INTERNATIONAL STANDARD

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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
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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 2.

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 document 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 second edition cancels and replaces the first edition (ISO 15630-1:2002), which has been technically revised.

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 the testing of metals, in general, as they are applicable. Complementary provisions have been given if needed.

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 for concrete.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

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

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

3 Symbols

The symbols used in this part of ISO 15630 are given in 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 or indentation depth in the centre	10.3.1.2, 11.3.2, 11.4.2
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 into p parts of length Δl, or average depth of a portion i of an indentation subdivided into p parts of width Δb	11.3.1, 11.4.1
$a_{1/4}$	mm	Rib height at the quarter-point or indentation depth at the quarter of their width	10.3.1.2, 11.3.2, 11.4.2
$a_{3/4}$	mm	Rib height at the three-quarters point or indentation depth at the three-quarters of their width	10.3.1.2, 11.3.2, 11.4.2
A	%	Percentage elongation after fracture	5.1, 5.3
A_g	%	Percentage non-proportional elongation at maximum force (F_m)	5.3

Table 1 (*continued*)

Symbol	Unit	Description	Reference
A_{gt}	%	Percentage total elongation at maximum force (F_m)	Clause 5
b	mm	Width of transversal rib at the mid-point or width of indentation	10.3.8
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, 8.4.7, 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 force cycles in the fatigue test	8.1, 8.4.3
f_P	—	Relative indentation area	Clause 11
f_R	—	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	11.4.1
F_r	N	Force range in the axial force 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 force fatigue test	8.1, 8.3, 8.4.2, 8.4.3
l	mm	Length of the transverse rib at the rib-core interface	Figure 6
n, m, q, p	—	Quantities used in formulae defining f_R, f_P, F_R and F_P	11.3, 11.4
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}	MPa	Upper yield strength	5.3
R_m	MPa	Tensile strength	5.3
$R_{p0,2}$	MPa	0,2 % proof strength, non-proportional extension	5.2, 5.3
S_n	mm^2	Nominal cross-sectional area of the bar, rod or wire rod	8.4.2
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
γ	°	Angle of bend in the bend or rebend test	6.3, 7.3.1 (Figure 4), 7.3.2
Δl	mm	Incremental part of the length of the transverse rib at the rib-core interface	Figure 6
δ	°	Angle of rebend in the rebend test	7.3.1 (Figure 4), 7.3.4
λ	—	Empirical factor in empirical formulae of f_R and f_P	11.3.2, 11.4.2
$2\sigma_a$	MPa	Stress range in the axial force fatigue test	8.4.2
σ_{max}	MPa	Maximum stress in the axial force fatigue test	8.4.2
$\sum e_i$	mm	Part of the circumference without indentation or rib	10.3.5, 11.3.2, 11.4.2

NOTE 1 MPa = 1 N/mm^2.

[a] In some product standards, the symbol h is also used for this parameter.

4 General provisions concerning test pieces

Unless otherwise agreed or specified in the product standard, 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 bend operation with a minimum amount of plastic deformation.

NOTE The straightness of the test piece is critical for the tensile test and the fatigue test.

The means of straightening the test piece (manual, machine) shall be indicated in the test report[1)].

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.

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

If 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.

If the percentage elongation after fracture (A) is determined manually, the test piece shall be marked in accordance with ISO 6892-1.

If the 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 ISO 6892-1). The distance between the marks shall be 20 mm, 10 mm or 5 mm, depending on the test piece 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.

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

Any extensometer used for the determination of 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.

1) For routine tests conducted by the reinforcing steel producers, the test information, including the test piece condition and method of straightening, should be contained within internal documentation.

5.3 Test procedure

The tensile test shall be carried out in accordance with ISO 6892-1. 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 ISO 6892-1;

— the straight portion of the force-extension diagram shall be considered as the line joining the points corresponding to $0{,}2F_m$ and $0{,}5F_m$.

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

The test may be considered invalid if 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. In case of dispute, A shall be determined manually.

For the determination of the percentage total elongation at maximum force (A_{gt}), ISO 6892-1 shall be applied with the following modification:

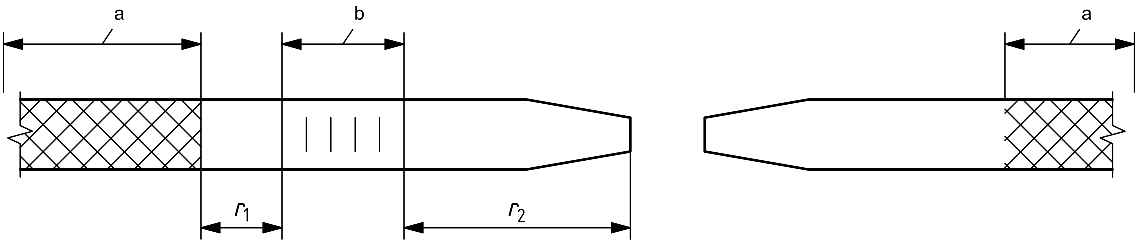
— if A_{gt} is determined by the manual method after fracture, A_{gt} shall be calculated from the following formula:

$$A_{gt} = A_g + R_m / 2\,000 \qquad (1)$$

where A_g is the percentage non-proportional elongation at maximum force.

The measurement of A_g shall be made on the longer of the two broken parts of the test piece on a gauge length of 100 mm, as close as possible to the fracture but 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

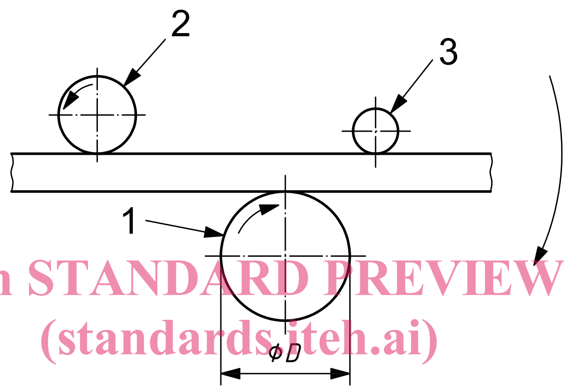
The general provisions in Clause 4 apply.

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 (e.g. see ISO 7438).



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, unless otherwise agreed by the parties involved.

For testing at a low temperature, if the agreement does not specify all the testing conditions, a deviation of ±2 °C on the agreed temperature should be applied. The test piece should be immersed in the cooling medium for a sufficient time to ensure that the required temperature is reached throughout the test piece (for example, at least 10 min in a liquid medium or at least 30 min in a gaseous medium). The bend test should start within 5 s from removal from the medium. The transfer device should be designed and used in such a way that the temperature of the test piece is maintained within the temperature range.

The test piece shall be bent over a mandrel.

The angle of bend (γ) and the diameter of the mandrel (D) shall be in accordance with the relevant product standard.