INTERNATIONAL STANDARD 1352

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Steel — Torsional stress fatigue testing

Acier — Essais de fatigue par contrainte de torsion

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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 1352 was developed by Technical Committee ISO/TC 17, *Steel,* and was circulated to the member bodies in November 1976. 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	South Africa, Rep. of
Austria	Iran	Sweden
Belgium	Italy	Switzerland
Brazil	Mexico	Turkey
Canada	Netherlands	United Kingdom
Czechoslovakia	New Zealand	U.S.A.
Denmark	Norway	U.S.S.R.
Egypt, Arab Rep. of	Poland	Yugoslavia
Finland	Portugal	
Hungary	Romania	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

France
Spain

Printed in Switzerland

Steel — Torsional stress fatigue testing

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the conditions for carrying out torsional stress fatigue tests on test pieces having a nominal diameter between 5 and 12,5 mm without deliberately introduced stress concentrations. The tests are carried out at room temperature in air, by applying to the test piece a pure couple about its longitudinal axis.

The form, preparation and testing of test pieces of circular cross-section are specified, but component testing and other specialized forms of test are not included. Similarly, high strain torsional fatigue tests, which lead to failure in a few thousand cycles, are also excluded.

2 REFERENCES

ISO/R 373, *General principles for fatigue testing of metals.*

ISO/R 468, *Surface roughness.*

ISO 554, *Standard atmospheres for conditioning and/or testing.*

3 PRINCIPLE

Nominally identical test pieces are mounted in a torsional fatigue testing machine and subjected to the loading conditions required to induce cycles of torsional stress having the form of any one of the stress cycles illustrated in diagrams 4 to 7 of figure 3 in ISO/R 373.

NOTE — Diagrams 1 to 3 of figure 3 in ISO/R 373 are not relevant since in an axially symmetrical test piece, change of direction of mean torque does not induce a different type of stress system, and mean stress in torsion can always be regarded as positive in sign.

The purpose of the test is to determine fatigue properties such as the *S/N* curve as detailed in ISO/R 373, the test being continued until the test piece fails by complete fracture or until a pre-determined degree of cracking has been achieved or a predetermined number of stress cycles has been exceeded.

NOTES

1 The form of cracking experienced as a result of torsional fatigue testing may be of different configurations. Cracks may be parallel to the longitudinal axis of the test piece, or perpendicular to the longitudinal axis, or at any angle between these two.

2 Results of fatigue tests may be affected by atmospheric conditions, and if, by agreement, controlled conditions are required, these shall be as detailed in 2.1 of ISO 554 [see clause 11, paragraph e)].

4 SYMBOLS AND DEFINITIONS

In this International Standard the following symbols (see figures 1 and 2) are used.

Symbol	Definition
D	The diameter or width across flats of the gripped ends of the test piece. The value of D may be different for each end of the test piece
d	The diameter of the test piece where the stress is a maximum
L_c	The parallel length of the test piece
r	The transition blending radius at the ends of the test section which starts the transition from the test diameter d to the end diameter D [see figure 1a)], or the single radius between the gripped ends [see figure 1b)]

Further symbols and definitions relating to fatigue testing are given in ISO/R 373.

5 TEST PIECES

5.1 Form

The test section shall be either :

a) cylindrical with tangentially blending radii at each end of a parallel length, L_c [see figure 1a)], or

b) of continually varying circular cross-section, its surface formed by a single radius r, there being no central parallel portion.

The ends of the test piece shall be of a form to suit the holders of the machine being used and the material being tested. Screwed and plain cylindrical ends are not recommended. Typical test piece ends are shown in figure 2.

5.2 Dimensions

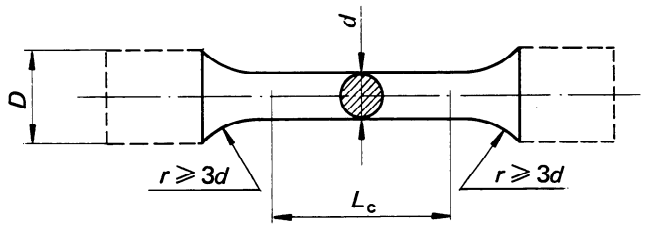
The nominal value of the diameter d shall be between 5 and 12,5 mm; the tolerance on diameter d shall be ± 0,05 mm.

