INTERNATIONAL STANDARD

ISO 6935-2

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Steel for the reinforcement of concrete —

Part 2:
Ribbed bars

Acier à béton pour armatures passives —

Partie 2: Barres nervurées

Reference number
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Contents

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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.

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 6935-2 was prepared by Technical Committee ISO/TC 17, *Steel*, Sub-Committee SC 16, *Steels for the reinforcement and prestressing of concrete*.

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*

Annexes A, B and C of this part of ISO 6935 are for information only.

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Steel for the reinforcement of concrete —

Part 2:
Ribbed bars

1 Scope

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

Five grades of steel are defined. Of these, RB 300, RB 400 and RB 500 should be considered as difficult to weld. The other two grades of steel, RB 400W and RB 500W, are readily welded by conventional welding procedures.

This part of ISO 6935 applies to hot-rolled steel without subsequent treatment, to hot-rolled steel with controlled cooling and tempering and to cold-worked steel. The production process is at the discretion of the manufacturer.

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

Ribbed 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. [ISO/IEC Guide 2]

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 core: The part of a cross-section of the bar that contains neither longitudinal nor transverse ribs.

3.5 longitudinal rib: A uniform continuous rib parallel to the axis of the bar, before cold twisting in the case of cold-twisted bars.

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

3.7 pitch, P (for twisted bars only): The distance between two consecutive corresponding points of a longitudinal rib on the same generatrix.

3.8 product analysis: Chemical analysis of a sample from a ribbed bar.

3.9 rib height, a: The distance from the highest point on the rib (transverse or longitudinal) to the surface of the core, to be measured normal to the axis of the bar. (See figure 2).

3.10 rib spacing, c: The distance between the centres of two consecutive transverse ribs measured parallel to the axis of the bar. (See figure 1.)

3.11 transverse rib: Protuberance at an angle, either perpendicular or oblique, to the longitudinal axis of the bar.

3.12 transversal ribless perimeter, $\sum f_i$: The sum of the distances along the surface of the core between the transverse ribs of adjacent rows measured as the projection on a plane perpendicular to the bar axis.

3.13 transverse rib inclination, β: The angle between the transverse rib and the longitudinal axis of the bar. (See figures 1, 3, 4 and 5.)

4 Dimensions, masses and tolerances

Dimensions, masses and tolerances are given in table 1.

Table 1 — Dimensions, masses and tolerances

Nominal bar diameter[1)]	Nominal cross-sectional area	Mass per length	
		Requirement	Permissible deviation[2)]
mm	mm²	kg/m	%
6	28,3	0,222	± 8
8	50,3	0,395	± 8
10	78,3	0,617	± 5
12	113	0,888	± 5
16	201	1,58	± 5
20	314	2,47	± 5
25	491	3,85	± 4
32	804	6,31	± 4
40	1 256	9,86	± 4

1) If diameters larger than 40 mm are required, the size increase should be in increments of 5 mm. Permissible deviation on such bars is ± 4 %.

2) Permissible deviation refers to a single bar.

Delivery length should be agreed between manufacturer and purchaser. Preferred standard lengths of straight bars are 12 m or 18 m. Permissible deviation on delivery length from rolling mill: $^{+100}_{\ \ 0}$ mm.

5 Geometry of ribs

Ribbed bars shall have transverse ribs. Longitudinal ribs are optional.

The geometry of ribs shall ensure that the bars have adequate bond properties to fulfil their function in concrete structures.

The bond properties are adequate if there are at least two rows of transverse ribs equally distributed around the perimeter. The transverse ribs within each row shall be distributed uniformly over the entire length of the bar, except in the area of marking.

Requirements for rib geometry are given in table 2.

Table 2 — Requirements for rib geometry

	Diameter D mm	Hot-rolled bar: Ribs of uniform height	Hot-rolled bar: Crescent-shaped ribs	Twisted bar: Crescent-shaped ribs	
Height of transverse ribs, a Minimum	All	0,05 D	0,065 D	0,052 D	0,065 D
Height of longitudinal ribs, a' Minimum	All			0,07 D	
Rib spacing, c Minimum to maximum	6 to 8 $\geqslant$ 10	0,5 D to 0,7 D 0,5 D to 0,7 D	0,5 D to 1,0 D 0,5 D to 0,8 D	0,5 D to 1,0 D 0,5 D to 0,8 D	0,5 D to 1,2 D 0,5 D to 1,0 D
Transverse rib inclination, β Minimum	All	35°	35°	35°	
Transversal ribless perimeter, $\sum f_i$ Maximum	All		0,25 D	0,35 D	
Nominal pitch, P	All			10 D ± 2 D	

Dimensions defining the rib geometry in table 2 are shown in figures 1 to 5.

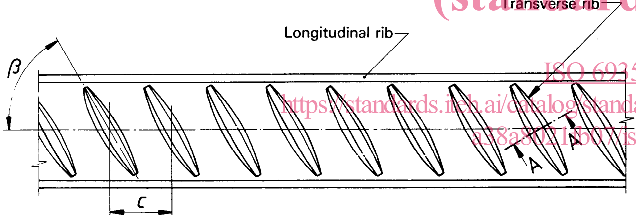

Figure 1 — Ribbed bar — Definitions of geometry

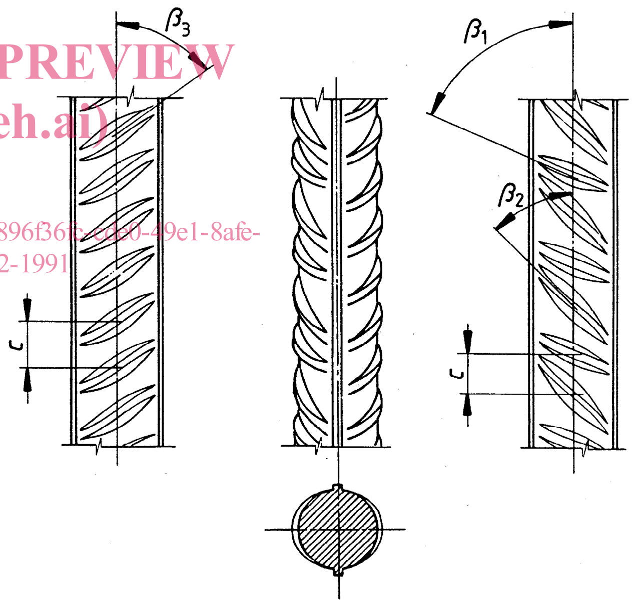

Figure 3 — Example of non-twisted bar with varying rib inclinations to the longitudinal axis

