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Steels for the reinforcement of concrete — Reinforcement couplers for mechanical splices of bars —

Part 2: Test methods

Aciers pour l'armature du béton — Coupleurs d'armature destinés aux raboutages mécaniques de barres —

Partie 2: Méthodes d'essai

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

The committee responsible for this document is 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 15835-2:2009), which has been technically revised with changes made to Clauses 5 and 6, 5.2, 5.4 and 5.6 and Table 1. The figures have been revised and renumbered.

A list of all the parts in the ISO 15835 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Steels for the reinforcement of concrete — Reinforcement couplers for mechanical splices of bars —

Part 2: **Test methods**

1 Scope

This document specifies test methods applicable to couplers for mechanical splices of steel reinforcing bars.

This document is applicable to the various standards for steel reinforcing bars as well as the various reinforced concrete design standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 6892-1:2016, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

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

ISO 15630-1, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 1: Reinforcing bars, wire rod and wire*

ISO 15835-1, *Steels for the reinforcement of concrete — Reinforcement couplers for mechanical splices of bars — Part 1: Requirements*

ISO 16020, *Steel for the reinforcement and prestressing of concrete — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15835-1 and ISO 16020 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbols

Table 1 — Symbols

Symbol	Unit	Designation
A_{gt}	%	Percentage total elongation at maximum tensile force, F_{max}
d	mm	Nominal diameter of the reinforcing bar
E	MPa[a]	Nominal modulus of elasticity of the reinforcing bar

[a] 1 MPa = 1 N/mm^2.

Table 1 *(continued)*

Symbol	Unit	Designation
L	mm	Length of mechanical splice as defined in ISO 15835-1
L_1	mm	Coupler length
L_g	mm	Gauge length for the measurement of slip
L_0	mm	Gauge length for conducting the low-cycle loading test
N	—	Specified number of load cycles in high-cycle fatigue test
$R_{eH, spec}$	MPa	Specified characteristic (or nominal) yield strength value of the reinforcing bar
ΔL_e	mm	Calculated elastic elongation of an unspliced bar
ΔL_g	mm	Total elongation of the spliced bar measured as elongation of the gauge length
ΔL_s	mm	Slip of the mechanical splice
ΔL_t	mm	Gauge length extension under load
ε_y	%	Strain at nominal yield strength
$2\sigma_a$	MPa	Stress range for high-cycle fatigue test
σ_{max}	MPa	Upper stress in the axial load fatigue test
σ_{min}	MPa	Lower stress in the axial load fatigue test

[a] 1 MPa = 1 N/mm^2.

5 Testing of mechanical splices

5.1 General

The test methods covered by this document are as follows:

a) tensile test (see 5.3);

b) slip test (see 5.4);

c) high-cycle fatigue test (see 5.5);

d) low-cycle loading test (see 5.6).

A reference bar shall always be tested in the case of qualification testing and continuous independent testing, for each test except the fatigue test. The reference bar shall be taken from the same length of reinforcing bar as used in the test splice. Where different diameters are used in a splice, the reference bar shall be taken from the smaller bar diameter of the splice.

For the calculation of stresses, the nominal cross-sectional area of the reinforcing bar shall be used.

For couplers with adjustable length, splices should be tested at their maximum extension in accordance with the manufacturer’s instructions.

The temperature in the testing laboratory should be between 10 °C and 30 °C.

5.2 Preparation of test pieces

All tests shall be performed on mechanical splices prepared and assembled in the same manner as they are prepared for normal use, according to written installation instructions from the supplier of the coupler. The installation instruction documents for the coupler shall be made available to the testing laboratory.

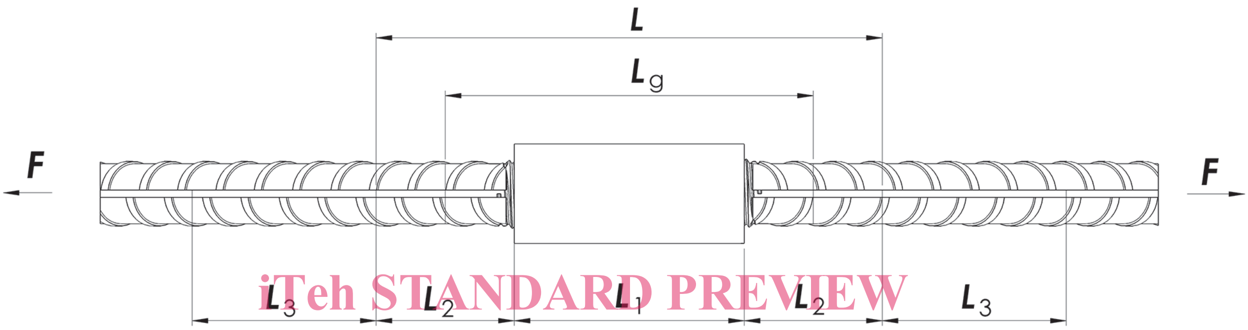
The coupler shall be positioned approximately in the middle of the test piece.

The test piece for the tensile test shall be sufficiently long to ensure a free length between the grips of the testing machine to allow the determination of A_{gt}. The minimum sufficient free length of the test piece for the tensile test is 400 mm + L, where L is the length of mechanical splice (as defined in ISO 15835-1). The length L_3 for determining A_{gt} shall, for both bars, be located outside the length of the mechanical splice (as defined in ISO 15835-1). This free length may, however, be reduced if the stroke of the testing machine is too short to accommodate the test piece, as long as it remains possible to measure A_{gt} over the gauge length specified in ISO 15630-1.

The test piece for the slip test may have a shorter free length than the test piece for the tensile test. However, the free length shall not be less than 250 mm + L.

