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Steel — Designation of test piece axes

Acier — Désignation des axes des éprouvettes

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3785 was drawn up by Technical Committee ISO/TC 17, *Steel*, and was circulated to the Member Bodies in August 1975. Subsequently, responsibility for this document has been transferred to ISO/TC 164, *Mechanical testing of metals*, which was set up in 1975.

It has been approved by the Member Bodies of the following countries :

Australia	India	Spain
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No Member Body expressed disapproval of the document.

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Steel – Designation of test piece axes

0 INTRODUCTION

The mechanical properties of a metallic product, especially those characterizing its deformability and toughness, such as elongation after fracture, reduction of area, fracture toughness and impact resistance, are dependent on the position in the product of the test piece on which these properties are measured. This International Standard provides a method for designating the position of the test piece in relation to product grain flow and its effect on these properties.

1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard specifies a method for the identification of test piece axes in relation to the grain flow, by means of a system of co-ordinates.

1.2 It applies to both unnotched and notched metal test pieces.

1.3 The system presented is only intended to be applied in situations where a uniform grain flow can be unambiguously identified (see also 4.2 and the annex).

2 DESIGNATORY SYSTEM

2.1 The method of designation is based on the assumption that a system of co-ordinates is laid into a metallic product so that :

1) the *X*-axis is coincident with the main direction of grain flow;

2) the *Z*-axis is coincident with the direction of the main working force;

3) the *Y*-axis is normal to the *X*- and *Z*-axis.

2.2 When applying this system to actual products, the following additional conditions shall obtain :

1) all test pieces normal to the grain flow of products whose grain flow has only one direction – so that, in accordance with the above definition, Y- and Z-test pieces are equivalent – are called Z-test pieces;

2) in cylindrical sections with an axial grain flow, the radial direction is the *Z*-axis;

3) all test pieces parallel to the surface of sheets processed with the same degree of deformation in two directions normal to each other – so that, in accordance with the above definition, X- and Y-test pieces are equivalent – are called Y-test pieces.

2.3 This system offers the possibility of accurately designating all the positions of test pieces which may occur, and positions which do not coincide with any of the three axes of the system of co-ordinates can also be defined by a simple combination of the relative letters.

2.4 Examples of this system are as follows :

1) A test piece taken parallel to the grain flow of a bar (geometrically a **longitudinal test piece**) is an X-test piece (or lies in the direction of *X*).

2) A test piece taken normal to the grain flow (lamella) of a sheet so that its axis coincides with the broad side of the lamella (geometrically a **transverse test piece**) is a Y-test piece (or lies in the direction of *Y*).

3) A test piece whose axis lies through the thickness of a plate (**short transverse test piece**) is a Z-test piece.

4) Test pieces taken either longitudinally or transversely from a (thin-walled) tube with helical grain flow are XY-test pieces.

2.5 The examples given in 2.4 and also further examples, applicable to unnotched test pieces, may be taken from figures 1 to 5. It should, however, be noted that the scale of reproduction of these drawings is not the same in all cases and that the place where the test pieces are taken and the actual sampling do not always apply in practice. These drawings, and especially the positions of the test pieces, have been idealized so as to show as clearly as possible the various methods of designating the test piece position by the system of *X*-*Y*-*Z* co-ordinates.

3 IDENTIFICATION OF NOTCHED TEST PIECES

3.1 The system described in clause 2 also offers the possibility of combining the designation of the position of the axis of the test piece with the designation of the direction of propagation of fracture during a test. This is of importance in the case of notched test pieces or test pieces for the assessment of the mechanism of fracture. Separated by a hyphen, this designation follows the designation of the position given in clause 2.

3.2 Examples of this system are as follows (further examples are shown in figures 6 to 8) :

1) A notched test piece as described in 2.4, paragraph 2), whose notch is normal to the sheet surface so that fracture propagates in the direction of *X*, is called a Y-X-test piece.

2) A notched test piece as described in 2.4, paragraph 4), notched so that fracture propagates in the direction of *Z*, is called an XY-Z-test piece.

