
**Steel for the reinforcement of
concrete —**

**Part 2:
Ribbed bars**

Aciers pour l'armature du béton —

Partie 2: Barres à verrous





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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.

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 documents 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 16, *Steels for the reinforcement and prestressing of concrete*.

This third edition cancels and replaces the second edition (ISO 6935-2:2007), which has been technically revised. The main changes are in [Table 4](#), [Table 5](#), [Table 6](#), [9.1](#), [9.2](#) (new), [11.1](#) and [12.2](#).

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*

Steel for the reinforcement of concrete —

Part 2: Ribbed bars

1 Scope

This part of ISO 6935 specifies technical requirements for ribbed bars to be used as reinforcement in concrete.

This part of ISO 6935 is applicable to steel delivered in the form of bars, coils and de-coiled products. It includes both weldable and non-weldable steels.

The production process is at the discretion of the manufacturer.

It is not applicable to ribbed bars produced from finished products, such as plates and railway rails.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO/TR 9769, *Steel and iron — Review of available methods of analysis*

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

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

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

3 Symbols

The symbols used in this part of ISO 6935 are listed in [Table 1](#).

Table 1 — Symbols

Symbol	Unit	Description	Reference
a	mm	Rib height	4.10, Clause 6
A	%	Percentage elongation after fracture	8.1, 9.1
A_{gt}	%	Percentage total elongation at maximum force	8.1, 9.1
S_0	mm ²	Nominal cross-sectional area	Clause 5, 9.1
c	mm	Rib spacing	4.11, Clause 6
d	mm	Nominal diameter of the bar	Clause 5, Clause 6, 9.1, 9.2, 9.3, Clause 10, 11.2,
Σf_i	mm	Ribless perimeter	4.12, Clause 6
f_k	—	Required characteristic value	12.2, 12.3.2.3
f_R	—	Relative rib area	4.9, Clause 6
k, k'	—	Indices	12.3.2.3.1
m_n	—	Mean value of n individual values	12.3.2.3.1
n	—	Number of individual values	12.3.2.3.1
R_{eH}	MPa ^a	Upper yield strength	8.1
R_m	MPa ^a	Tensile strength	8.1
$R_{p0,2}$	MPa ^a	0,2 % proof strength, non-proportional extension	8.1
s_n	—	Standard deviation for n individual values	12.3.2.3.1
x_i	—	Individual value	12.3.2.3.1
α	Degree	Transverse-rib flank inclination	4.14, Clause 6
β	Degree	Transverse-rib inclination	4.15, Clause 6
^a 1 MPa = 1 N/mm ²			

4 Terms and definitions

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

4.1
cast analysis
 chemical analysis representative of the cast determined by the manufacturer in accordance with its own procedures

[SOURCE: ISO 16020:2005, 2.4.3, modified.]

4.2
conformity assessment scheme
 conformity assessment system related to specific objects of conformity assessment, to which the same specified requirements, specific rules and procedures apply

Note 1 to entry: Conformity assessment schemes may be operated at an international, national or sub-national level.

Note 2 to entry: Certification, i.e. third party attestation related to products, processes, systems or persons, is applicable to all objects of conformity assessment except for conformity assessment bodies themselves, to which accreditation is applicable.

4.3
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 – added Note 2.]

4.4

core

part of the cross-section of the bar not containing either ribs or indentations

[SOURCE: ISO 16020:2005, 2.2.5, modified.]

4.5

ductility class

classification of the ductility properties of reinforcing steels based on the value of the ratio of tensile strength to yield strength, as well as the elongation measured either as A_{gt} or as A

Note 1 to entry: see [Table 6](#).

4.6

longitudinal rib

uniform continuous rib parallel to the axis of the bar

[SOURCE: ISO 16020:2005, 2.2.7.1, modified.]

4.7

S_0

nominal cross-sectional area

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

[SOURCE: ISO 16020:2005, 2.2.15, modified.]

