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IS 3711 (2012): Steel And Steel Products- Location and Preparation of Samples And Test Pieces For Mechanical Testing [MTD 3: Mechanical Testing of Metals]
Indian Standard

STEEL AND STEEL PRODUCTS — LOCATION AND PREPARATION OF SAMPLES AND TEST PIECES FOR MECHANICAL TESTING

(Second Revision)
NATIONAL FOREWORD

This Indian Standard (Second Revision) which is identical with ISO 377 : 1997 'Steel and steel products — Location and preparation of samples and test pieces for mechanical testing' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Mechanical Testing of Metals Sectional Committee and approval of the Metallurgical Engineering Division Council.

This standard was originally published in 1966 and subsequently revised in 1990. This revision of the standard has been taken up to align it with the latest version of ISO 377 by adoption under dual numbering system.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminology and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

<table>
<thead>
<tr>
<th>International Standard</th>
<th>Corresponding Indian Standard</th>
<th>Degree of Equivalence</th>
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<tbody>
<tr>
<td>ISO 6929 : 1987 Steel products — Definitions and classification</td>
<td>IS 1956 (All parts) Glossary of terms relating to iron and steel</td>
<td>Not Equivalent</td>
</tr>
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</table>

Technical corrigendum 1 issued in the year 1997 to the above International Standard has been given at the end of this publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (revised)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
1 Scope

This International Standard specifies requirements for the identification, location and preparation of samples and test pieces intended for mechanical tests on steel sections, bars, rod, flat products and tubular products as defined in ISO 6929. If agreed in the order this standard may also apply to other metallic products. It does not apply to non-destructive tests.

These samples and test pieces are for use in tests which are carried out in conformity with the methods specified in the product or material standard or, in the absence of this, in the test standard.

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

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3785:—1), Metallic materials — Designation of test piece axes.


3 Definitions

For the purposes of this International Standard, the definitions given in ISO 6929 and the following 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. bar, sheet, coil) selected for inspection and/or testing. (See figure 1.)

1) To be published. (Revision of ISO 3785:1976)
Figure 1 — Examples of terms defined in clause 3
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, for the purpose of producing a test piece. (See figure 1.)

3.5 **test piece:** Part of a sample or rough specimen, with specified dimensions, machined or unmachined, 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 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.

4 **General requirements**

4.1 **Representative testing**

Sample, 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. molting, 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.

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

Sample products, samples, rough specimens and test pieces shall be marked to ensure traceability to the original product and their location and orientation in that product. For this purpose, if, during the preparation of the sample, rough specimen and/or test pieces, removal of the marks cannot be avoided, transfer of these marks shall be carried out 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 testing and where requested by the purchaser the transfer of the 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 **Selection and dimensions of samples and location of test pieces**

The sample shall be selected so that the test piece can be located as indicated in annex A. The sample shall have sufficient dimensions to allow sufficient 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. The designation of the test piece axis shall be in accordance with ISO 3765.
5.3 Condition and separation of samples

5.3.1 General

The material or product standard shall specify whether the test is intended to determine the properties,

a) in the as-delivered condition (see 5.3.2) or

b) in the reference condition (see 5.3.3).

5.3.2 Testing in the as-delivered condition

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

a) after the forming and heat treatment processes have been completed or

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 of 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 provide the test pieces.

Where flattening or straightening of the sample is unavoidable in 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 after heat treatment.

NOTE — When flattening or straightening is necessary it may be carried out either hot or cold before any heat treatment. When carried out hot it should 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) Mechanical treatment 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 rough 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 those specified in the appropriate test methods.

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 applies to the location of test pieces for the following product forms
- sections;
- bars and rod;
- flat products;
- tubular products.

The location of test pieces for tensile and impact tests are indicated in figures A.1 to A.15. For bend tests the width position is as for the tensile test pieces.

Where more than one 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 of section
The location of test pieces shall be in accordance with figure A.1.

NOTES
1 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) and d]) or the sample from the tapered flange may be machined.
2 For unequal leg angles, samples may be taken from either leg.

A.2.2 Location of test pieces in thickness 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 allows.

A.2.2.2 Impact test pieces
The location of impact test pieces shall be in accordance with figure A.3.

