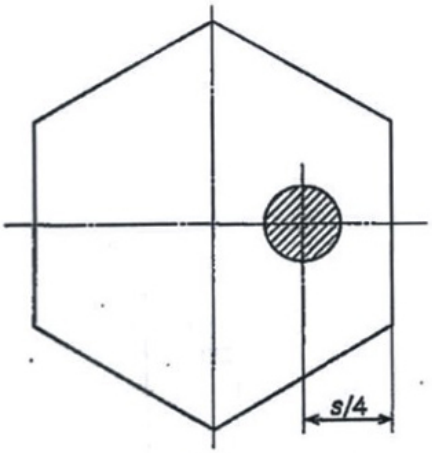
a) Full section test piece (preferred, see A.4.1)



b) Round bar test piece where $s \leq 25$ mm



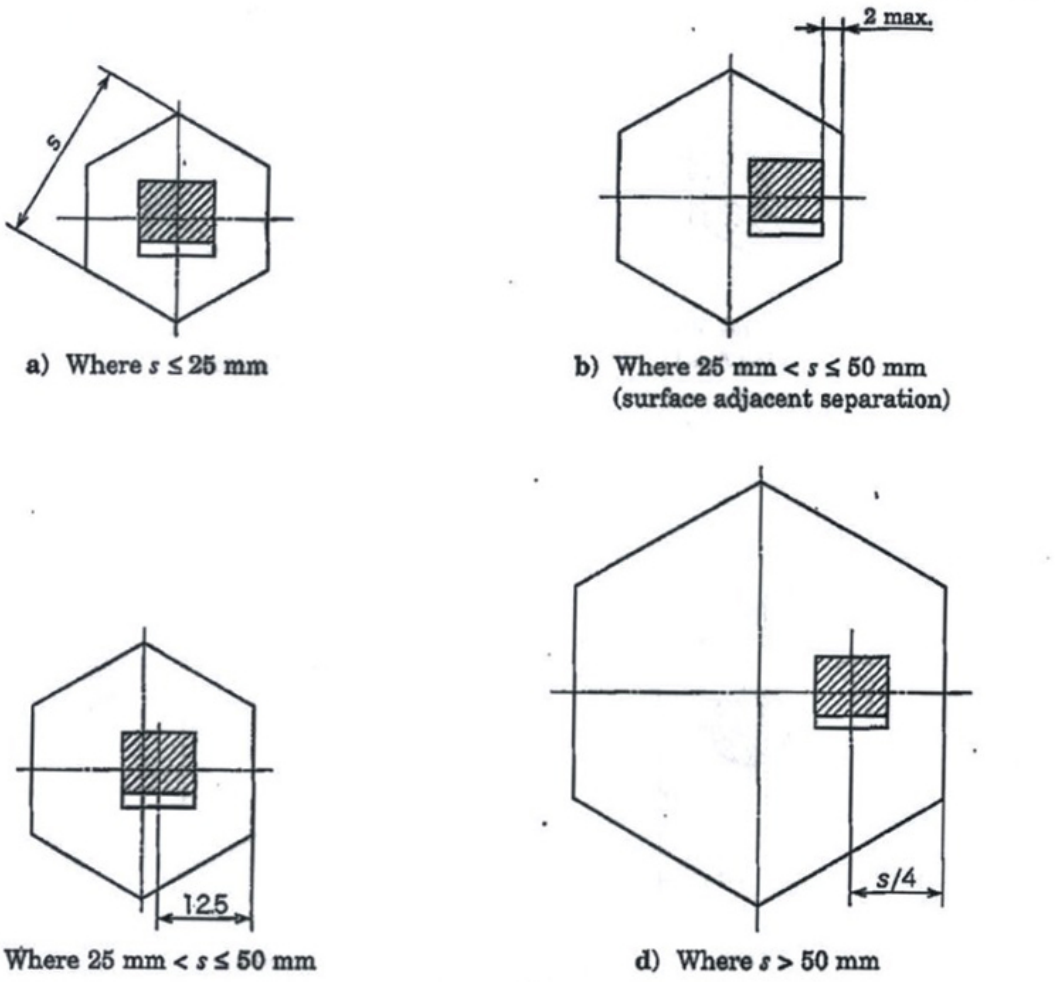
c) Round bar test piece where $25 \text{ mm} < s \leq 50$ mm



d) Round bar test piece where $s > 50$ mm

Figure A.6 Hexagonal bar—Location of test pieces for tensile testing (see A.4.1)