4.8

product analysis

chemical analysis carried out on the product

[SOURCE: ISO 16020:2005, 2.4.4]

4.9

relative rib area

f_R

area of the projections of all transverse ribs within a defined length on a plane perpendicular to the longitudinal axis of the bar, divided by this length and the nominal circumference

[SOURCE: ISO 16020:2005, 2.2.11, modified.]

4.10

rib height

a

distance from the highest point on the rib to the surface of the core, to be measured perpendicular to the axis of the bar

Note 1 to entry: see [Figure 2](#).

[SOURCE: ISO 16020:2005, 2.2.12, modified.]

4.11

rib spacing

c

distance between the centres of two consecutive transverse ribs measured parallel to the axis of the bar

Note 1 to entry: see [Figure 1](#).

[SOURCE: ISO 16020:2005, 2.2.10, modified.]

4.12

ribless perimeter

Σf_i
sum of the distances along the surface of the core between the end of the transverse ribs of adjacent rows measured as the projection on a plane perpendicular to the axis of the bar

[SOURCE: ISO 16020:2005, 2.2.13, modified.]

4.13

transverse rib

rib at an angle, either perpendicular or oblique, to the longitudinal axis of the bar

[SOURCE: ISO 16020:2005, 2.2.7.2, modified.]

4.14

transverse-rib flank inclination

α
angle between the flank of a transverse rib and the core surface of a bar measured perpendicular to the longitudinal axis of the transverse rib

Note 1 to entry: see [Figure 2](#).

[SOURCE: ISO 16020:2005, 2.2.9, modified.]

4.15

transverse-rib inclination

β
angle between the rib and the longitudinal axis of the bar

Note 1 to entry: see [Figures 1, 3](#) and [4](#).

[SOURCE: ISO 16020:2005, 2.2.8, modified.]

5 Dimensions, mass per unit length and permissible deviations

Dimensions, mass per unit length and permissible deviations are given in [Table 2](#). By agreement between the manufacturer and purchaser, ribbed bars whose nominal diameters are other than those shown in [Table 2](#) may be used. A list of options for agreement between the manufacturer and purchaser is provided in [Annex B](#).

Table 2 — Dimensions, mass per unit length and permissible deviations

Nominal bar diameter ^a <i>d</i> mm	Nominal cross-sectional area ^b <i>S</i> ₀ mm ²	Mass per unit length	
		Nominal ^c kg/m	Permissible deviation ^d %
6	28,3	0,222	±8
8	50,3	0,395	±8
10	78,5	0,617	±6
12	113	0,888	±6
14	154	1,21	±5
16	201	1,58	±5
20	314	2,47	±5
25	491	3,85	±4
28	616	4,84	±4
32	804	6,31	±4
40	1 257	9,86	±4
50	1 964	15,42	±4

^a Diameters larger than 50 mm should be agreed between the manufacturer and purchaser. The permissible deviation on mass for such bars shall be ± 4 %.

^b $S_0 = 0,785 4 \times d^2$

^c Mass per unit length = $7,85 \times 10^{-3} \times S_0$.

^d Permissible deviation refers to a single bar.

The delivery length is subject to agreement between the manufacturer and purchaser.

NOTE Common delivery lengths of straight bars are 6 m, 9 m, 12 m and 18 m.

Unless otherwise agreed, the permissible deviation on delivery lengths from rolling mill shall be ${}^{+100}_0$ mm.

6 Requirements for ribs

Ribbed bars shall have transverse ribs. Longitudinal ribs may be present or not.

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

Ribs shall conform to the requirements in [Table 3](#).

