INTERNATIONAL STANDARD

ISO 15835-1

First edition
2009-04-01

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

Part 1: **Requirements**

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

Partie 1: Exigences

Reference number
ISO 15835-1:2009(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 15835-1 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 1: Requirements

1 Scope

This part of ISO 15835 specifies requirements for reinforcement couplers, hereafter called couplers, to be used for splicing of steel reinforcing bars.

This part of ISO 15835 specifies requirements for couplers to be used for mechanical splices in reinforced concrete structures under predominantly static loads and additional requirements for couplers to be used in structures subject to high cycle elastic fatigue loading and/or to low cycle elastic-plastic reverse loading.

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

This part of ISO 15835 also provides directions for the evaluation of conformity of couplers.

Compression-only couplers such as end-bearing sleeves are not covered by this part of ISO 15835.

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 6935-2, *Steel for the reinforcement of concrete — Part 2: Ribbed bars*

ISO 9001, *Quality management systems — Requirements*

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

ISO 15835-2:2009, *Steels for the reinforcement of concrete — Reinforcement couplers for mechanical splices of bars — Part 2: Test methods*

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 16020 and the following apply.

3.1
coupler length
actual length of the coupler including all load-transferring parts, if more than one, and including lock nuts, if any

3.2
length of mechanical splice
coupler length plus two times the nominal bar diameter at both ends of the coupler

NOTE This is a conventionally agreed definition to take account of the affected zone in an approximate way.

3.3
mechanical splice
complete assembly of a coupler or an end-bearing sleeve including any additional intervening material or other components providing a splice of two reinforcing bars

3.4
reinforcement coupler
coupling sleeve or threaded coupler for mechanical splices of reinforcement bars for the purpose of providing transfer of axial tension and/or compression from one bar to the other where

— coupling sleeve is a device fitting over the ends of two reinforcing bars,

— threaded coupler is a threaded device for joining reinforcing bars with matching threads

3.5
slip
permanent extension of a mechanical splice after being loaded to a defined load level

3.6
slip measurement device
ensemble constituted by the extensometer and any system used to fix it to the mechanical splice

3.7
qualification test
test performed at the initiation of a product to demonstrate that the properties conform to the requirements

4 Symbols

See Table 1.

Table 1 — Symbols

Symbol	Unit	Designation
A_5	%	Percentage elongation after fracture on an original gauge length of $5d$
A_{10}	%	Percentage elongation after fracture on an original gauge length of $10d$
A_{gt}	%	Percentage total elongation at maximum tensile force, F_{max}
d	mm	Nominal diameter of the reinforcing bar
F_{max}	N	Maximum tensile force
N	—	Specified number of load cycles in axial load fatigue test
$R_{eH,\ spec}$	MPa[a]	Specified characteristic (or nominal) yield strength value of the reinforcing bar
$R_{m,\ spec}$	MPa	Specified (or nominal) tensile strength value of the reinforcing bar
$(R_m/R_{eH})_{spec}$	—	Specified tensile/yield strength ratio of the reinforcing bar
u_4, u_8, u_{20}	mm	Residual elongation after 4, 8, 20 cycles, respectively
$2\sigma_a$	MPa	Stress range for high cycle fatigue test
σ_{max}	MPa	Maximum stress in axial load fatigue test
σ_{min}	MPa	Minimum stress in axial load fatigue test
[a] 1 MPa = 1 N/mm^2		

5 Requirements

5.1 General

The requirements apply to the coupler even though the check of the properties of the coupler is carried out on a mechanical splice that has been installed in accordance with the manufacturer's written instructions.

The technical requirements for couplers are related to the following properties where a) and b) are mandatory while c) and d) are related to categories defined in Annex C:

a) strength and ductility under static forces;

b) slip under static forces;

c) properties under high cycle fatigue loading in the elastic range;

d) properties under low cycle reverse loading in the elastic-plastic range.

Testing of these properties shall be carried out in accordance with ISO 15835-2.

Further requirements are specified for:

e) identification and marking;

f) installation instructions.

Additional requirements can exist in the reference standard for the steel reinforcing bars to be connected in the mechanical splice. In this case, the purchaser and the supplier should agree on any additional technical requirements.

If a material other than steel is used in a coupler, the suitability for use of such material in fire-rated structures as well as any health implications should be evaluated.

5.2 Strength and ductility under static forces

5.2.1 General

Strength and ductility of the mechanical splice shall be verified by testing to satisfy the requirements of both 5.2.2 and 5.2.3 with the following exception.