A.3 Round bars and rod

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 allows.
A.3.2 Impact test pieces
The location of impact test pieces shall be selected in accordance with figure A.5.

A.4 Hexagonal bar

A.4.1 Tensile test pieces
The location of tensile test pieces shall be selected in accordance with figure A.6.
Full section test pieces [see figure A.6 a)] shall be used wherever machining and test equipment allows.

A.4.2 Impact test pieces
The location of impact test pieces shall be selected 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 rectangular test pieces [see figures A.8 a), b) or 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 Flat products

A.6.1 Tensile test pieces
The location of tensile test pieces shall be in accordance with figure A.10.
Full section test pieces [see figure A.10 a)] shall be used whenever machining and test equipment allow.
Where transverse tensile test pieces are specified and the width of flat product is not sufficient to take the test piece from the $\frac{w}{4}$ location, then the centre of the test piece shall be as near to $\frac{w}{4}$ as possible.

A.6.2 Impact test pieces
The location of impact test pieces shall be in accordance with figure A.11. For products of thickness $\geq 40$ mm the location [figure A.11 a), b) or c)] shall be specified in the product standard or in the order.
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 selected in accordance with figure A.12. Full section test pieces [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.

NOTES

1 The full section test piece as shown in figure A.12 a) is also applicable for a tube:— flattening test;— drift expanding test;— flanging test;— ring expanding test;— ring tensile test;— bend test in full section;
2 Test pieces shown in figure A.12 b) are used for strip bend test.

If not specified in the product standard or in the order the sampling position is at the discretion of the manufacturer.

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.

If not 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 between 10 mm and 5 mm shall be produced.

The minimum (nominal) diameter $D_{\text{mm}}$ of the tube necessary to obtain such a test piece is given by:

$$D_{\text{min}} = (T - 5) + \frac{756.25}{T - 5}$$

where $T$ is the wall thickness.

Where the smallest permitted transverse test piece is not obtainable, the widest possible longitudinal size between 10 mm and 5 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.
Figure A.1 — Sections — Location of test pieces for tensile and impact testing in width of flange (see A 2.1)
Figure A.2 — Sections — Location of test pieces for tensile testing in thickness of flange (see A.2.2.1)

Dimensions in millimetres

Figure A.3 — Sections — Location of test pieces for impact testing in thickness of flange (see A.2.2.2)
Figure A.4 — Round bar and rod — Location of test pieces for tensile testing (see A.3.1)

Figure A.5 — Round bar and rod — Location of test pieces for impact testing (see A.3.2)
Figure A.6 — Hexagonal bar — Location of test pieces for tensile testing (see A.4.1)

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

b) Round test piece where $s = 25$ mm

c) Round test piece where $s = 25$ mm

d) Round test piece where $s = 50$ mm
Figure A.7 — Hexagonal bar — Location of test pieces for impact testing (see A.4.2)
Figure A.8 — Rectangular bar — Location of test pieces for tensile testing (see A.5.1)

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

Figure A.10 — Flat products — Location of test pieces for tensile testing (see A.6.1)

Figure A.11 — Flat products — Location of test pieces for impact testing (see A.6.2)
Figure A.12 — Tubular products — Location of test pieces for tensile testing of tubes and circular hollow sections (see A.7.1.1)

Dimensions in millimetres

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

Weld joint for welded sections remote from test piece

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)

Dimensions in millimetres

Weld joint for welded sections remote from test piece

L = Longitudinal test piece
T = Transverse test piece

Figure A.15 — Tubular products — Location of test pieces for impact testing of hollow section
(see A.7.2.2)
TECHNICAL CORRIGENDUM 1

Technical Corrigendum 1 to International Standard ISO 377:1997 was prepared by Technical Committee ISO/TC 17, Steel, Subcommittee SC 20, General technical delivery conditions, sampling and mechanical testing methods.

Page 15, figure A.11

Instead of the existing subtitles for b) and c) read:

"Where \( r \geq 40 \text{ mm} \)"
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This Indian Standard has been developed from Doc No.: MTD 3 (4896).

Amendments Issued Since Publication

<table>
<thead>
<tr>
<th>Amend No.</th>
<th>Date of Issue</th>
<th>Text Affected</th>
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