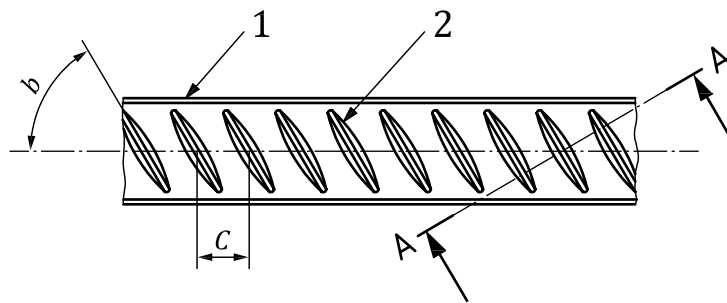
Table 3 — Requirements for transverse ribs

	Nominal bar diameter <i>d</i> mm	Ribs of uniform height	Crescent-shaped ribs
Rib height, <i>a</i> Minimum	All	0,05 <i>d</i>	0,065 <i>d</i>
Rib spacing, <i>c</i> Range	6 ≤ <i>d</i> < 10 <i>d</i> > 10	0,5 <i>d</i> ≤ <i>c</i> ≤ 0,7 <i>d</i> 0,5 <i>d</i> ≤ <i>c</i> ≤ 0,7 <i>d</i>	0,5 <i>d</i> ≤ <i>c</i> ≤ 1,0 <i>d</i> 0,5 <i>d</i> ≤ <i>c</i> ≤ 0,8 <i>d</i>
Transverse-rib inclination, β	All	35° ≤ β ≤ 90°	35° ≤ β ≤ 75°
Transverse-rib flank inclination, α	All	α ≥ 45°	α ≥ 45°
Ribless perimeter, Σf_i Maximum	All		0,25 <i>d</i> π

Requirements for rib parameters may be specified by the relative rib area, or by agreement between the manufacturer and purchaser. Measurement of rib parameters shall be performed in accordance with ISO 15630-1.

Dimensions defining the rib geometry in Table 3 are shown in Figures 1 to 4.

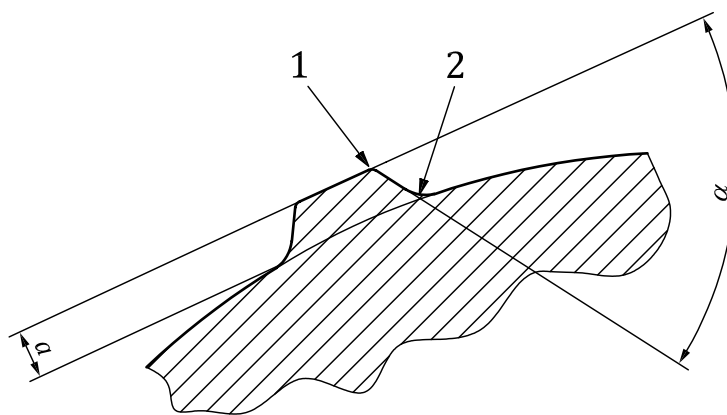
When longitudinal ribs are present, their height shall not exceed 0,15*d*.