If all samples of the mechanical splice tensile strength tests fail outside the length of the mechanical splice and the test results satisfy the product standard of the bar, no further verification of tensile strength or ductility of the mechanical splice is required.

5.2.2 Strength

The tensile strength of the mechanical splice shall be at least $R_{eH,\ spec} \times (R_m/R_{eH})_{spec}$.

If $R_{m,\ spec}$ is the only value specified in the reinforcing bar standard, the tensile strength of the mechanical splice shall be at least $R_{m,\ spec}$.

5.2.3 Ductility

The ductility of spliced bars shall be verified directly by option 1. Subject to national provisions, the indirect method of option 2 may also be used.

Requirements for ductility of spliced bars should ensure that the use of the mechanical splice maintains a minimum amount of ductility in the reinforcement. Ductility of the coupler itself is not subject to testing.

Option 1) The minimum A_{gt} measured in accordance with ISO 15630-1 in the reinforcing bar outside the length of the mechanical splice shall not be less than $0{,}7A_{gt}$, where A_{gt} is the specified characteristic value of the reinforcing bar taken from ISO 6935-2.

Where A_{gt} is not specified for the reinforcing bars, a minimum value of 3 % should be reached in the bar outside the mechanical splice before failure of the test piece.

NOTE 1 The A_{gt} value specified for the reinforcing bars is normally a characteristic value. Since it is not practical to specify a characteristic A_{gt} value for mechanical splices, a minimum value for the bar is specified.

NOTE 2 If an A_5 or A_{10} value is specified for the reinforcing bars instead of an A_{gt} value, this value cannot be used for evaluation of mechanical splices since the failure could occur within the mechanical splice; the A_5 or A_{10} value cannot then be determined.

Option 2) The samples tested shall have a 99 % characteristic strength of not less than the minimum specified tensile strength of the reinforcing bar. Where this criterion is not fulfilled, further samples may be tested to increase the population size.

NOTE 3 Annex E gives an example of the calculation of 99 % characteristic strength based on test results.

If couplers are used to connect bars of different sizes, strength and ductility, requirements shall be based on the smaller reinforcing bar diameter.

5.3 Slip under static forces

5.3.1 Testing requirements

The slip shall be found by one of the following two options for testing.

Option 1) The slip across the mechanical splice shall be found as the measured length of the mechanical splice under a force corresponding to at least $0{,}6R_{\mathrm{eH,\ spec}}$, where $R_{\mathrm{eH,\ spec}}$ is the specified yield strength of the reinforcing bar minus the calculated length of an unspliced bar under similar force.

Option 2) The slip across the mechanical splice shall be found as the measured length of the mechanical splice after unloading from a load level of at least $0{,}6R_{\mathrm{eH,\ spec}}$, where $R_{\mathrm{eH,\ spec}}$ is the specified yield strength of the reinforcing bar minus the length prior to loading.

5.3.2 Slip requirement

The total slip value measured shall not exceed 0,10 mm.

NOTE Slip requirement is important for limitation of crack widths in reinforced concrete structures.

For certain types of couplers, e.g. couplers with a length larger than 300 mm for bars with a diameter larger than 40 mm, a greater slip than 0,10 mm may be accepted if specified in national provisions.

5.4 Properties under high cycle elastic fatigue loading

5.4.1 Fatigue properties

Mechanical splices of category F shall sustain a fatigue loading of at least 2 megacycles with a stress range, $2\sigma_{\mathrm{a}}$, of 60 MPa without failure. The upper stress, σ_{max}, in the test shall be $0{,}6R_{\mathrm{eH,\ spec}}$. Other values for the maximum stress, the stress range or the number of cycles may be specified in national provisions.

The following acceptance criteria shall be complied with:

— if all test samples resist the fatigue loading, the test is passed;

— if one test sample fails the test, three additional samples of the same type and diameter that have failed shall be tested. If all three additional test samples pass, the test is passed;

— if two or more test samples fail the fatigue test, the test is failed.

5.4.2 *S-N* diagram (optional)

The performance of a mechanical splice under high cycle stresses of different amplitudes can be characterised by an *S-N* diagram. If an *S-N* diagram is determined, the provisions in ISO 15835-2:2009, 5.5.4, shall be applied.

5.5 Properties under low cycle reverse elastic-plastic loading

There are two sets of low cycle fatigue requirements, one simulating moderate-scale earthquakes (couplers of category S1) and one simulating violent earthquakes (couplers of category S2).

