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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

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 15835-2 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 16, *Steels for the reinforcement and prestressing of concrete*.

ISO 15835 consists of the following parts, under the general title *Steels for the reinforcement of concrete — Reinforcement couplers for mechanical splices of bars*:

— *Part 1: Requirements*

— *Part 2: Test methods*

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

Part 2:
Test methods

1 Scope

This part of ISO 15835 specifies test methods applicable to couplers for mechanical splices of steel reinforcing bars.

This part of ISO 15835 is intended to be applicable in relation to the various standards for steel reinforcing bars as well as in relation to the various reinforced concrete design standards.

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 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*

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

ISO 15835-1:2009, *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 part of ISO 15835, the terms and definitions given in ISO 15835-1 and ISO 16020 apply.

4 Symbols

See Table 1.

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
L	mm	Length of mechanical splice as defined in ISO 15835-1
L_1	mm	Coupler length
L_g	mm	Gauge length
N	—	Specified number of load cycles in axial load 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
ε_y	%	Strain at nominal yield strength
$2\sigma_a$	MPa	Stress range for high cycle fatigue test
σ_{max}	MPa	Maximum stress in the axial load fatigue test
σ_{min}	MPa	Minimum stress in the axial load fatigue test

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

5 Testing of mechanical splices

5.1 General

All tests shall be carried out on mechanical splices assembled in the same manner as they are prepared for normal use, see 5.2.

The installation instruction documents for the coupler shall be made available to the testing laboratory.

A reference bar from the same heat shall be tested to determine its actual mechanical properties.

The test methods covered by this part of ISO 15835 are:

a) tensile test;

b) slip test;

c) high cycle fatigue test;

d) low cycle fatigue tests.

The performance of mechanical splices may be dependent on the rib geometry of the steel reinforcing bar. The specified rib geometry of the test bar shall be provided by the supplier and recorded with the test results.

The principle of measurement and the geometry for the measuring of elongations is shown in Figures 1 and 2.

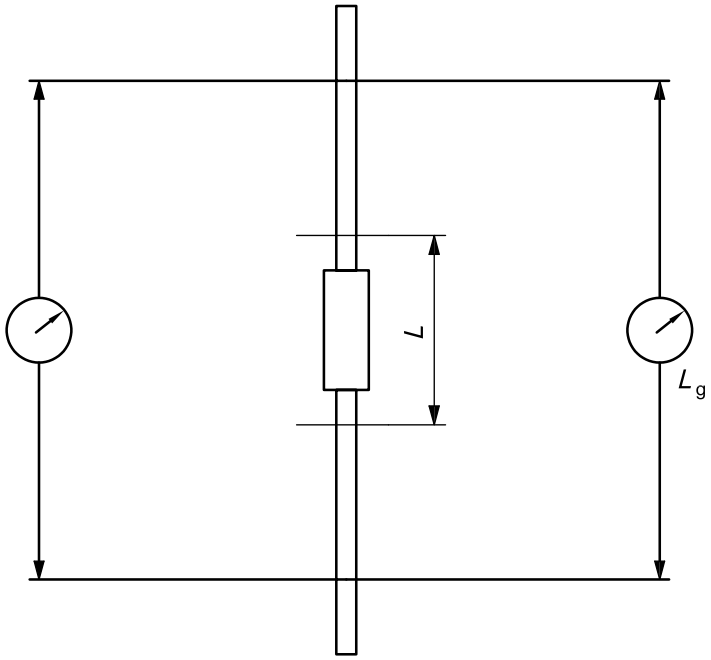
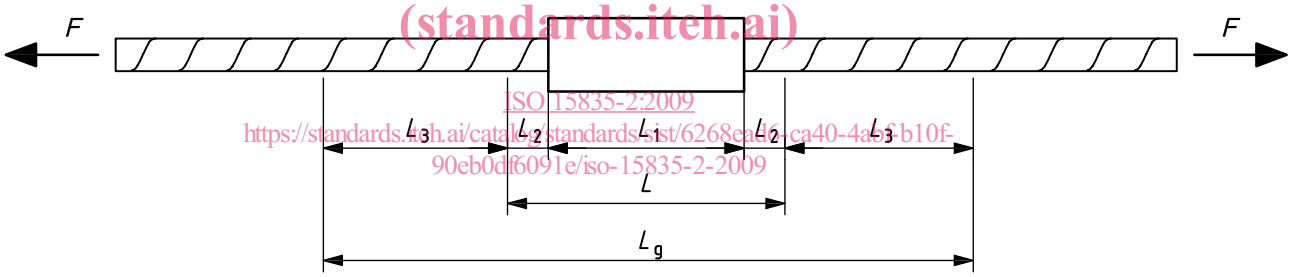


Figure 1 — Principle of measurement



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 in the range, $2d$ to $3d$

L_g overall gauge length, in the range from $L_1 + 8d$ to $L_1 + 10d$

Figure 2 — Definition of lengths for measuring elongations of the mechanical splice

5.2 Preparation of test pieces

The test pieces shall be assembled and prepared according to written installation instructions from the supplier of the coupler.

The coupler shall be positioned 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 determination of A_{gt}. The minimum sufficient free length, in millimetres, of the test piece for the tensile test is $400 + L$, where L is the length of mechanical splice (as defined in ISO 15835-1).

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, in millimetres, should not be less than $250 + L$.

The gauge length for determining A_{gt} shall, for both bars, be located outside the length of the mechanical splice (as defined in ISO 15835-1).

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.

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 carried out according to ISO 15630-1.

The A_{gt} in the spliced bar shall be tested and measured according to 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 largest shall be used to assess conformity.

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

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 this is defined in ISO 15835-1;

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

The failure mode shall be reported, if requested.

5.4 Slip test

5.4.1 General

The slip shall be measured overall according to Figure 1. If the coupler consists of more than one load-transferring part, an additional slip measurement between each load-carrying part should also be taken. The slip measurement shall be taken as the largest of the overall measurement and the sum of measurements for each part.

Determine the slip measurement, ΔL_s, according to Option 1 of 5.3.1 (in ISO 15835-1:2009), for each position, by Equation (1):

$$\Delta L_s = \Delta L_t - \Delta L_e \quad (1)$$

The elastic elongation of the unspliced bar, ΔL_e, is given by Equation (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 $2{,}0 \times 10^5$ 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.

Determine slip measurement, ΔL_s, according to Option 2 of 5.3.1 (in ISO 15835-1:2009), for each position, by Equation (3):

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

where

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

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

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 2 or better. The extensometer used to determine the slip shall be at least a two-point (averaging) type, but preferably a three-point (averaging) type.

The slip measurement device shall be rigid enough, and fixed securely, so that the slip can be measured with an accuracy of not less than 0,01 mm.

This accuracy should be checked periodically (e.g. annually and always if there is a change in the testing conditions) by performing the test on a control bar with the same gauge length. The measurement accuracy is computed as the sum of the accuracy of the extensometer (as stated by its manufacturer) plus the error that could be generated by the fixing devices. If the slip measurement is done under load, the measurement accuracy is the difference between the measured and the calculated elastic elongation. If the measurement is done after load release, the measurement accuracy is the reading after the load is returned to zero.

5.4.3 Test procedure

The test piece shall be gripped in the testing equipment in such a way 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 should be carried out without any preloading of the test piece. If a small preloading is unavoidable to clamp the bar, the preloading stress in the bar shall be less than 4 MPa and the corresponding slip measurement, if any, shall be noted and included in the test report.

NOTE 1 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 gauges shall be set to zero after closure of the jaws of the tensile testing machine.