Key

- 1 longitudinal rib
- 2 transverse rib

Figure 1 — Ribbed bar — Definitions of geometry



Key

- 1 Rib
- 2 rounded transition

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

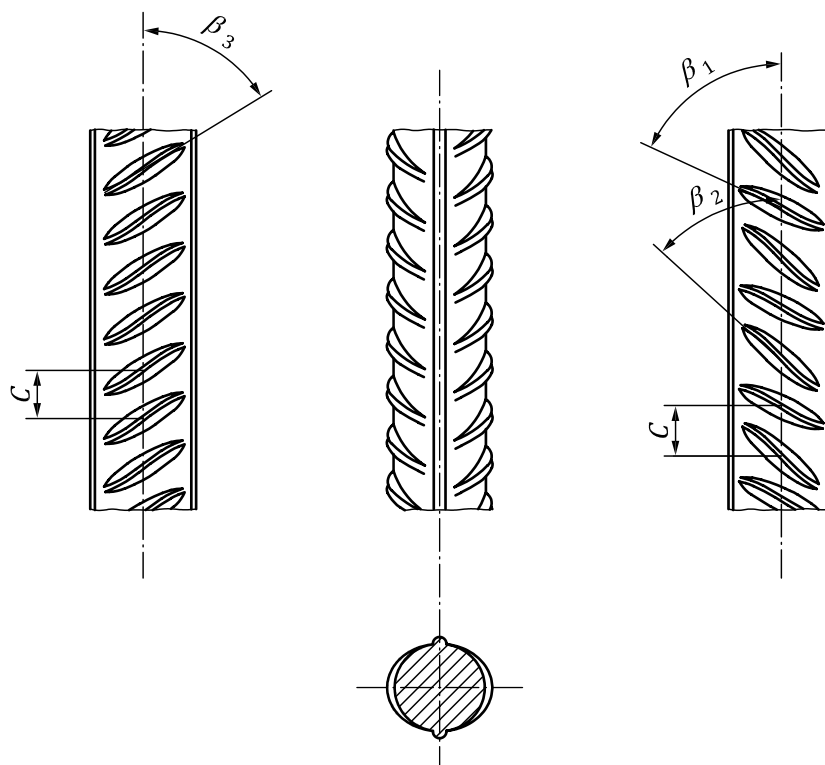


Figure 3 — Example of bar with varying rib inclinations to the longitudinal axis

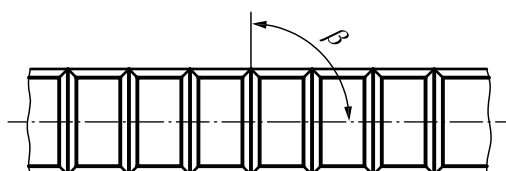


Figure 4 — Example of bar with transverse ribs of uniform height ($\beta = 90^\circ$)

7 Chemical composition

The chemical composition of the steel, as determined by cast analysis, shall conform to [Table 4](#).

Calculate the carbon equivalent, CEV, according to Formula (1):

$$\text{CEV} = C + \frac{\text{Mn}}{6} + \frac{(\text{Cr} + \text{V} + \text{Mo})}{5} + \frac{(\text{Cu} + \text{Ni})}{15} \quad (1)$$

where C, Mn, Cr, V, Mo, Cu and Ni are the mass fractions, expressed as percentages of the respective chemical elements of the steel.

The permissible deviation of the product analysis relative to the cast analysis as specified in [Table 4](#) is given in [Table 5](#).

Table 4 — Chemical composition based on cast analysis — Maximum values of mass fractions, in percentage

Steel grade ^a	C ^b	Si	Mn	P	S	N ^c	CEV ^{b, d}
B300A-R							
B300B-R							
B300C-R							
B400A-R							
B400B-R	—	—	—	0,060	0,060	—	—
B400C-R							
B500A-R							
B500B-R							
B500C-R							
B600A-R							
B600B-R	—	—	—	0,060	0,060	—	—
B600C-R							
B400AWR ^e							
B400BWR							
B400CWR	0,22	0,60	1,60	0,050	0,050	0,012	0,50
B500AWR							
B500BWR							
B500CWR							
B450AWR	0,22	—	—	0,050	0,050	0,012	0,50
B450CWR							
B300D-R	—	—	—	0,050	0,050	—	—
B300DWR	0,27	0,55	1,50	0,040	0,040	0,012	0,49
B350DWR	0,27	0,55	1,60	0,040	0,040	0,012	0,51
B400DWR	0,29	0,55	1,80	0,040	0,040	0,012	0,56
B420DWR ^d	0,30	0,55	1,50	0,040	0,040	0,012	0,56
B500DWR	0,32	0,55	1,80	0,040	0,040	0,012	0,61

^a The first “B” stands for steel for reinforcing concrete. The next 3 digits represent the specified characteristic value of minimum upper yield strength. The fifth symbol stands for ductility class (4.5). The sixth symbol relates to welding; “-” means not intended for welding and “W” means intended for welding. The last “R” stands for ribbed bar.

^b For B400AWR, B400BWR, B400CWR, B500AWR, B500BWR and B500CWR with diameters larger than 32 mm, the maximum carbon content (C) is 0,25 % and the maximum carbon equivalent (CEV) is 0,55 %.

^c A higher mass fraction of nitrogen may be used, if sufficient quantities of nitrogen-binding elements are present.

^d Other CEV formulae and values may be used by agreement between the manufacturer and purchaser.