Unit: mm



a) Where $s \leq 25$ mm

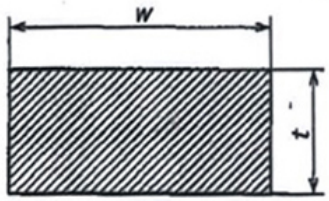
b) Where 25 mm < $s \leq$ 50 mm (surface adjacent separation)

c) Where 25 mm < $s \leq$ 50 mm

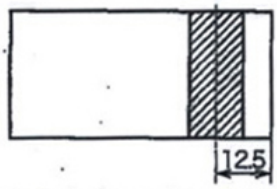
d) Where $s >$ 50 mm

Figure A.7 Hexagonal bar—Location of test pieces for impact testing (see A.4.2)

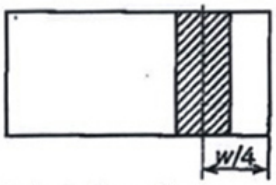
Unit: mm



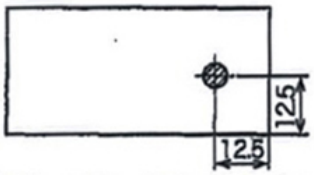
a) Full section test piece
(where possible, see A.5.1)



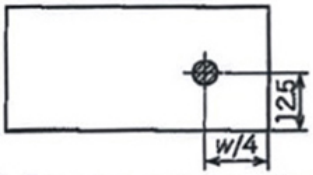
b) Strip test piece where $w \leq 50$ mm



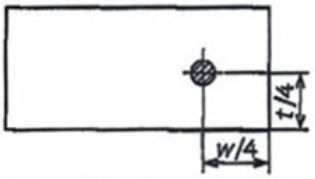
c) Strip test piece where $w > 50$ mm



d) Round bar test piece where
$w \leq 50$ mm and $t \leq 50$ mm



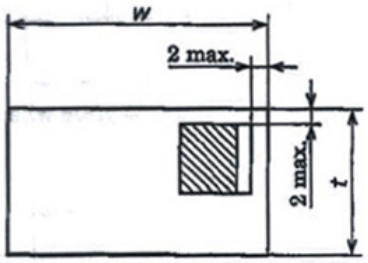
e) Round bar test piece where
$w > 50$ mm and $t \leq 50$ mm



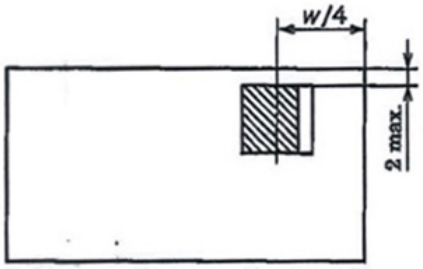
f) Round bar test piece where
$w > 50$ mm and $t > 50$ mm

Figure A.8 Rectangular bar—Location of test pieces for tensile testing (see A.5.1)

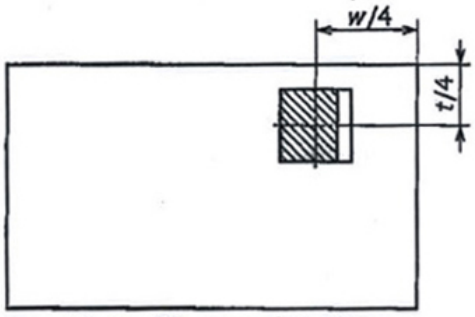
Unit: mm



a) 12 mm $\leq w \leq$ 50 mm and $t \leq 50$ mm



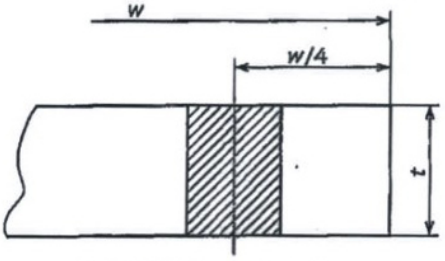
b) $w > 50$ mm and $t \leq 50$ mm



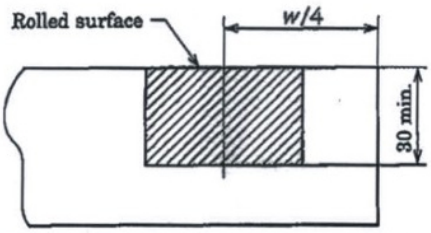
c) $w > 50$ mm and $t > 50$ mm

Figure A.9 Rectangular bar—Location of test pieces for impact testing (see A.5.2)

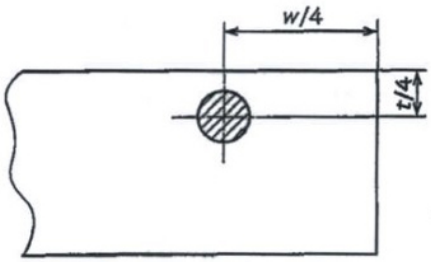
Unit: mm



a) Full thickness test piece (where possible, see A.6.1)



b) Reduced-thickness test piece where $t \geq 30$ mm [a)]



