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Steel for the reinforcement and prestressing of concrete — Test methods —

Part 1: Reinforcing bars, wire rod and wire

Aciers pour l'armature et la précontrainte du béton — Méthodes d'essai —
Partie 1: Barres, fils machine et fils pour béton armé

Reference number
ISO 15630-1:2002(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15630 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15630-1 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 16, *Steels for the reinforcement and prestressing of concrete*.

This part of ISO 15630, together with parts 2 and 3, cancels and replaces ISO 10065:1990, ISO 10287:1992 and ISO 10606:1995.

ISO 15630 consists of the following parts, under the general title *Steel for the reinforcement and prestressing of concrete — Test methods*:

— *Part 1: Reinforcing bars, wire rod and wire*

— *Part 2: Welded fabric*

— *Part 3: Prestressing steel*

Introduction

The aim of ISO 15630 is to provide all relevant test methods for reinforcing and prestressing steels in one standard. In that context, the existing International Standards for testing these products have been revised and updated. Some further test methods have been added.

Reference is made to International Standards on testing of metals in general as they are applicable. Complementary provisions have been given if needed.

Test methods which do not form the subject of an existing International Standard on metal testing are fully described in ISO 15630.

Steel for the reinforcement and prestressing of concrete — Test methods —

Part 1:
Reinforcing bars, wire rod and wire

1 Scope

This part of ISO 15630 specifies test methods applicable to reinforcing bars, wire rod and wire.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15630. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15630 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 4965:1979, *Axial load fatigue testing machines — Dynamic force calibration — Strain gauge technique*

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature*

ISO 7438:1985, *Metallic materials — Bend test*

ISO 7500-1:1999, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 9513:1999, *Metallic materials — Calibration of extensometers used in uniaxial testing*

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis*

3 Symbols

See Table 1.

Table 1 — Symbols

Symbol	Unit	Description	Reference
a'	mm	Height of longitudinal rib	10.3.2, 11.3
a_m	mm	Rib height at the mid-point	10.3.1.2, 11.3.3
a_{max} [a]	mm	Maximum height of transverse rib or maximum indentation depth	10.3.1.1
$a_{s,i}$	mm	Average height of a portion i of a rib subdivided in p parts of length Δl	11.3.1
$a_{1/4}$	mm	Rib height at the quarter-point	10.3.1.2, 11.3.3
$a_{3/4}$	mm	Rib height at the three-quarters point	10.3.1.2, 11.3.3
A	%	Percentage elongation after fracture	5.1, 5.3
A_g	%	Percentage non-proportional elongation at maximum force (F_m)	5.3
A_{gt}	%	Percentage total elongation at maximum force (F_m)	5
A_n	mm^2	Nominal cross-sectional area of the bar, rod or wire rod	8.4.2
c	mm	Transverse rib or indentation spacing	10.3.3, 11.3
d	mm	Nominal diameter of the bar, wire rod or wire	5.3, 8.2, 8.4.8, 11.3
D	mm	Diameter of the mandrel of the bending device in the bend or rebend test	6.3, 7.3.2
e	mm	Average gap between two adjacent rib or indentation rows	10.3.5
f	Hz	Frequency of load cycles in the fatigue test	8.1, 8.4.3
f_P	1	Relative indentation area	Clause 11
f_R	1	Relative rib area	Clause 11
F_m	N	Maximum force in the tensile test	5.3
F_P	mm^2	Area of the longitudinal section of one indentation	11.3.2
F_r	N	Force range in the axial load fatigue test	8.1, 8.3, 8.4.2, 8.4.3
F_R	mm^2	Area of the longitudinal section of one rib	11.3.1
F_{up}	N	Upper force in the axial load fatigue test	8.1, 8.3, 8.4.2, 8.4.3
n, m, q, p	1	Quantities used in formulae defining f_R, f_P, F_R and F_P	11.3
P	mm	Pitch for cold-twisted bars	10.3.4, 11.3
r_1	mm	Distance between the grips and the gauge length for the manual measurement of A_{gt}	5.3
r_2	mm	Distance between the fracture and the gauge length for the manual measurement of A_{gt}	5.3
R_{eH}	N/mm^2	Upper yield strength	5.2, 5.3
R_m	N/mm^2	Tensile strength	5.3
$R_{p0,2}$	N/mm^2	0,2 % proof strength, non-proportional extension	5.2, 5.3
α	°	Transverse rib flank inclination	10.3.7
β	°	Angle between the axis of a transverse rib or indentation and the bar, wire rod or wire axis	10.3.6, 11.3

Table 1 (*continued*)

Symbol	Unit	Description	Reference
γ	°	Angle of bend in the bend or rebend test	6.3, 7.3.1 (Figure 4), 7.3.2
δ	°	Angle of rebend in the rebend test	7.3.1 (Figure 4), 7.3.4
λ	1	Empirical factor in empirical formulae of f_R and f_P	11.3.3
$2\sigma_a$	N/mm^2	Stress range in the axial load fatigue test	8.4.2
σ_{max}	N/mm^2	Maximum stress in the axial load fatigue test	8.4.2
Σe_i	mm	Part of the circumference without indentation or rib	10.3.5, 11.3.3
[a] In some product standards, the symbol h is also used for this parameter.			
NOTE 1 N/mm^2 = 1 MPa.			

4 General provisions concerning test pieces

Unless otherwise agreed, the test piece shall be taken from the bar, wire rod or wire in the as-delivered condition.

In the case of a test piece taken from coil, the test piece shall be straightened prior to any tests by a simple bend operation with a minimum amount of plastic deformation.

For the determination of the mechanical properties in the tensile test and the fatigue test, the test piece may be artificially aged (after straightening if applicable) depending on the requirements of the product standard.