For the purpose of calculating the torque to be applied to obtain the required stress, the actual diameter of each test piece shall be measured to an accuracy of 0,01 mm. Care should be taken during the measurement of the test piece prior to testing that the surface is not damaged.

In the case of a cylindrical test piece having a parallel test section, this test section shall have a length not greater than $5d$ and it shall be parallel within 0,02 mm. The transition blending radius at the end of the parallel test section shall have a radius not less than $3d$.

In the case of a test piece having a test section formed by a continuous radius, this radius shall be not less than $5d$.

a)



b)

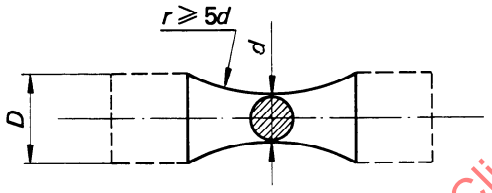


FIGURE 1 – **Forms of test piece**

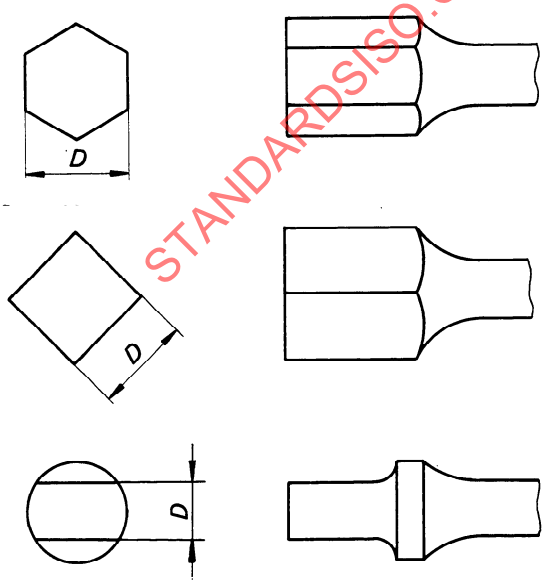


FIGURE 2 – **Typical test piece ends**

6 PREPARATION OF TEST PIECE

6.1 General

It is essential that any cutting or machining operation required, either to rough out the test piece from the blank, or to finish it to size, shall not alter the metallurgical structure or the mechanical properties of the test piece or induce substantial residual surface stress.

Care should be taken in the preparation of the ends of the test piece to ensure that the requirements of clause 7 can be met.

6.2 Turning

It is recommended that the following procedure be adopted :

6.2.1 In rough turning the test piece from a diameter $x + 5$ mm (x will generally be the diameter, d, plus a suitable allowance for surface finishing) to $x + 0,5$ mm, a succession of cuts of decreasing depth should be made, the recommended depths of cuts being :

1,25 mm, 0,75 mm and 0,25 mm.

6.2.2 From a diameter of $x + 0,5$ mm to x, a further succession of cuts of decreasing depths should be made, the recommended depths of cuts being :

0,125 mm, 0,075 mm and 0,05 mm,

using for these finishing cuts a feed not exceeding 0,06 mm per revolution.

6.3 Grinding

For test pieces in material which cannot be readily turned, it is recommended that the finishing operations be carried out by grinding. If the strength properties of the material are developed by heat treatment, this heat treatment may be carried out after rough turning to a diameter of $x + 0,5$ mm.

The test piece should then be ground to size. A succession of cuts of decreasing depth should be made, the recommended values being :

- 0,030 mm depth of cut to 0,1 mm oversize;
- 0,005 mm depth of cut to 0,025 mm oversize;
- 0,002 5 mm depth of cut to size.

6.4 Surface finishing

After the test section has been machined or ground to nominal dimensions, it shall be polished either by hand or by machine, using successively finer grades of abrasive papers or cloths. The polishing should generally be in a circumferential direction, although intermediate stages may be done in any direction, to ensure that scratches made by the coarser grades of abrasive papers, or cloths, are removed. The direction of the final polishing should mainly be circumferential.