4 APPLICATION OF DESIGNATORY SYSTEM TO PROPERTIES LISTED IN MATERIAL SPECIFICATIONS

4.1 Application

As pointed out in the annex, the position of the test piece in relation to the grain flow is only one of the characteristics required for ascertaining the properties which may be obtained. Moreover, the position of a test piece relative to the grain flow is only sufficiently defined in simple products whose production and processing are well known. Therefore, the position relative to the direction of the grain flow, the geometrical position in the product, and the various additional effects mentioned in the annex shall, as a rule, be taken into account when estimating the importance of a special position of the test piece.

4.2 Limits of application

4.2.1 The system described may be used to designate the position of test pieces relative to the direction of the grain flow whenever a uniform grain flow direction can be identified. In all other cases, the location of the test piece shall be related to component geometry and marked on a drawing of the same, together with a brief description of the method of production of the component (i.e. casting, upset forging, etc.).

(The position of the test pieces in actual products shall be taken from the relevant material specifications.)

4.2.2 The cases in which various products may be compared depend on the circumstances and may differ, to a varying extent, from one another. Thus definite numerical relations of the property values which have been obtained in this way for various classifications of the position of the test piece in relation to the grain flow apply to the particular case only and may not be generalized.

FIGURES 1 to 5 — Designation of unnotched test pieces

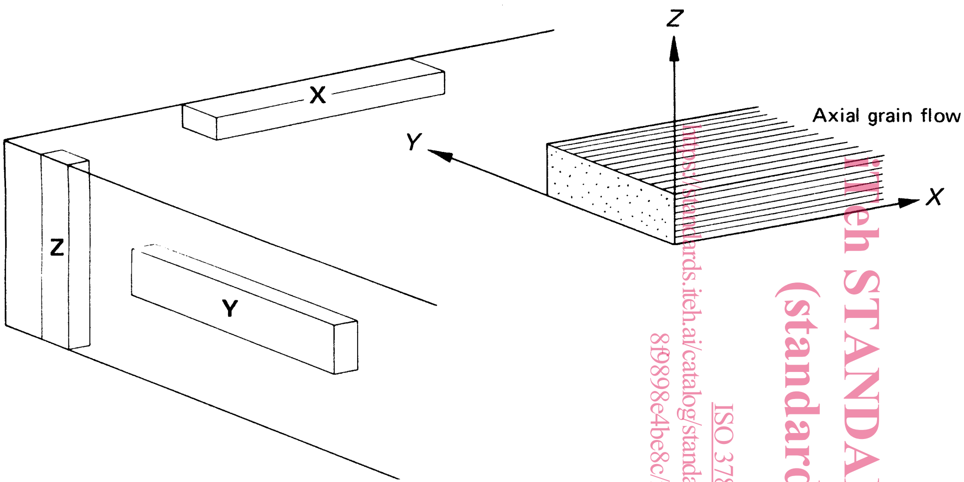

FIGURE 1 — **Flat rolled products**

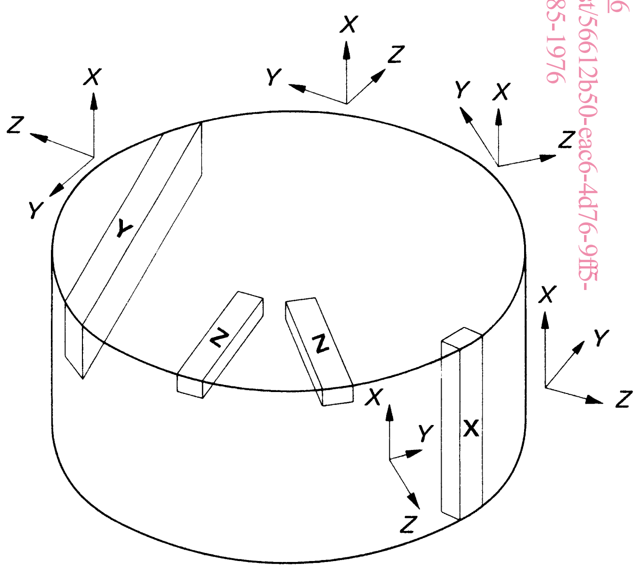

FIGURE 2 — **Cylindrical section (axial grain flow)**

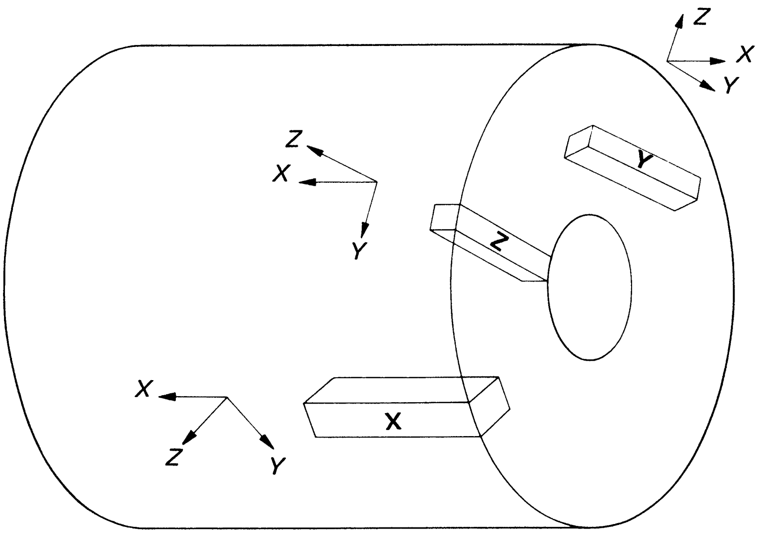

FIGURE 3 — **Tube (axial grain flow)**

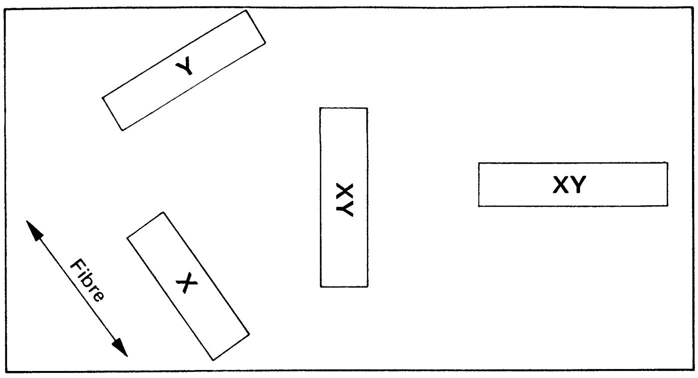

FIGURE 4 — **Thin-walled tube with helical grain flow**

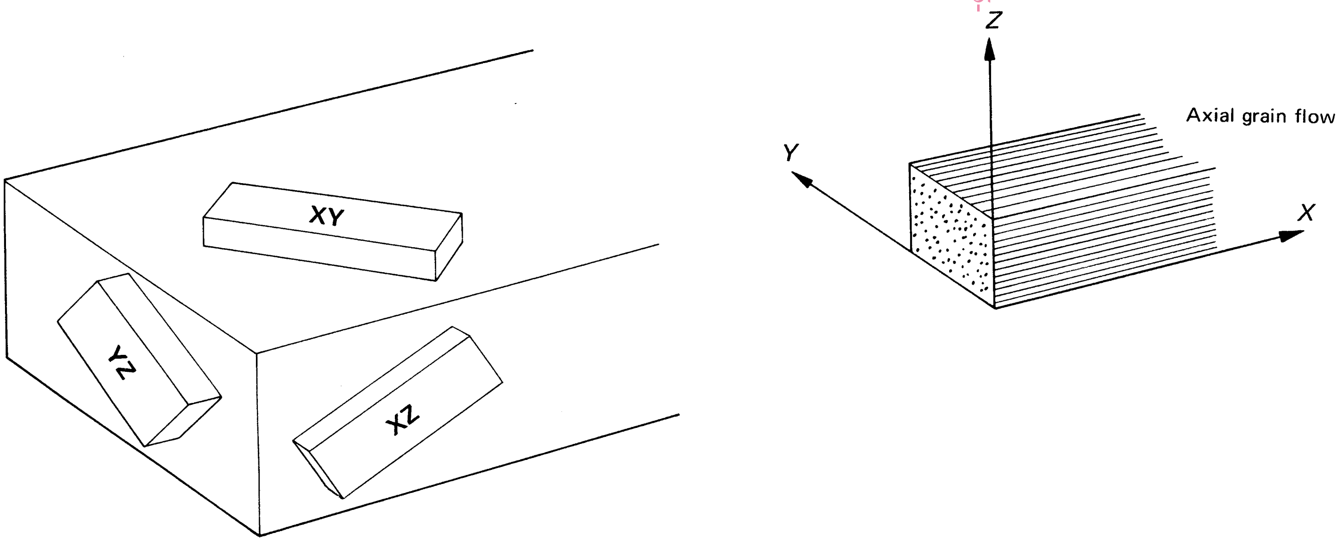

FIGURE 5 — **Non-basic flat product**

FIGURES 6 to 8 — Designation of notched test pieces

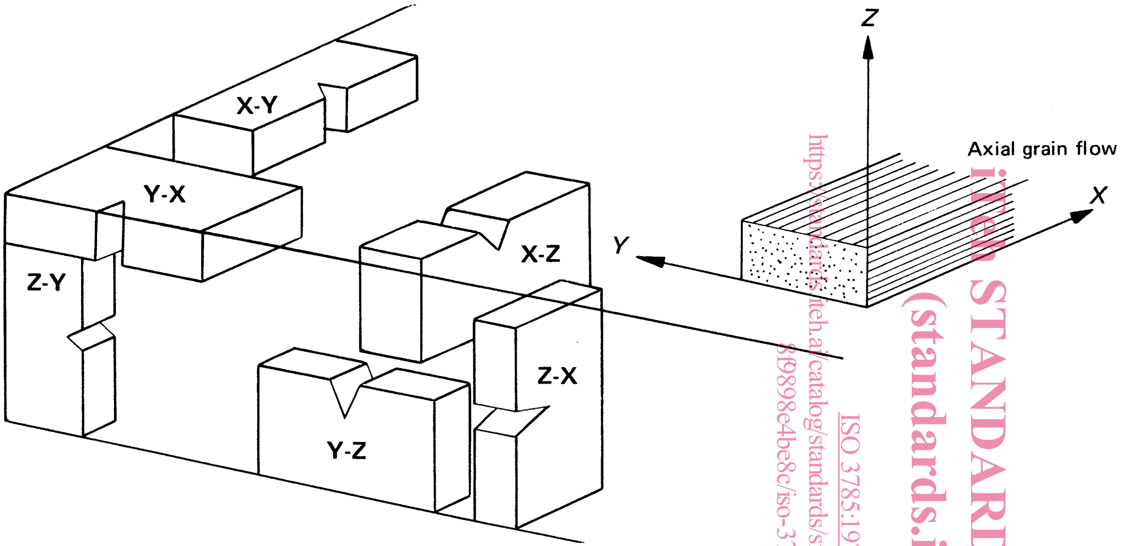

FIGURE 6 — **Basic fracture plane — Flat rolled products**

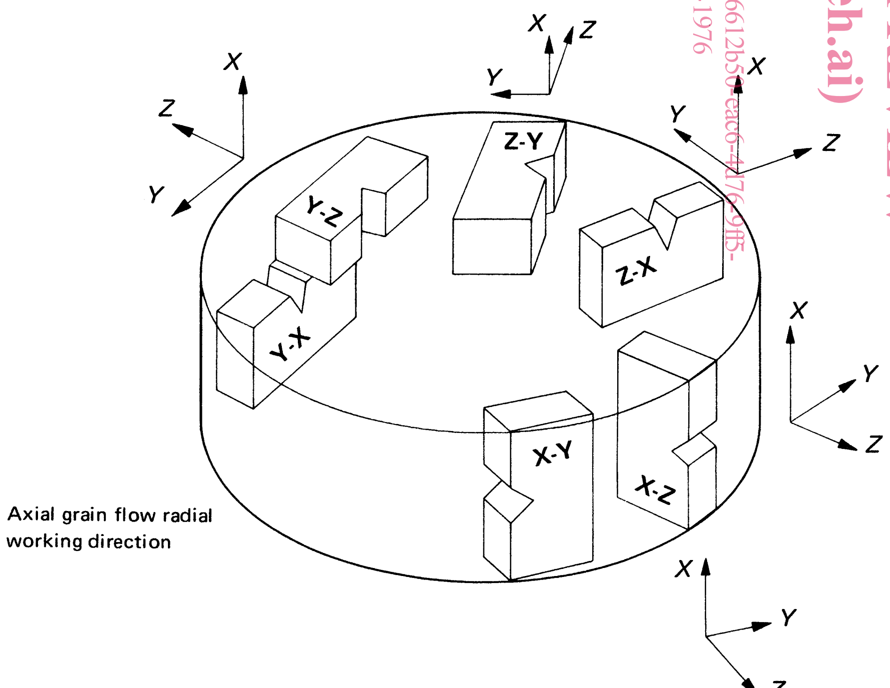

FIGURE 7 — **Fracture plane — Cylindrical sections**

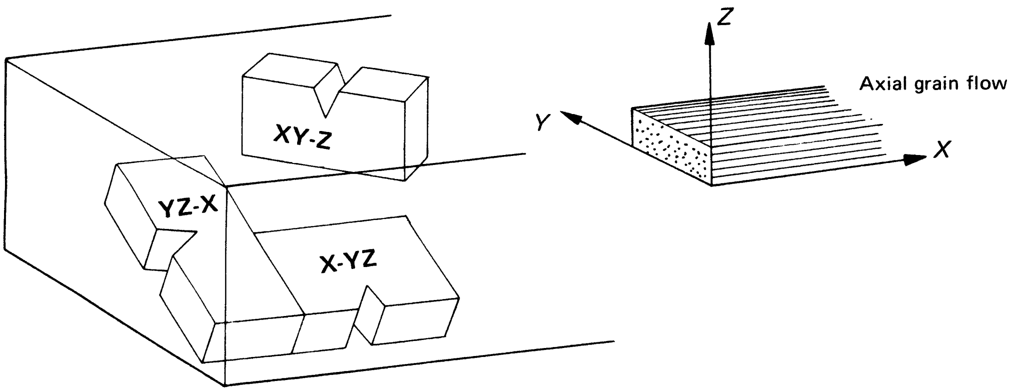

FIGURE 8 — **Non-basic fracture plane**

ANNEX

INFLUENCE OF MECHANICAL WORKING ON MATERIAL STRUCTURE AND PROPERTIES

A.1 During solidification of molten metals, dendrites grow and form grains which may be elongated in the direction of freezing where steep temperature gradients exist, or more or less equi-axial when freezing takes place in a region of low temperature gradient. In addition, irregularly shaped intermetallic compounds may form and small roughly equiaxed particles of non-metallics may be included.

