INTERNATIONAL STANDARD

ISO 6935-1

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Steel for the reinforcement of concrete —

Part 1:
Plain bars

Acier à béton pour armatures passives —

Partie 1: Barres lisses

Reference number
ISO 6935-1:1991(E)

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.

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.

International Standard ISO 6935-1 was prepared by Technical Committee ISO/TC 17, *Steel*.

ISO 6935 consists of the following parts, under the general title *Steel for the reinforcement of concrete*:

— *Part 1: Plain bars*

— *Part 2: Ribbed bars*

— *Part 3: Welded fabric*

Annex A of this part of ISO 6935 is for information only.

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Steel for the reinforcement of concrete —

Part 1:
Plain bars

1 Scope

This part of ISO 6935 specifies technical requirements for plain bars designed for reinforcement in ordinary concrete structures and for non-prestressed reinforcement in prestressed concrete structures.

Two steel grades, PB 240 and PB 300 are defined.

This part of ISO 6935 applies to hot-rolled steel without subsequent treatment.

It also applies to reinforcement supplied in coil form. The requirements of this part of ISO 6935 apply to the straightened product.

Plain bars produced from finished products, such as plates and railway rails, are excluded. Steel bars for use as lifting hooks are also not included.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 6935. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 6935 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 377-2:1989, *Selection and preparation of samples and test pieces of wrought steels — Part 2: Samples for the determination of the chemical composition.*

ISO 404:1981, *Steel and steel products — General technical delivery requirements.*

ISO 6892:1984, *Metallic materials — Tensile testing.*

ISO 10065:1990, *Steel bars for reinforcement of concrete — Bend and rebend tests.*

ISO 10144:1991, *Certification scheme for steel bars and wires for the reinforcement of concrete structures.*

3 Definitions

For the purposes of this part of ISO 6935, the following definitions apply.

3.1 cast analysis: Chemical analysis of a sample of the molten steel during casting.

3.2 certification scheme: Certification system as related to specified products, processes or services to which the same particular standards and rules, and the same procedure, apply.

3.3 characteristic value: Value having a prescribed probability of not being attained in a hypothetical unlimited test series. [ISO 8930]

NOTE 1 Equivalent to fractile, which is defined in ISO 3534.

3.4 nominal cross-sectional area: The cross-sectional area equivalent to the area of a circular plain bar of nominal diameter.

3.5 product analysis: Chemical analysis of a sample from a plain bar.

4 Dimensions, masses and tolerances

Dimensions, masses and tolerances are given in table 1.

Table 1 — Dimensions and masses for plain bars

Nominal bar diameter	Nominal cross-sectional area	Mass per length	
		Requirement	Permissible deviation[1]
mm	mm^2	kg/m	%
6	28,3	0,222	± 8
8	50,3	0,395	± 8
10	78,5	0,617	± 5
12	113	0,888	± 5
16	201	1,58	± 5
20	314	2,47	± 5

1) Permissible deviation refers to a single bar.

By agreement between manufacturer and purchaser, the permissible deviation on mass per length may be replaced by tolerances on diameters.

Delivery length should be agreed between manufacturer and purchaser. Preferred standard length of straight bars is 12 m. Permissible deviation on delivery length from rolling mill: +100/−0 mm.

5 Chemical composition

The steel grades shall not contain more than 0,060 % sulfur and 0,060 % phosphorus by cast analysis. If product analysis is required, the maximum sulfur and phosphorus contents shall each be 0,070 %.

6 Mechanical properties

6.1 Tensile properties

Required tensile properties for the two steel grades are given in table 2.

At least 95 % of the population under consideration shall have tensile properties equal to or above the characteristic values specified.

Table 2 — Characteristic values for upper yield stress, tensile strength and percentage elongation after fracture

Steel grade	Upper yield stress R_{eH}	Tensile strength R_m	Elongation $A_{5,65}$
	N/mm^2	N/mm^2	%
PB 240	240	265	20
PB 300	300	330	16

No single test result shall be less than 95 % of the characteristic value given in table 2.

By agreement between manufacturer and purchaser, the values in table 2 may be used as guaranteed minimum values.

The ratio of tensile strength to yield stress for each test specimen shall be at least 1,10.

For steels that have no significant yield stress, the proof stress $R_{p0,2}$ shall be used to define the yield stress.

6.2 Bending properties

After testing, none of the test pieces shall show fractures or cracks visible to the naked eye.

7 Testing of mechanical properties

7.1 Tensile test

The tensile test shall be carried out according to ISO 6892.

For the determination of elongation after fracture, the original gauge length shall be 5 times the nominal diameter.

For calculation of mechanical properties, the nominal cross-sectional area shall be used.

7.2 Bend test

The bend test shall be carried out according to ISO 10065.

The test piece shall be bent to an angle between 160° and 180° over a mandrel of the diameter specified in table 3.

Table 3 — Mandrel diameter to be used for the bend test

Dimensions in millimetres

Nominal diameter of bar	6	8	10	12	16	20
Steel grade PB 240	12,5	16	20	25	32	40
PB 300	12,5	16	20	32	50	63

8 Designation

Plain bars according to this part of ISO 6935 shall be designated in the following order:

— reinforcing steel;

— the number of this part of ISO 6935, (ISO 6935-1);

— nominal diameter, in millimetres, according to table 1;

— steel grade.