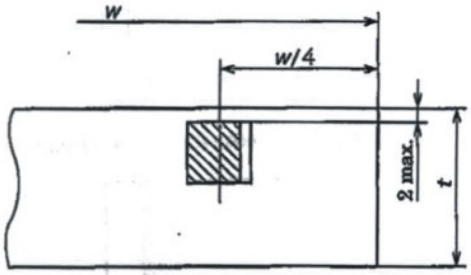
c) Round bar test piece where $t \geq 25$ mm [b)]

Notes [a)] When b) is applied to quenched and tempered or thermomechanically rolled plates, the test piece thickness shall be half the product thickness on either side of the product. In this case, the test piece thickness need not be 30 mm or over (see A.6.1).

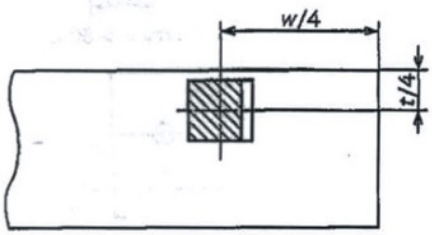
[b)] According to A.6.1, the round bar test piece may be applied to sheets whose thickness is 20 mm or over to and excluding 25 mm. In this case, the centre of the test piece shall be located at the centre of the thickness.

Figure A.10 Sheets, strips in coil and flats—Location of test pieces for tensile testing (see A.6.1)

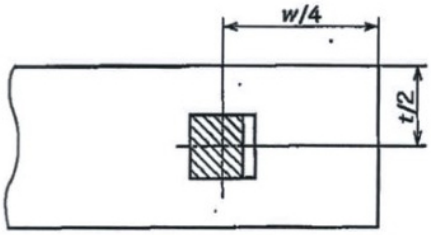
Unit: mm



a) Applicable [a)] for all values of t



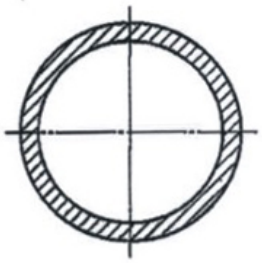
b) Where $t \geq 40$ mm (t/4 separation)



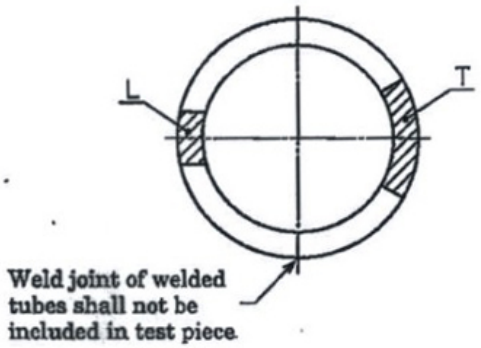
c) Where $t \geq 40$ mm (t/2 separation)

Note [a)] Unless otherwise specified, the location shall be as shown in a) for sheets whose thickness is 28 mm or under, and shall be one-fourth thickness for sheets whose thickness is over 28 mm (see A.6.2).

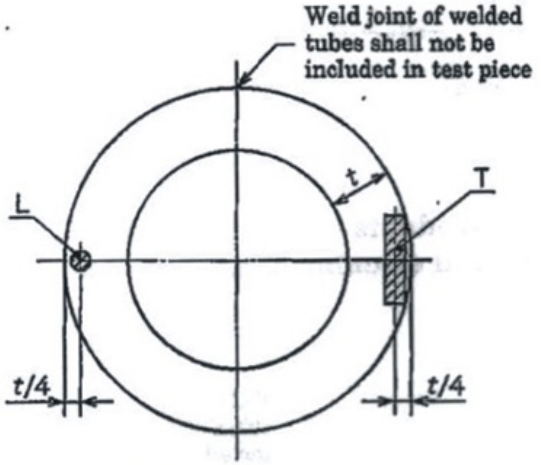
Figure A.11 Sheets, strips in coil and flats—Location of test pieces for impact testing (see A.6.2)