Couplers of categories S1 and S2 shall satisfy the requirements of 5.5.1 and 5.5.2 respectively. Couplers tested according to category S2 satisfy the testing requirements of category S1.

5.5.1 Couplers of category S1

The performance requirements for couplers subject to tension and compression tests simulating a moderate-scale earthquake are:

— tensile strength: at least $R_{m,\,spec}$ or $R_{eH,\,spec} \times (R_m/R_{eH})_{spec}$ (as in 5.2);

— residual elongation: $u_{20} \leqslant 0{,}3$ mm.

The requirement on u_{20} may be disregarded if allowed in national provisions and agreed between purchaser and supplier.

5.5.2 Couplers of category S2

Performance requirements for couplers subject to tension and compression tests of large deformation in the simulated violent earthquake are:

— tensile strength: at least $R_{m,\,spec}$ or $R_{eH,\,spec} \times (R_m/R_{eH})_{spec}$ (as in 5.2);

— residual elongation: $u_4 \leqslant 0{,}3$ mm, $u_8 \leqslant 0{,}6$ mm.

The requirements on u_4 and u_8 may be disregarded if allowed in national regulations and agreed between purchaser and supplier.

5.6 Marking and traceability

Each coupler shall be legibly and durably marked (e.g. hard stamped) with the identification of the manufacturer, the nominal bar size for which it is intended, and a batch mark for traceability purposes. Each coupler shall be traceable back to its production data.

NOTE The provisions and methods for traceability can differ according to national provisions.

5.7 Installation instructions

The supplier shall provide a clear written installation instruction. The described installation process of the couplers shall be achievable in construction site conditions.

6 Evaluation of conformity

The conformity of the couplers to the requirements of this part of ISO 15835 shall be evaluated according to either of the following methods:

— if conformity to the applicable requirements of this part of ISO 15835 is verified by system certification, the conditions in Annex A shall be applied;

— if conformity to the applicable requirements of this part of ISO 15835 is verified by batches, the conditions in Annex B shall be applied.

Annex A
(normative)

System for certification of couplers

A.1 General

To assure the purchaser of the couplers that the performance criteria of this part of ISO 15835 are met, the manufacturer of the couplers shall have a quality system approved by a certification body. It is the task of the certification body to check and certify that the performance criteria can be sustainably met.

The certification of a coupler is based on qualification testing, factory production control, and on continuous third party surveillance of the factory production control.

The purpose of this annex is to provide rules for a product certification of couplers.

The manufacturer and the certification body have different tasks to carry out in the certification process, as specified in Clauses A.2 and A.3, respectively.

NOTE The product certification applies to the mechanical coupler, but is tested in the form of a mechanical splice.

A.2 Tasks of the manufacturer

A.2.1 General

The manufacturer of the couplers shall have a quality system, based on a sectorial application of ISO 9001.

A quality system which meets the requirements of ISO 9001 (with or without certification) and which addresses the requirements of this part of ISO 15835 is acceptable. The certification body should accept quality management system certificates from other bodies which verify compliance with this subclause.

A.2.2 Qualification testing

Random samples shall be taken from the products to be tested, which reflect the properties of the products to be delivered. Tests shall be carried out on a full cross-section of the products. Tests shall be performed for all characteristics of the products, mandatory or optional, for which the manufacturer intends to declare conformity.

The tests may be carried out by the manufacturer under supervision of the certification body. Independent control tests may be carried out at the discretion of the certification body.

The qualification test shall comprise testing of the following items:

— strength and ductility under static actions;

— slip under static actions;

— marking and traceability;

— installation instructions.

Optionally, the behaviour under the following fatigue conditions shall be tested:

— high cycle fatigue in the elastic range;

— low cycle reverse fatigue loading.

A.2.3 Factory production control

The manufacturer shall demonstrate that the factory production control system is sufficient to ensure that the level of confidence in the conformity of the finished product is achieved. The factory production control system shall cover all characteristics of the products for which the manufacturer intends to declare conformity.

If fatigue properties shall be declared, the frequency in testing of the properties should be such that all sizes are tested within a period of 3 years, and always if there is a change in material properties, geometry or production technology for which a change in the product properties is registered.

The test unit shall be the cast.

The results of all test units shall be statistically evaluated and presented as the long term quality level for each type of coupler. Requirements shall also be stated for the maximum accepted deviation from the specified requirement for a single test.

