INTERNATIONAL STANDARD

ISO 6935-3

Second edition
2023-11

Steel for the reinforcement of concrete —

Part 3: **Welded fabric**

Aciers à béton pour armatures passives —

Partie 3: Treillis soudés

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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 document 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).

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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.

This document 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 6935-3:1992), which has been technically revised. It also incorporates the Technical Corrigendum ISO 6935-3:1992/Cor 1:2000.

The main changes are as follows:

— Clauses 1, 2, 3 and 4 have been revised;

— Figure 1 has been replaced with a new figure.

A list of all parts in the ISO 6935 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.

Steel for the reinforcement of concrete —

Part 3:
Welded fabric

1 Scope

This document specifies technical requirements for factory made sheets or rolls of welded fabric, manufactured from steel wires or bars with diameters from 4 mm to 18 mm and designed for the reinforcement of concrete structures and the ordinary reinforcement of prestressed concrete structures.

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 6935-1, *Steel for the reinforcement of concrete — Part 1: Plain bars*

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

ISO 10544, *Cold-reduced steel wire for the reinforcement of concrete and the manufacture of welded fabric*

ISO 15630-2, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 2: Welded fabric and lattice girders*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
characteristic value
value having a prescribed probability of not being attained in a hypothetical unlimited test series

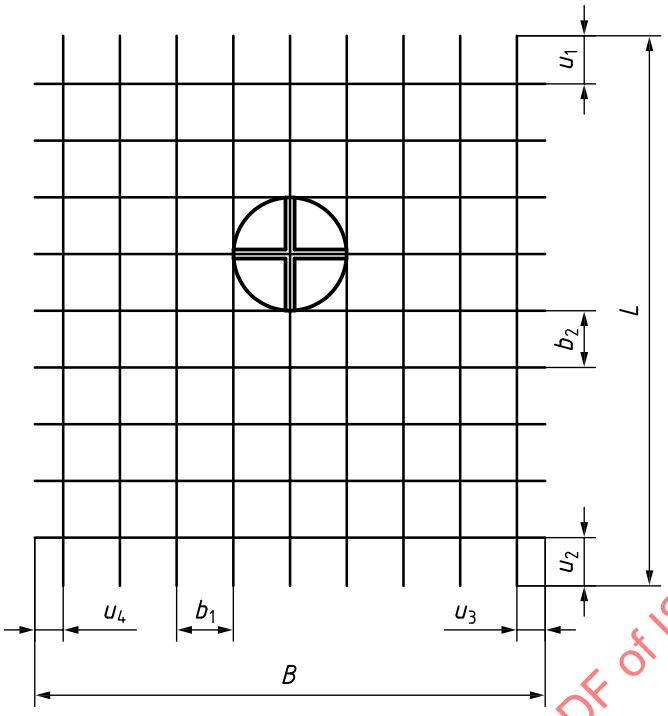
Note 1 to entry: Equivalent to “fractile”, which is defined in ISO 3534-1:2006.

Note 2 to entry: A nominal value is used as the characteristic value in some circumstances.

[SOURCE: ISO 16020:2005, 2.4.10, modified —Note 2 to entry has been added.]

3.2
fabric
geometrical arrangement of longitudinal and transverse wires that are arranged substantially at right angles to each other and welded together at all points of intersection

Note 1 to entry: See Figure 1.



Key

b_1 spacing of the longitudinal wire
b_2 spacing of the transverse wire
u_1 overhang of the longitudinal wire
u_2 overhang of the longitudinal wire
u_3 overhang of the transverse wire
u_4 overhang of the transverse wire
B width of fabric (length of the transverse wire)
L length of fabric (length of the longitudinal wire)

Figure 1 — Geometric characteristics of fabric

3.3
inspection
activities such as measuring, examining, testing, gauging one or more characteristics of a product or service and comparing these with specified requirements to determine conformity

3.4
length of fabric
longest side of the fabric, irrespective of the manufacturing direction

3.5
longitudinal wire
wire in the manufacturing direction of the fabric

3.6
nominal cross-sectional area
cross-sectional area equivalent to the area of a circular plain bar of the same nominal diameter

[SOURCE: ISO 16020:2005, 2.2.15, modified — "wire" has been removed from the definition.]

3.7
overhang
length of longitudinal or transverse wires beyond the centre of the outer crossing wire in a fabric

Note 1 to entry: For twin wire fabric, the overhang is measured from the tangent line of the adjacent wires, see Figure 2.

3.8
spacing
centre-to-centre distance of wires in a fabric

Note 1 to entry: For twin wire fabric, the spacing is measured between the tangents of the adjacent wires, see Figure 2.