^e Alloy elements, such as Cu, Ni, Cr, Mo, V, Nb, Ti and Zr, may be added by agreement between the manufacturer and purchaser.

Table 5 — Permissible deviation in product analysis in percentage by mass ^a

Elements	Specified maximum value in cast analysis in Table 4 %	Permissible deviation in product analysis from the specified limits of the cast analysis in Table 4 %
C	≤ 0,25	+ 0,02
	> 0,25	+ 0,03
Si	≤ 0,60	+ 0,05
Mn	≤ 1,65	+ 0,06
	> 1,65	+ 0,08
P	≤ 0,05	+ 0,008
	> 0,05	+ 0,010
S	≤ 0,05	+ 0,008
	> 0,05	+ 0,010
N	≤ 0,012	+ 0,002

^a In case of product analysis, the maximum value of CEV shall be as given in [Table 4](#) with a tolerance of 0,05.

8 Mechanical properties

8.1 Tensile properties

The tensile test shall be performed in accordance with [9.1](#).

The material shall conform to the requirements for specified characteristic tensile properties specified in [Table 6](#).

In the context of this part of ISO 6935, the characteristic value is (unless otherwise indicated) the lower or upper limit of the statistical tolerance interval at which there is a 90 % probability ($1 - \alpha = 0,90$) that 95 % ($p = 0,95$) of the values are at or above this lower limit, or are at or below this upper limit, respectively. This definition refers to the long-term quality level of production.

Table 6 — Tensile properties

Ductility class	Steel grade	Specified characteristic value of upper yield strength R_{eH} MPa ^c		Ductility properties		
				Specified characteristic value of R_m/R_{eH}	Specified characteristic value of elongation ^a %	
		Minimum	Maximum		Minimum	A Minimum
A	B300A-R	300	—	1,02	16	2
	B400A-R B400AWR	400	—		14	
	B500A-R B500AWR	500	—		10	
	B600A-R	600	—			
	B450AWR	450	1,25 × R _{eH} (min.)	1,05	-	2,5
B	300B-R	300	—	1,08	16	5
	B400B-R B400BWR	400	—		14	
	B500B-R B500BWR	500	—		10	
	B600B-R	600	—			
C	B300C-R	300	—	1,15	16	7
	B400C-R B400CWR	400	—		14	
	B500C-R B500CWR	500	—		10	
	B600C-R	600	—			
	B450CWR	450	1,25 × R _{eH} (min.)			
D	B300D-R	300	—	1,25	17 ^b	8
	B300DWR		1,3 × R _{eH} (min.)			
	B350DWR	350				
	B400DWR	400				
	B420DWR	420				
	B500DWR	500				

^a By agreement between the manufacturer and purchaser, the type of elongation shall be selected between A and A_{gt}. If the type of elongation is not specified by agreement, A_{gt} should be used.

^b In the case of the bars with diameter 32 mm or more in ductility class D, the minimum specified characteristic value for A may be decreased by 2 % for each 3 mm increase in diameter. However, the maximum diminution from the minimum specified characteristic value stated in Table 6 is limited to 4 %.

^c 1 MPa = 1 N/mm²

By agreement between the manufacturer and purchaser, the values shown in Table 6 may be used as specified minimum and/or maximum values.

If a yield phenomenon is not present, the 0,2 % proof strength (R_{p0,2}) shall be determined.

8.2 Bending properties

The bend test shall be performed in accordance with 9.3. After testing, the bars shall show neither rupture nor cracks visible to a person of normal or corrected vision.

8.3 Rebending properties after ageing

Regarding 15 steel grades of B400A-R, B400B-R, B400C-R, B400AWR, B400BWR, B400CWR, B400DWR, B420DWR, B500A-R, B500B-R, B500C-R, B500AWR, B500BWR, B500CWR and B500DWR, if required by the purchaser, the rebend test shall be performed in accordance with [9.4](#).

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

After testing, the bars shall show neither rupture nor cracks visible to a person of normal or corrected vision.