Example:

Reinforcing steel ISO 6935-1 — 10 PB 240

9 Marking

Each bundle of bars of at least 500 kg shall have a label stating the name of the manufacturer, number of this part of ISO 6935 (ISO 6935-1), steel grade, nominal diameter, cast number or reference related to test record and country of origin.

10 Certification and inspection

Certification and inspection of reinforcement shall be performed

— in accordance with a certification scheme monitored by an external body;

or

— according to testing of a specific delivery.

10.1 Certification scheme

In the case of a certification scheme, certification and inspection shall be performed in accordance with ISO 10144.

10.2 Testing of a specific delivery

Provisions regarding the nature, extent and evaluation of acceptance tests on deliveries of reinforcing steel not subject to a certification scheme are given in 10.3 and 10.4.

Testing of a specific delivery shall be performed according to 10.3.

By agreement between manufacturer and purchaser, 10.4 may be used.

10.3 Verification of characteristic values

10.3.1 Organization

The tests shall be organized and carried out according to an agreement between purchaser and manufacturer, taking into consideration the national rules of the receiving country.

10.3.2 Extent of sampling and testing

For the purpose of testing, the delivery shall be subdivided into test units with a maximum mass of 50 t or a fraction thereof. Each test unit shall consist of products of the same steel grade and the same nominal diameter from the same cast. The manufacturer shall confirm in the test report that all samples in the test unit originate from the same cast. The chemical composition (cast analysis) shall be stated in this test report.

Test pieces shall be taken from each test unit as follows:

a) two test pieces from various bars for testing the chemical composition (product analysis);

b) fifteen test pieces (if appropriate 60 test pieces; see 10.3.3.1) from various bars for testing all other properties specified in this part of ISO 6935.

10.3.3 Evaluation of the results

10.3.3.1 Inspection by variables

For properties which are specified as characteristic values, the following shall be determined:

a) all individual values x_i of the 15 test pieces ($n = 15$);

b) the mean value m_{15} (for $n = 15$);

c) the standard deviation s_{15} (for $n = 15$).

The test unit corresponds to the requirements if the condition stated below is fulfilled for all properties:

$$m_{15} - 2{,}33 \times s_{15} \geqslant f_k$$

where

f_k is the required characteristic value;

2,33 is the value for the acceptability index k for $n = 15$ for a failure rate of 5 % ($p = 0{,}95$) at a probability of 90 % ($1 - \alpha = 0{,}90$).

If the condition stated above is not fulfilled, the index

$$k' = \frac{m_{15} - f_k}{s_{15}}$$

is determined from the test results available. Where $k' \geqslant 2$, testing can be continued. In this case 45 further test pieces shall be taken and tested from different bars in the test unit, so that a total of 60 test results are available ($n = 60$).

The test unit shall be considered to comply with the requirements if the condition stated below is fulfilled for all properties:

$$m_{60} - 1{,}93 \times s_{60} > f_k$$

where 1,93 is the value for the acceptability index k for $n=60$ for a failure rate of 5 % ($p=0{,}95$) at a probability of 90 % ($1 - \alpha = 0{,}90$).

10.3.3.2 Inspection by attributes

When testing properties specified as maximum or minimum values, all results determined on the 15 test pieces shall comply with the requirements of the product standard. In this case the test unit shall be considered to comply with the requirements.

The tests may be continued when at most 2 results not conforming to conditions occur. In this case 45 further test pieces from various bars in the test unit shall be tested, so that a total of 60 test results are available. The test unit complies with the requirements if at most 2 of the 60 results do not conform to the conditions.

10.3.3.3 Chemical composition

Both test pieces shall comply with the requirements in this part of ISO 6935.

10.4 Verification of guaranteed minimum values

Tests shall be carried out according to the following.

— Bars of the same cast shall constitute one group. For every 50 t or fraction thereof, one tensile and one bend test shall be carried out for each bar diameter.

— Each individual test result shall meet the required values in table 2 and the required bending properties in 6.2.

— One cast analysis shall be carried out for every cast to verify chemical composition (clause 5). Samples shall be taken in accordance with ISO 377-2.

— If any test result does not meet the requirements, retests may be carried out, according to ISO 404.

— The manufacturer shall submit a test report stating that products of the delivery satisfy the chemical and mechanical properties defined in clause 5 and clause 6, and a confirmation that the other requirements of this part of ISO 6935 are fulfilled.

11 Test report

The test report shall contain the following information:

a) designation of the reinforcing steel according to this part of ISO 6935;

b) marking on the reinforcing steel;

c) date of testing;

d) mass of the test unit;

e) test results.

Annex A
(informative)

Bibliography

[1] ISO 3534:1977, *Statistics — Vocabulary and symbols.*

[2] ISO 8930:1987, *General principles on reliability for structures — List of equivalent terms.*

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Descriptors: concrete, reinforced concrete, steels, reinforcing steels, reinforcing bars, round bars, specifications, dimensions, designation, marking, certification, inspection.

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