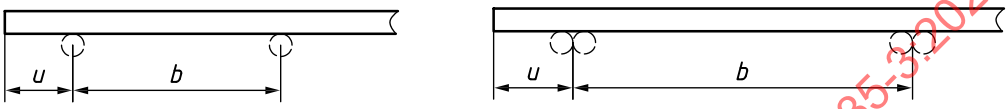


Figure 2 — Wire spacing, *b*, and overhang, *u*

3.9
transverse wire
wire perpendicular to the manufacturing direction of the fabric

3.10
twin wires
two wires of the same type and size placed adjacently and in contact with each other as a pair

3.11
width of fabric
shortest side of the fabric, irrespective of the manufacturing direction

3.12
wire
material from which the fabric is welded

Note 1 to entry: For the purposes of this document, the term "wire" also includes bars within the size range specified in 4.1.1.

4 Form and dimensions

4.1 General requirements

4.1.1 The fabric shall be made of either

— cold-reduced wires with nominal diameters in the range from 4 mm to 18 mm and with mass and geometry in accordance with ISO 10544,

— plain bars with nominal diameters of 6 mm to 18 mm (recommended: 6 mm, 8 mm, 10 mm and 12 mm, 18 mm plain bars may be used by agreement between the manufacturer and purchaser) and with mass in accordance with ISO 6935-1, or

— ribbed bars with nominal diameters of 6 mm to 18 mm (recommended: 6 mm, 8 mm, 10 mm and 12 mm, 18 mm ribbed bars may be used by agreement between the manufacturer and purchaser) and with mass and geometry in accordance with ISO 6935-2.

4.1.2 All fabric shall be machine made, and the joints at the intersections of the longitudinal and transverse wires shall be made by electrical resistance welding to provide shear resistant connections in accordance with Clause 6.

4.1.3 Each sheet of fabric shall contain the number of wires appropriate to its specified length, width, spacing and overhang dimensions.

The number of broken welds shall not exceed either 1 % of the total number of cross-welded joints in the sheet or half the number of cross-welded joints along any one wire.

4.1.4 Fabric shall be free from any defect which can be shown to affect adversely the mechanical properties of the steel. Fabric including butt-welded wires shall be permitted and missing wires resulting from test sampling in accordance with Clause 7 shall not be considered as defects.

4.1.5 The longitudinal wires may be single or twin wires. The transverse wires shall be single wires.

4.1.6 The diameters of crossing wires in single-wire fabric shall meet the following requirement:

$$d_{min} \geq 0{,}6\ d_{max}$$

where

d_{max} is the nominal diameter of the thickest wire;

d_{min} is the nominal diameter of the crossing wire.

For twin-wire fabric, the wire diameters shall meet the following requirement:

$$0{,}7 d_T \leq d_L \leq 1{,}25\ d_T$$

where

d_T is the nominal diameter of the transverse wire;

d_L is the nominal diameter of one of the twin wires.

4.1.7 The dimensions of the fabric shall be specified as gross length in both directions. The welded fabric may be composed of wires of different product characteristics.

4.1.8 The permitted geometric deviations for fabric are:

length and width: ±25 mm or ±0,5 %, whichever is greater;

wire spacing: ±10 mm or ±5 %, whichever is greater.

diagonal difference (the difference between the two outermost diagonal solder joints): ±0,5 %.

4.1.9 The spacing of longitudinal wires should be a multiple of 50 mm and not less than 100 mm.

The spacing of transverse wires should be a multiple of 25 mm and not less than 100 mm.

4.2 Geometry of regular fabric

Regular fabric is characterized by having wires of equal nominal diameter across the length and width of the fabric. The spacing is also constant in each direction. The wire diameters and spacing may differ for the two directions.

All the wires in one direction shall be of equal length.

The overhang, u, should not be less than 25 mm.

4.3 Geometry of designed fabric

Designed fabric differs from regular fabric, which is described in 4.2.

The geometry and dimensions of designed fabric shall be agreed between the manufacturer and purchaser, and shall be specified on a drawing.

The overhang, *u*, should not be less than 25 mm.

5 Chemical composition

The chemical composition of the welded fabric shall conform with the product analysis requirements of

— ISO 10544 for cold-reduced wires,

— ISO 6935-1 for plain bars, and

— ISO 6935-2 for ribbed bars.

6 Mechanical properties

The tensile and bending properties of the welded fabric shall conform with the requirements of

— ISO 10544 for cold-reduced wires,

— ISO 6935-1 for plain bars, and

— ISO 6935-2 for ribbed bars.

The shear force of the welded joints, in newtons, shall be at least 30 % of the specified characteristic yield or proof stress multiplied by the nominal cross-sectional area of the thickest wire.

NOTE By the agreement between purchaser and manufacturer, the shear force can be reduced to 25 % of the specified characteristic yield or proof stress multiplied by the nominal cross-sectional area of the thickest wire.