8.4 Fatigue properties

If required by the purchaser, the manufacturer shall demonstrate the fatigue properties of the product based on axial-force-controlled fatigue testing in the fluctuating tension range in accordance with [9.5](#).

The specified number(s) of stress cycles, stress range(s) $2\sigma_a$ and maximum stress(es) σ_{max} shall be as agreed between the purchaser and manufacturer at the time of enquiry and order.

9 Testing

9.1 Tensile test

The tensile test shall be carried out in accordance with ISO 15630-1.

For the determination of percentage total elongation at maximum force, A_{gt} , equidistant marks shall be made on the free length of the test piece.

For determination of tensile properties, the nominal cross-sectional area of the bar shall be used.

9.2 Conditions of testing

The conditions of testing are given in [Table 7](#).

Table 7 — Conditions of testing

Manufacturing and delivery conditions of the product	Conditions of testing (test pieces)
Produced in straight lengths by hot rolling	As delivered ^a or aged ^b
Produced in straight lengths by cold working	Aged ^b
Produced and delivered as coil	Straightened and aged
^a Aged in the case of dispute. ^b Aged means: Heating of the test piece to 100 °C, maintaining at this temperature ± 10 °C for a period of 1 h $^{+15}_0$ min and then cooling in still air to room temperature. The method of heating is left to the discretion of the manufacturer.	

9.3 Bend test

The bend test shall be carried out in accordance with ISO 15630-1.

The test piece shall be bent to an angle between 160° and 180° over a mandrel of the diameter specified in [Table 8](#).

Table 8 — Mandrel diameter to be used for the bend test

Dimensions in millimetres

Nominal bar diameter <i>d</i>	Mandrel diameter (max.) ^{a, b}
≤ 16	$3d$
$16 < d \leq 32$	$6d$
$32 < d \leq 50$	$7d$
^a For nominal diameters larger than 50 mm, the mandrel diameter in bend tests shall be agreed between the manufacturer and purchaser. ^b By agreement between the manufacturer and purchaser, larger mandrel diameters may be used.	

9.4 Rebend test

The rebend test shall be carried out in accordance with ISO 15630-1. The test piece shall be bent over a mandrel of the diameter specified in [Table 9](#).

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

Table 9 — Mandrel diameter to be used for the rebend test

Dimensions in millimetres

Nominal bar diameter <i>d</i>	Mandrel diameter (max.) ^{a, b}
≤ 16	$5d$
$16 < d \leq 25$	$8d$
$25 < d \leq 50$	$10d$
^a For nominal diameters larger than 50 mm, the mandrel diameter in rebend tests shall be agreed between the manufacturer and purchaser. ^b By agreement between the manufacturer and purchaser, larger mandrel diameters may be used.	

9.5 Fatigue test

The fatigue test shall be carried out according to ISO 15630-1.

9.6 Chemical composition

In general, the chemical composition is determined by spectrometric methods.

In case of dispute about the analytical method, the chemical composition shall be determined by an appropriate referee method specified in one of the International Standards listed in ISO/TR 9769.

10 Designation

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

- a) reinforcing steel;
- b) a reference to this part of ISO 6935 (i.e. ISO 6935-2);
- c) the nominal diameter, in millimetres, according to [Table 2](#);
- d) the steel grade.

EXAMPLE Reinforcing steel ISO 6935-2 – 12 B500CWR

11 Marking

11.1 Marking on the bar

All bars should be identifiable by permanent marks that indicate

- a) the steel grade, and
- b) the name of the manufacturer.

Some examples of multinational marking systems are shown in [Annex A](#).

11.2 Marking of bundles

Each bundle of bars shall have a label stating the name of the manufacturer, a reference to this part of ISO 6935 (i.e. ISO 6935-2), the steel grade, the nominal diameter, the cast number or reference related to the test record and country of origin.

12 Evaluation of conformity

12.1 General

Certification and inspection of reinforcement can be performed

- a) in accordance with a certification following a conformity assessment scheme, see [12.2](#), or
- b) according to testing of a specific delivery, see [12.3](#).