NOTE When the product standard does not specify any ageing treatment, the following conditions may be applied: Heating the test piece to 100 °C, maintaining at this temperature ± 10 °C for a period of 1 hour $^{+15}_{0}$ min and then free cooling in still air to ambient temperature.

When an ageing treatment is applied to the test piece, the conditions of the ageing treatment shall be stated in the test report.

5 Tensile test

5.1 Test piece

In addition to the general provisions given in clause 4, the free length of the test piece shall be sufficient for the determination of the percentage elongations in accordance with 5.3.

When percentage elongation after fracture (A) is determined, the test piece shall be marked according to clause 8 of ISO 6892:1998.

When percentage total elongation at maximum force (A_{gt}) is determined by the manual method, equidistant marks shall be made on the free length of the test piece (see annex H of ISO 6892:1998). The distance between the marks shall be 20 mm, 10 mm or 5 mm, depending on bar, wire rod or wire diameter.

5.2 Test equipment

The testing machine shall be verified and calibrated in accordance with ISO 7500-1 and shall be at least of class 1.

When an extensometer is used, it shall be of class 1 (see ISO 9513) for the determination of R_{eH} or $R_{p0,2}$; for the determination of A_{gt}, a class 2 extensometer (see ISO 9513) can be used.

The extensometer which may be used to determine the percentage total elongation at maximum force (A_{gt}) shall have a gauge length of at least 100 mm. The gauge length shall be indicated in the test report.

5.3 Test procedure

The tensile test shall be carried out in accordance with ISO 6892. For the determination of $R_{p0,2}$, if the straight portion of the force-extension diagram is limited or not clearly defined, one of the following methods shall be applied:

— the procedure recommended in 13.1 of ISO 6892:1998;

— the straight portion of the force-extension diagram shall be considered as the line joining the points corresponding to 0,1 F_m and 0,3 F_m.

In case of dispute, the second procedure shall be applied.

NOTE The test should be considered invalid when the slope of this line differs by more than 10 % from the theoretical value of the modulus of elasticity.

For the calculation of tensile properties (R_{eH} or $R_{p0,2}$, R_m), the nominal cross-sectional area shall be used, unless otherwise specified in the relevant product standard.

Where fracture occurs in the grips or at a distance from the grips less than 20 mm or d (whichever is the greater), the test may be considered as invalid.

For the determination of percentage elongation after fracture (A), the original gauge length shall be 5 times the nominal diameter (d), unless otherwise specified in the relevant product standard.

For the determination of the percentage total elongation at maximum force (A_{gt}), ISO 6892 shall be applied with the following modifications or complements:

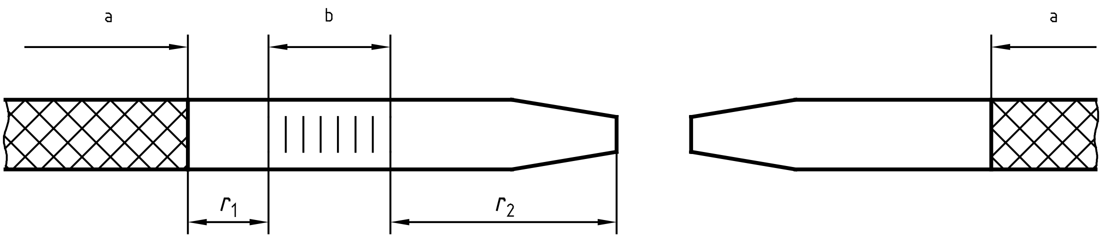
— if A_{gt} is measured by using an extensometer, A_{gt} shall be recorded before the force has dropped more than 0,5 % from its maximum value;

— if A_{gt} is determined by the manual method after fracture, A_{gt} shall be calculated from the following formula:

$$A_{gt} = A_g + R_m / 2\,000$$

where A_g is the percentage non-proportional elongation at maximum force. The measurement of A_g shall be made on a gauge length of 100 mm at a distance, r_2, of at least 50 mm or 2d (whichever is the greater) away from the fracture. This measurement may be considered as invalid if the distance, r_1, between the grips and the gauge length is less than 20 mm or d (whichever is the greater). See Figure 1;

— in case of dispute, the manual method shall apply.



a Grip length

b Gauge length 100 mm

Figure 1 — Measurement of A_{gt} by the manual method

6 Bend test

6.1 Test piece

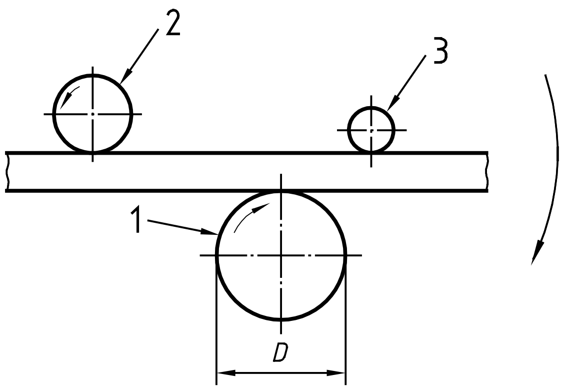
The general provisions in clause 4 apply.

6.2 Test equipment

6.2.1 A bending device, the principle of which is shown in Figure 2, shall be used.

NOTE Figure 2 shows a configuration where the mandrel and support rotate and the carrier is locked. It is also possible that the carrier rotates and the support or mandrel is locked.

6.2.2 The bend test may also be carried out by using a device with supports and a mandrel (see 4.1 of ISO 7438:1985).



Key

1 Mandrel

2 Support

3 Carrier

Figure 2 — Principle of a bending device

6.3 Test procedure

The bend test shall be carried out at a temperature between 10 °C and 35 °C. The test piece shall be bent over a mandrel.

NOTE The bending rate should be about 60 °/s.