7 Testing of mechanical properties

7.1 General

The testing shall be done on wires taken from the fabric in the delivery condition. The test piece shall not be worked before testing and may be aged at 100 °C as per ISO 15630-2.

The mechanical properties of the wires after artificially aged treatment shall meet the requirements of ISO 6935-1, ISO 6935-2 or ISO 10544.

7.2 Tensile test

The tensile properties shall be determined in accordance with ISO 15630-2. The test piece shall have an original gauge length of 5 times the nominal diameter and shall have at least one crossing wire. The free distance between the grips shall be at least 20 times the nominal diameter, and not less than 180 mm.

In fabric with twin wires, the wire which is not under test shall be cut off approximately 20 mm from the joints.

For calculation of yield or proof stress and tensile strength, the nominal cross-sectional area of the wire shall be used.

7.3 Bend test

The bend test shall be carried out in accordance with ISO 15630-2.

The test piece shall be taken from the thickest wire in fabric with single wires in both directions. In the case of twin-wire fabric, the test piece shall be taken from the twin wire.

The length of the test piece shall be at least 200 mm, and it shall be free from crossing wires in the length subject to bending.

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

— ISO 10544 for cold-reduced wires,

— ISO 6935-1 for plain bars, and

— ISO 6935-2 for ribbed bars.

The angle of bend shall be measured before unloading.

7.4 Strength of welded joints

The joints shall be tested in accordance with ISO 15630-2.

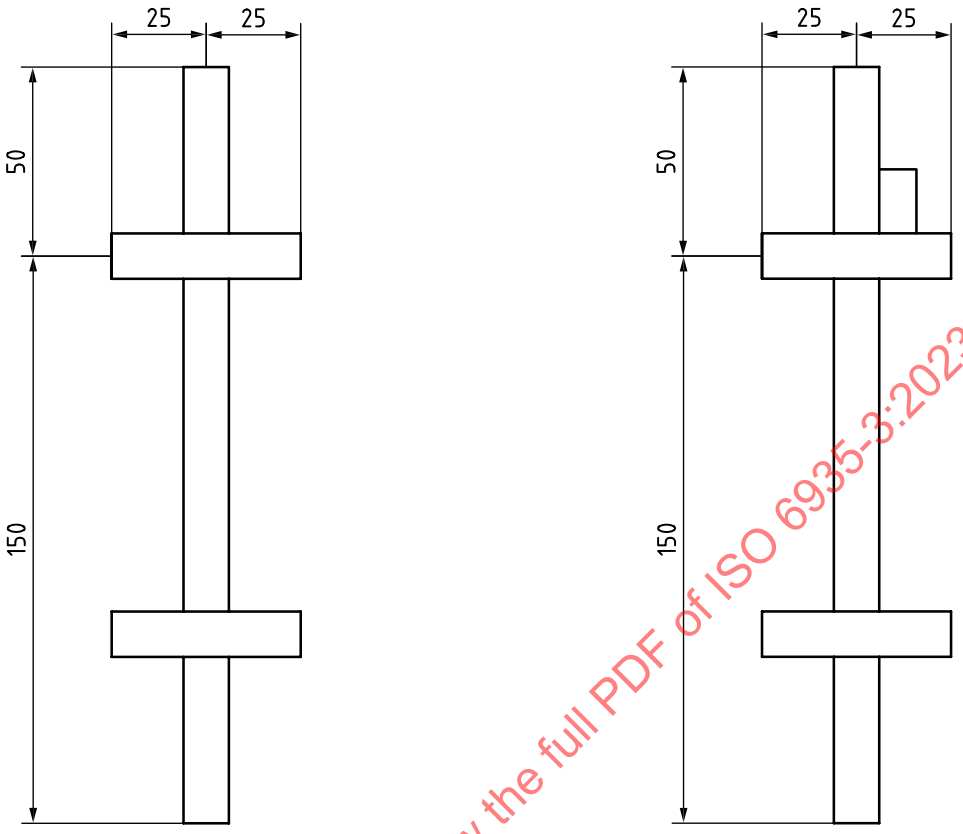
A test piece with the recommended minimum dimensions shown in Figure 3 shall be cut from the fabric. In addition to the weld to be tested, the test piece may have one or more welds, depending on the spacing.

For fabric with single wires in both directions, the thicker wire shall be used as the pulling wire.

For fabric with twin wires, one of the twin wires shall be the pulling wire. The other twin wire is cut off from the crossing wire without affecting the weld under test.

Test pieces previously subjected to tensile testing may be used for the weld shear test, provided that the necking at the fracture is clear of the weld zone.