12.2 Evaluation of conformity during production

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

NOTE ISO 10144 specifies scheme requirements for the certification for the continuous production of steel bars for the reinforcement of concrete in order to verify the conformity with requirements specified in product standards such as ISO 6935-1 and ISO 6935-2.

For each of the characteristics specified in this part of ISO 6935 except chemical composition, one test piece shall be taken per 40 t for all diameters, with at least three test pieces per cast and nominal diameter.

The chemical composition (cast analysis) shall also be determined for all casts. The contents of the elements specified in this standard shall be determined in this analysis.

Each individual value x_i shall satisfy the equation

$$x_i > 0,95f_k \quad (2)$$

where f_k is the required characteristic value according to [Table 6](#).

The mean value of the test unit shall satisfy the equation

$$m > f_k + ks \quad (3)$$

where

k is the acceptability index according to [Table 10](#); and

s is the standard deviation of the test results.

Proven values of k s for each product and manufacturer shall be used.

The mean value requirement of Formula (3) does not apply if all individual values lie above the required characteristic value.

All casts shall comply with the requirements for the chemical composition including the carbon equivalent. All other requirements shall be met for each individual test piece.

Where test results are unsatisfactory according to this clause, the manufacturer shall immediately take the necessary precautions. Casts that do not conform to the requirement shall be set aside.

Table 10 — Acceptability index (k) 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	1000	1,71
20	2,21	∞	1,64

12.3 Acceptance testing of a specific delivery

12.3.1 General

Provisions regarding the nature, extent and evaluation of acceptance testing on deliveries of reinforcing steel not subject to certification following a conformity assessment scheme are given in [12.3.2](#) and [12.3.3](#).

Acceptance testing of a specific delivery shall be performed according to [12.3.2](#).

By agreement between the manufacturer and purchaser, [12.3.3](#) may be used.

12.3.2 Evaluation of characteristic values

12.3.2.1 Organization

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

12.3.2.2 Extent of sampling and testing

For the purpose of testing, the delivery shall be subdivided into test units with a maximum mass of 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) a minimum of 15 test pieces (if appropriate, 60 test pieces, see [12.3.2.3.1](#)) from various bars for testing all other properties specified in this part of ISO 6935.

12.3.2.3 Evaluation of the results

12.3.2.3.1 Inspection by variables

For properties that 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:

$$m_{15} - 2,33 \times s_{15} \geq f_k \quad (4)$$

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 % ($1 - \alpha = 0,90$).

$$s_{15} = \sqrt{\frac{\sum (x_i - m_{15})^2}{14}} \quad (5)$$

If the condition stated above is not fulfilled, the index

$$k' = \frac{m_{15} - f_k}{s_{15}} \quad (6)$$

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 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:

$$m_{60} - 1,93 \times s_{60} > f_k \quad (7)$$

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 % ($1 - \alpha = 0,90$).

12.3.2.3.2 Inspection by attributes

When testing properties are specified as maximum or minimum values, all results determined on the 15 test pieces shall comply with the requirements of this part of ISO 6935. 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 the conditions occur. In this case, 45 additional 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 not more than 2 of the 60 results do not conform to the conditions.

12.3.2.3.3 Chemical composition

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

12.3.3 Evaluation of specified minimum/maximum values

Tests shall be carried out according to the following:

- a) Bars of the same cast shall constitute one group. For every 50 t or fraction thereof, one tensile test and one bend/rebend test shall be carried out for each bar diameter;
- b) Each individual test result shall meet the required values in [Table 6](#), and the required bending/rebending properties in [8.2](#) and [8.3](#). One cast analysis shall be carried out for every cast to verify chemical composition ([Clause 7](#)). Samples shall be taken in accordance with ISO 14284;
- c) If any test result does not meet the requirements, retests may be carried out, according to ISO 404;
- d) The manufacturer shall submit a test report stating that the products of the delivery satisfy the chemical and mechanical properties defined in [Clauses 7](#) and [8](#), and a confirmation that the other requirements of this part of ISO 6935 are fulfilled.