During hot working, recrystallization occurs and new grains are formed, and the intermetallics and non-metallics may also change in character. Increasing distortion of the metal produces a degree of preferred crystal orientation within the grains, and intermetallics and non-metallics, if sufficiently ductile, tend to be drawn out along the direction of the greatest elongation of the metal.

During cold working, the grains do not recrystallize but they become elongated in the direction of elongation of the product, and there may be further elongation of intermetallics and non-metallics.

Thus metals tend to become more anisotropic during mechanical working, particularly cold working (i.e. below the recrystallization temperature). The properties in different directions within the product then vary, and identification of test piece axes is necessary to represent the characterization of the product.

A.2 In many instances, the geometry of the product indicates the direction of elongation of grain flow. For example, grain flow occurs along the length of a bar or section made by rolling or extrusion; in sheet, grain flow occurs primarily along the direction of rolling, usually the longer of the two main axes.

Because of this frequent coincidence of the direction of grain flow with the longitudinal axis of the product, the position of a test piece (i.e. the direction of its longitudinal axis) is usually referred to the geometry of the product. Test pieces taken parallel to the longitudinal axis of a rolled or extruded bar or section are therefore called **longitudinal test pieces** and those taken in a transverse direction to the longitudinal axis of the product are called **transverse test pieces**; these are further identified as **long transverse** or **short transverse** when the transverse dimensions of the product differ by a factor of, say, 1,5 or more.

A difficulty arises when the direction of main elongation of the product is *known* and this differs from its longest axis; for example short sheets cut from rolled wide coiled strip. It is then necessary to report this knowledge. Thus designations referring to the geometry of the product, such as tangential test pieces, radial test pieces or axial test pieces, are often insufficient to define the position of the test piece with respect to the grain flow, if the method of production is not indicated. This is particularly so in the case of forgings.

A.3 In addition to the position of the test piece in relation to the direction of grain flow, other factors are also important, such as the type of product, its chemical content, its processing, and its heat treatment. When assessing the position of a test piece with regard to the properties which may be obtained, all these factors must be taken into account. This, however, can only be done in the relevant material specifications.