Dimensions in millimetres



a) Single wire **b) Twin wires**

Figure 3 — Test pieces

8 Designation

8.1 Regular fabric

Regular fabric shall be designated in the following order:

— welded fabric;

— the reference number of this document, i.e. ISO 6935-3;

— spacing in the direction of length and width respectively, in millimetres;

— length × width, in metres;

— designation of the wires in the direction of length and width respectively, in accordance with the International Standard whose requirements apply.

EXAMPLE

Welded fabric ISO 6935-3 - 150 mm × 200 mm - 5 m × 2 m, Reinforcing steel ISO 10544, 8 mm indented, Reinforcing steel ISO 10544 mm indented.

8.2 Designed fabric

Designed fabric should be designated in the following order:

— welded fabric;

— the reference number of this document, i.e. ISO 6935-3;

— D (for designed);

— length × width, in metres;

— drwg. No. (for drawing);

— pos. No. (for position);

— designation of the wires in accordance with the International Standard whose requirements apply.

EXAMPLE

Welded fabric ISO 6935-3-D 6,2 m × 3,4 m, drwg. No. 318 - pos. No. 3, Reinforcing steel ISO 6935-2- 16 RB 500W, Reinforcing steel ISO 6935-1- 10 PB 300.

9 Marking

Each bundle of welded fabric shall have a label stating the manufacturer, the number of this document and a reference number related to the test certificate. For designed fabric the position number shall be included.

10 Testing and inspection

10.1 General

Testing and inspection of welded fabric for the reinforcement of concrete can be performed

a) in accordance with requirements for the evaluation of conformity during production, see 10.2; or

b) according to the testing of a specific delivery, see 10.3.

10.2 Evaluation of conformity during production

This subclause specifies requirements for the evaluation of conformity during production.

NOTE ISO 11082 specifies scheme requirements for the certification for the continuous production of welded fabric for the reinforcement of concrete in order to verify the conformity with requirements specified in product standards, such as this document.

The acceptance unit when testing partial quantities for each fabric type shall not exceed 25 tonnes. For each of the characteristics specified in this document, at least one test piece shall be taken from the test-unit:

Each individual value X_i shall satisfy Formula (1):

$$X_i \geq 0{,}95 f_k \tag{1}$$

where f_k is the required characteristic value.

The mean value of the test unit, m, shall satisfy Formula (2):

$$m \geq f_k + kS \tag{2}$$

where

k is the acceptability index according to Table 1;

S is the standard deviation of the test results.

Where test results are unsatisfactory according to this subclause, the manufacturer shall immediately take the necessary precautions. Test units that do not conform to the requirements shall be set aside.

Table 1 — Acceptability index, k, [a] as a function of the number, n, of the test results

n	k	n	k
5	3,40	30	2,08
6	3,09	40	2,01
7	2,89	50	1,97
8	2,75	60	1,93
9	2,65	70	1,90
10	2,57	80	1,89
11	2,50	90	1,87
12	2,45	100	1,86
13	2,40	150	1,82
14	2,36	200	1,79
15	2,33	250	1,78
16	2,30	300	1,77
17	2,27	400	1,75
18	2,25	500	1,74
19	2,23	1 000	1,71
20	2,21	∞	1,64

[a] See 10.3.2.3.1 for k.

10.3 Acceptance testing of a specific delivery

10.3.1 General

Provisions regarding the nature, extent and evaluation of acceptance tests on deliveries of welded fabric not subject to a certification scheme are given in 10.3.2 and 10.3.3.

Acceptance testing of a specific delivery shall be performed according to 10.3.2.

By agreement between manufacturer and purchaser, 10.3.3 may be used.

10.3.2 Evaluation of characteristic values

10.3.2.1 Organization

The tests shall be organized and carried out in accordance with an agreement between the purchaser and manufacturer.

NOTE National rules of the receiving country can apply.

10.3.2.2 Extent of sampling and testing

For the purpose of testing, the delivery shall be subdivided into test units with a maximum mass of 25 t or a fraction thereof. Each test unit shall consist of products of the same fabric type and from the same production lot.

Fifteen test pieces (if appropriate 60 test pieces; see 10.3.2.3.1) from various fabrics shall be taken from each test unit.

10.3.2.3 Evaluation of the results

10.3.2.3.1 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:

$$m_{15} - 2{,}33 \times S_{15} \geq f_k$$

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 $k' = \dfrac{m_{15} - f_k}{S_{15}}$ is determined from the test results available. Where $k' \geq 2$, testing can be continued. In this case 45 additional test pieces shall be taken and tested from various fabrics, so that a total of 60 test results are available (n = 60).

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

$$m_{60} - 1{,}93 \times S_{60} \geq f_k$$

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).

10.3.2.3.2 Inspection by attributes

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

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