a) Full section test piece



b) Strip test pieces

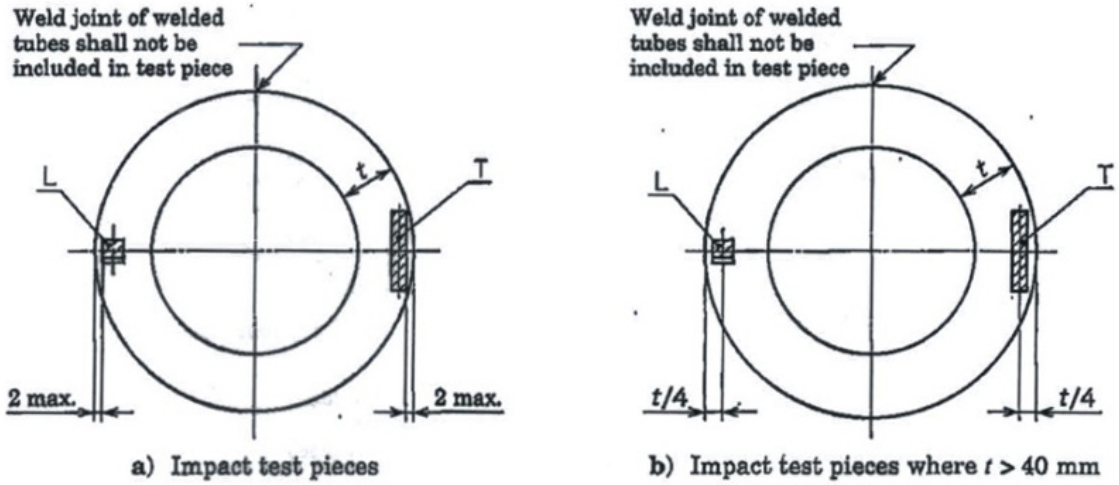


c) Round bar test pieces

L = Longitudinal test piece
T = Transverse test piece

Figure A.12 Tubular products—Location of test pieces for tensile testing of tubes and circular hollow sections (see A.7.1.1)

Unit: mm



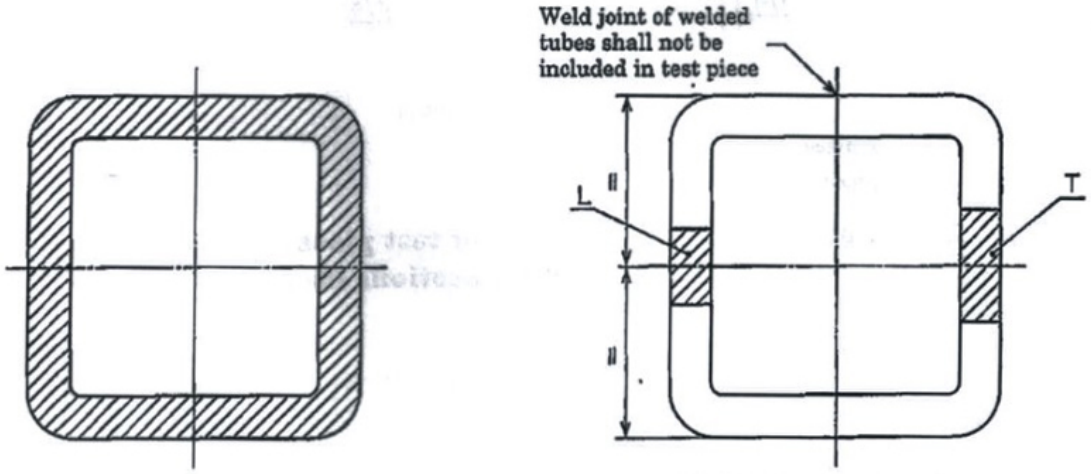
a) Impact test pieces

b) Impact test pieces where $t > 40$ mm

L = Longitudinal test piece

T = Transverse test piece

Figure A.13 Tubular products—Location of test pieces for impact testing of tubes and circular hollow sections (see A.7.1.2)



a) Full section test piece

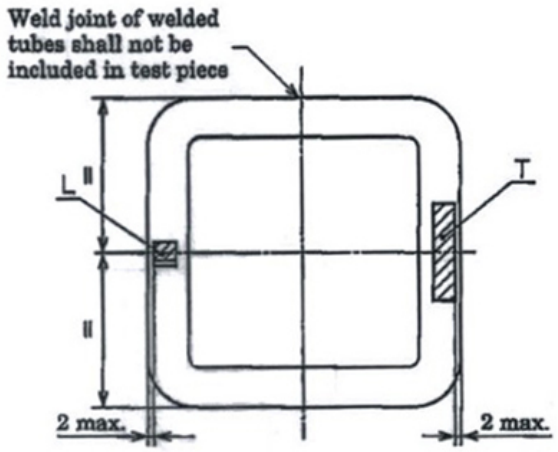
b) Rectangular test pieces

L = Longitudinal test piece

T = Transverse test piece

Figure A.14 Tubular products—Location of test pieces for tensile testing of hollow sections (see A.7.2.1)

Unit: mm



L = Longitudinal test piece

T = Transverse test piece

Figure A.15 Tubular products—Location of test pieces for impact testing of hollow sections (see A.7.2.2)