A.2.4 Continuous third party surveillance of the factory production control

A continuous third party surveillance of the factory production control shall be carried out to demonstrate that the manufacturer's factory production control system continues to ensure that the products conform to the requirements.

Factory production control may be carried out by the manufacturer under supervision of the certification body. Independent control tests may be carried out at the discretion of the certification body.

A.2.5 Documentation and user information

For each type of coupler, the manufacturer shall maintain a file of data sheets with which the coupler shall comply. The manufacturer shall maintain a series of test results in accordance with Table A.1 that demonstrate that the couplers perform satisfactorily. The manufacturer shall present detailed information to the purchaser on how to prepare the bar ends to be joined, tools to be used, and installation instructions to be followed. Written instructions shall be made available to the purchaser and to the testing laboratory.

A.2.6 Traceability

In accordance with 5.6, the manufacturer shall: a) establish and maintain records for demonstration of traceability; and b) mark the couplers durably.

A.2.7 Sampling plan

As part of the factory production control system, the manufacturer shall establish and work according to a sampling plan. All relevant coupler parameters shall be evaluated periodically according to the sampling plan.

A.2.8 Documentation of conformity

For each delivery, a declaration of conformity for strength, ductility, and slip shall follow the delivery. The evaluation of conformity shall be based on the quality assurance documentation cited in Clause A.4.

A.3 Tasks of the certification body

A.3.1 Qualification testing

Qualification testing shall be performed to assess that the quality control system complies with the requirements of Clause A.2, and that the couplers conform to the requirements . For each type of coupler, and each manufacturing location, qualification testing shall be performed in accordance with Table A.1. If various types are very similar and use identical components, the certification body may decide not to test all of them.

If the manufacturer's quality control system and the couplers meet the requirements, the certification body shall issue a certificate to the manufacturer covering the products to be delivered under the certification scheme, see Clause A.4.

A.3.2 Continuous third party surveillance and factory production control

Surveillance audits shall be performed by the certification body at each manufacturing location, to confirm that the manufacturer continues to operate a factory production control system that complies with Clause A.2. During this audit, samples shall be taken for external independent testing in accordance with Table A.1. External audits shall be performed at least annually.

Testing of assembled couplers may be performed by the manufacturers laboratory under supervision of the certification body. Independent control tests may be carried out at the discretion of the certification body. Samples should be assembled by the testing laboratory in accordance with the manufacturer's written instructions under the same conditions as they would have been when delivered to a job site. The test file shall be checked by the certification body.

For each type of coupler and each manufacturing location, testing as described in Table A.1 shall be performed by a laboratory independent from production.

Table A.1 — Testing

Stage	Size	Scope of testing			
		Strength and ductility	Slip	High cycle elastic fatigue loading for category F	Low cycle reverse elastic-plastic loading for categories S1 and S2
Qualification testing[a]	Largest, medium and smallest of size range for each type	Three samples of each selected size and type	Three samples of each selected size and type	Three samples of the largest size Three of the medium size Three of the smallest size	Three samples of the largest size Three of the medium size Three of the smallest size
Continuous third party surveillance[b]	One size of each type	Three samples	Three samples	Three samples[e]	No
Factory production control[c]	Three random samples for each delivery or batch of 500	One sample for each delivery or batch of 500[d]	No	No	No

[a] If one of the samples fails, the whole test series shall be repeated, except for high cycle fatigue testing, see 5.4.1.

[b] If one of the samples fails, the test series shall be repeated with six samples, and no failure shall occur. If two or more samples fail during the qualification testing, then a cause shall be found by the manufacturer and appropriate corrective actions taken, after which six samples shall be tested without failure.

[c] If the sample fails, then a cause shall be found by the manufacturer and appropriate corrective actions taken, after which three samples shall be tested without failure.

[d] After successful results of continuous testing during the first 2 years of production, the test frequency may be reduced to one in every 1 000.

[e] Testing to be carried out every second year.

For qualification testing, the sensitivity of the mechanism of load transfer shall be tested for influence of various parameters which are likely to vary in practice. Examples of these are:

— different reinforcing bar batch/producer;

— rib height;

— torque influence;

— dirt in/on coupler/threads/mating surfaces.

A number of tests shall be performed to investigate the effect of these fluctuations, mainly on the strength of the mechanical splice.

A.3.3 Factory production control

The certification body shall check the results from the factory production control.