The test pieces for the fatigue tests shall be sufficiently long to ensure a free length between the grips of the testing machine, which is larger than the length of the mechanical splice.

The geometry for the measurement of elongations is shown in Figure 1.



Key

F applied force

L length of the mechanical splice (as defined in ISO 15835-1)

L_1 coupler length

L_2 2d where d is the nominal diameter of the reinforcing bar

L_3 minimum free length for the measurement of A_{gt} (as defined in ISO 15630-1)

L_g gauge length for the measurement of slip

Figure 1 — Definition of lengths for measuring elongations of the mechanical splice

5.3 Tensile test

5.3.1 General

The strength and ductility are determined by means of a tensile test. The test pieces from the slip test may be used for this test.

5.3.2 Testing equipment

The testing equipment shall conform to ISO 15630-1.

5.3.3 Test procedure

The test shall be performed in accordance with ISO 15630-1.

The A_{gt} in the spliced bar shall be tested and measured in accordance with ISO 15630-1 outside the length of the mechanical splice (as defined in ISO 15835-1) on both sides of the connection. Both values shall be recorded and the larger shall be used to assess conformity. However, if the length of the test piece has been reduced to accommodate the stroke of the testing machine, the A_{gt} may be measured on only one side of the connection. If an extensometer is used, the bar shall still be marked so that manual measurement remains possible.

When a transitional coupler is tested, A_{gt}, is only measured on the smaller bar.

5.3.4 Failure mode and location

The location of the failure shall be reported as one of the following two locations:

a) within the mechanical splice length as defined in ISO 15835-1;

b) outside the mechanical splice length as defined in ISO 15835-1.

5.4 Slip test

5.4.1 General

The slip shall be measured by an arrangement of extensometers which are at least dual averaging. The gauge length of the extensometers shall be between L_1 + 2d and L_1 + 6d, as close to L_1 + 2d as possible.

NOTE Some types of extensometers have a fixed gauge length, which may not be equal to the length L of the mechanical splice as defined in ISO 15835-1. In case of choice, a shorter gauge length is preferable.

5.4.2 Testing equipment

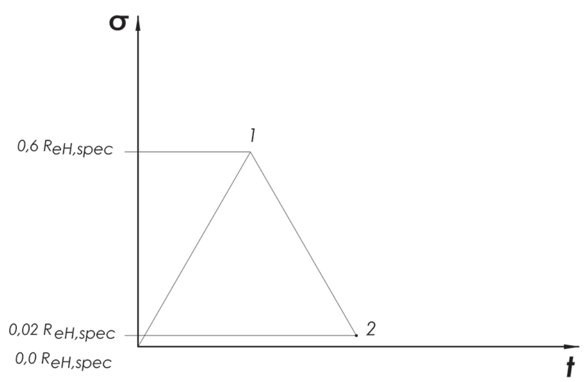
The tensile testing machine to be used shall conform to ISO 15630-1.

The extensometer used shall be in accordance with ISO 9513, class 1 or better. The distance between the axis of measurement and the axis of the splice should be minimized.

The slip measurement device shall be rigid and fastened securely, so that the slip can be measured with an accuracy of not less than 0,01 mm. The uncertainty of measurement shall be determined in accordance with ISO 6892-1:2016, Annex J.

5.4.3 Test procedure

The load cycling for qualification testing shall be performed in accordance with the principle shown in Figure 2.



Key

1 stress for option 1 measurement

2 stress for option 2 measurement

σ stress

t time

Figure 2 — Load cycle diagram for the slip test

The test piece shall be gripped in the testing equipment so that the load is transmitted axially and as much as possible free of any bending moment on the whole length of the test piece.

The slip measurement shall be conducted with the minimum possible pre-load applied to the test piece before the extensometer is attached. Any load applied to the sample during gripping before the attachment of the extensometer shall not exceed 10 MPa.

NOTE Preloading of the test piece will normally take most of the slip out. A preloading does not normally occur for spliced bars in a structure.

The initial gauge length shall be measured after gripping the sample in the tensile testing machine.

The load applied to 0,6$R_{eH,\ spec}$ shall not deviate from the theoretical load by more than ±3 %.

The recommended maximum speed of loading is 500 MPa/min.

5.4.4 Evaluation of slip under Option 1 as defined in ISO 15835-1

If Option 1 is used, the elongation of the spliced bar shall be recorded when the specified stress equivalent to 0,6$R_{eH,\ spec}$ is reached. The slip shall be calculated using Formula (1).

$$\Delta L_s = \Delta L_t - \Delta L_e \tag{1}$$

where ΔL_t is the gauge length extension under load.

The elastic elongation of the unspliced bar, ΔL_e, is given by Formula (2).

$$\Delta L_e = \frac{\sigma}{E} \times L_g \tag{2}$$

where

$$\sigma = \frac{4F}{\pi d^2}$$

in which F is the applied force.

For carbon steel and low-alloy steel reinforcing bars, the value for E shall be taken as 2,0 × 10^5 MPa.

NOTE By this option a reduced stiffness of the splice is compensated by a stiff coupling. The test result can, in special cases, be registered as a negative slip. This is not a problem and simply means that the mechanical splice is stiffer than the bar.

5.4.5 Evaluation of slip under Option 2 as defined in ISO 15835-1

If Option 2 is used, the elongation of the spliced bar shall be recorded when the load has been released to the minimum defined in 5.4.3. The slip shall be calculated using Formula (3).

$$\Delta L_S = L_{g2} - L_{g1} - \Delta L_e \tag{3}$$

where

L_{g2} is the measured length, L_g, after load release;

L_{g1} is the measured length, L_g, before loading;

ΔL_e is the elastic elongation of the unspliced bar under the stress 2 at load release, as defined by Formula (2).