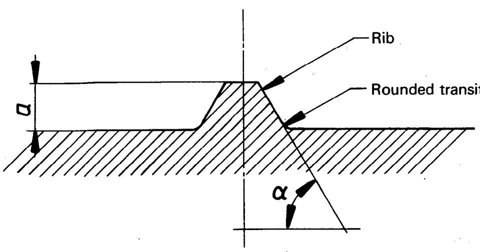

Figure 2 — Rib flank inclination, α, and rib height, a — Section A-A from figure 1

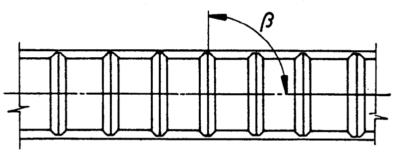

Figure 4 — Example of non-twisted bar with transverse ribs of uniform height ($\beta = 90°$)

Table 3 — Chemical composition — Maximum values in percentage by mass

Steel grade	C[1]	Si	Mn	P	S	N[2]	C_{eq} [1]
RB 300 RB 400 RB 500	—	—	—	0,060 (0,070)	0,060 (0,070)	—	—
RB 400W RB 500W	0,22 (0,24)[3]	0,60 (0,65)	1,60 (1,70)	0,050 (0,055)	0,050 (0,055)	0,012 (0,013)	0,50 (0,52)

1) For RB 400W and RB 500W with diameters larger than 32 mm, the maximum carbon content (C) is 0,25 % (0,27 %) and the maximum carbon equivalent (C_{eq}) is 0,55 % (0,57 %).

2) A higher nitrogen content may be used if sufficient quantities of nitrogen-binding elements are present.

3) The values in brackets apply for the product analysis.

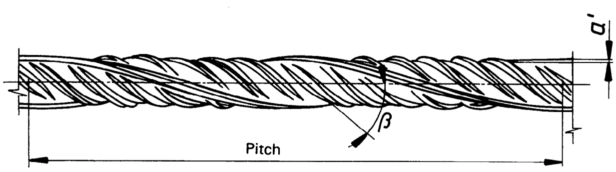

Figure 5 — Twisted bar with oblique ribs

Rib spacing shall be taken as the mean value measured along one pitch.

6 Chemical composition

The steel shall not contain quantities of the given elements higher than those specified in table 3.

The carbon equivalent, C_{eq}, is calculated according to the formula

$$C_{eq} = C + \frac{Mn}{6} + \frac{(Cr + V + Mo)}{5} + \frac{(Cu + Ni)}{15}$$

where C, Mn, Cr, V, Mo, Cu and Ni are percentages by mass of the respective elements of the steel.

7 Mechanical properties

7.1 Tensile properties

Required tensile properties for the various steel grades are given in table 4.

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

Table 4 — Characteristic values for upper yield stress, tensile strength and percentage elongation after fracture

Steel grade	Upper yield stress R_{eH} N/mm²	Tensile strength R_m N/mm²	Elongation $A_{5,65}$ %
RB 300	300	330	16
RB 400 RB 400W	400	440	14
RB 500 RB 500W	500	550	14

No single test result shall be less than 95 % of the characteristic value given in table 4.

By agreement between manufacturer and purchaser, the values in table 4 may be used as guaranteed minimum values.

The ratio of tensile strength to yield stress for each test specimen shall be at least 1,05.

A type test of the product shall demonstrate that the total elongation at maximum force, A_{gt}, is equal to or larger than 2,5 %.

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

7.2 Bending properties

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

7.3 Rebending properties

By agreement between manufacturer and purchaser, the rebend test may replace the bend test for steel grades RB 400, RB 400W, RB 500 and RB 500W.

The rebend test is used to verify the ageing properties of bent bars.

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

7.4 Fatigue properties

If required by the purchaser, the manufacturer shall demonstrate the fatigue properties of the product.

8 Testing of mechanical properties

8.1 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.

8.2 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 5.

8.3 Rebend test

The rebend test shall be carried out according to ISO 10065. The test piece shall be bent over a mandrel of the diameter specified in table 6.

The angle of bend before heating (ageing) shall be 90°, and the angle of rebend shall be 20°. Both angles shall be measured before unloading.

Table 5 — Mandrel diameter to be used for the bend test

Dimensions in millimetres

Nominal diameter[1] of bar	6	8	10	12	16	20	25	32	40
Steel grade									
RB 300	12,5	16	20	32	50	63	100	125	160
RB 400 RB 400W	16	20	25	40	63	80	125	160	200
RB 500 RB 500W	20	25	32	50	80	100	160	200	250

1) For nominal diameters larger than 40 mm, the mandrel diameter in bend tests shall be agreed between manufacturer and purchaser.

Table 6 — Mandrel diameter to be used for the rebend test

Dimensions in millimetres

Nominal diameter of bar	6	8	10	12	16	20	25	32	40
Steel grade RB 400 RB 400W RB 500 RB 500W	32	40	50	63	100	160	200	320	400