A.4 Quality assurance documentation

The certification body shall issue a document to the manufacturer which shall contain at least the following information:

— name of manufacturer (including manufacturing locations);

— type of reinforcing bar for which the certificate is valid by reference to standard or specification;

— certification body name (logo);

— types and sizes approved, including the dimensions of the coupler (length and width);

— tools/equipment to be used;

— written installation instructions;

— marking/identification to be found on the couplers;

— category of the coupler, see Annex C;

— statement of conformity with this part of ISO 15835;

— certificate number.

Annex B
(normative)

Evaluation of conformity based on testing of batches

B.1 General

To assure the purchaser of the coupler that the performance criteria of this part of ISO 15835 are met, the evaluation and attestation of conformity shall be conducted in accordance with this annex, subject to agreement between the purchaser and supplier.

B.2 Extent of sampling and testing

For the purpose of testing, the delivery shall be subdivided into test units. For testing strength, ductility and slip under static loading, each test unit shall consist of couplers of the same type and size, and shall represent a maximum number of couplers in accordance with Table B.1. For testing fatigue, see Table B.2.

Couplers of the same type, diameter and material traceable to the same cast shall be considered as one manufacturing batch.

Table B.1 — Test unit size

Type of coupler	Maximum number of couplers
Couplers from the same manufacturing batch	1 000
Couplers not from the same manufacturing batch	200

The extent of testing for each test unit shall be as described in Table B.2.

Table B.2 — Samples from each test unit

Properties to be tested	Number of samples
Strength, ductility and slip under static loading	12
Properties under high cycle fatigue loading and low cycle loading for couplers of categories F, S1 and S2.	A minimum of three samples for each type of coupler. For a size range of the same type of coupler, at least three samples for the largest size, three samples for the medium size and three samples for the smallest size.

B.3 Acceptance and report

A test unit is accepted if each of the samples meets the requirements of this part of ISO 15835, and a report is prepared and furnished in accordance with ISO 15835-2:2009, Clause 6. For high cycle fatigue testing, retesting in accordance with 5.4.1 shall be carried out if one of the test pieces fails.

Annex C
(informative)

Categories of reinforcement couplers

Table C.1 provides a survey of the categories of couplers in mechanical splices for reinforcing bars specified in this part of ISO 15835, with reference to the subclauses where the requirements and test methods for their properties are given.

Table C.1 — Categories of couplers in mechanical splices[a]

Category designation	Properties tested	Requirement subclauses in this part of ISO 15835	Testing subclauses in ISO 15835-2
B (Basic or no designation)	Strength, ductility and slip under static forces	5.2, 5.3	5.1, 5.2, 5.3, 5.4
F (Fatigue)	As for B + High cycle fatigue	As for B + 5.4	As for B + 5.5
S1 (Seismic 1 – moderate)	As for B + Moderate low cycle loading	As for B + 5.5.1	As for B + 5.6.1
S2 (Seismic 2 – violent)	As for B + Violent low cycle loading	As for B + 5.5.2	As for B + 5.6.2

[a] If the coupler in a mechanical splice has been tested according to both class F and class S, it can be classified as such with denominations FS1, FS2 or FS12 as appropriate (FS12 denotes that the coupler has been tested for S2 and thus qualifies for both S1 and S2 in addition to F).

Annex D
(informative)

Items to be specified

Where couplers are specified by reference to this part of ISO 15835, some features or technical conditions should be decided case by case by the specifier because they are subject to agreement between purchaser and supplier.

This list is meant to serve as a checklist for the manufacturer/supplier of couplers as well as information to the purchaser on subjects for which a specification might be relevant and included in a data sheet for the product/delivery:

— type (technical class) and size(s) of reinforcing bars to be spliced, with reference to standard or specification;

— category of the coupler, see Table C.1;

— S-N diagram of the coupler, if available;

— method for evaluation of conformity, with reference to either Annex A or Annex B.

Annex E
(informative)

Example of calculation of 99 % characteristic strength based on test results

The specified characteristic strength value, C_v, can be calculated using Condition (E.1) which is based on the premise that at the 90 % probability level, 99 % of the results in a limited series of tests will be at or above the stated characteristic value.

$$C_v < \overline{x} - ks \tag{E.1}$$

where

$\overline{x}$ is the average value;

k is a coefficient, listed the Table E.1;

s is the estimate of the standard deviation of the population.

Table E.1 — Coefficient, k, in Condition (E.1) as a function of number of tested samples

Number of samples	Coefficient k
3	6,965
4	4,541
5	3,747
6	3,365
7	3,143
8	2,998
9	2,896
10	2,821
25	2,492
50	2,405

ICS 77.140.15

Price based on 14 pages