12.3.4 Test report

The test report shall at least contain the following information:

- a) designation of the reinforcing steel in accordance with 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)

Four examples of marking systems for ribbed bars

A.1 Introduction

This annex lists examples of marking systems for ribbed bars as these are specified on regional level. The annex is written for information only. To comply with the regional specifications, the latest version of the relevant regional standard needs to be addressed in full.

A.2 References

References [5],[6],[7],[8] and [9] in the Bibliography.

A.3 Example No. 1: System according to EN 10080:2005

A.3.1 Each reinforcing bar shall bear on one rib row a mark identifying the works. This mark shall be repeated at an interval of not more than 1,5 m.

A.3.2 The mark shall consist of the following:

- a) a symbol denoting the beginning of the mark;
- b) a numerical system identifying the manufacturer, consisting of a country-of-origin number and a works number.

A.3.3 The numerical system identifying the country of origin and the works shall use one of the following methods:

- a) a number of normal ribs or indentations between widened ribs or indentations (for example, see [Figure A.1](#));
- b) a number of normal ribs or indentations between missing ribs or indentations;
- c) numbers on the surface of the bar;
- d) rolled or indented marks with a number of normal ribs or indentations in between them.

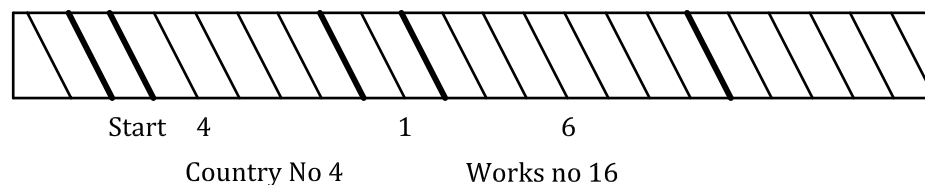


Figure A.1 — Example of manufacturer's identification mark (using widened ribs)

A.3.4 The symbol indicating the start of the mark shall be one of the following:

- a) where the marking method uses widened ribs or indentations, the symbol identifying the start of the mark shall consist of two consecutive widened ribs or indentations. (For example, see [Figure A.1](#));
- b) where the marking method uses missing ribs or indentations, the symbol identifying the start of the mark shall consist of two consecutive missing ribs or indentations;
- c) where numbers are rolled onto the surface of the bar, the symbol indicating the start of the mark shall be an X or O;
- d) where marks are rolled or indented onto the surface, the start of the mark shall consist of two marks between one pair of normal ribs or indentations.

A.3.5 The country of origin shall be indicated by a number between 1 and 9, according to [Table A.1](#). (For example, see [Figure A.1](#).)

A.3.6 The works number shall consist of a one- or two-digit number between 1 and 99, except for multiples of 10. (For example, see [Figure A.1](#).)

Table A.1 — Marking of country of origin

Country	Number of normal oblique ribs between two thickened oblique ribs
Austria, Czech Republic, Germany, Poland, Slovakia	1
Belgium, Netherlands, Luxemburg, Switzerland	2
France, Hungary	3
Italy, Malta, Slovenia	4
UK, Ireland, Iceland	5
Denmark, Estonia, Finland, Latvia, Lithuania, Norway, Sweden	6
Portugal, Spain	7
Cyprus, Greece	8
Other countries	9

A.4 Example No. 2: System according to ASTM A615/A615M-15a and ASTM A706/A706M-14

A.4.1 When loaded for mill shipment, bars shall be properly separated and tagged with the manufacturer’s cast or test identification number.

A.4.2 Each manufacturer shall identify the symbols of the manufacturer’s own marking system.

A.4.3 All bars shall be identified by a distinguishing set of marks legibly rolled onto the surface of one side of the bar to denote, in the order given in [A.4.3.1](#) to [A.4.3.4](#), the following items.

A.4.3.1 Point of origin

Letter or symbol established as the manufacturer’s mill designation.

A.4.3.2 Size designation

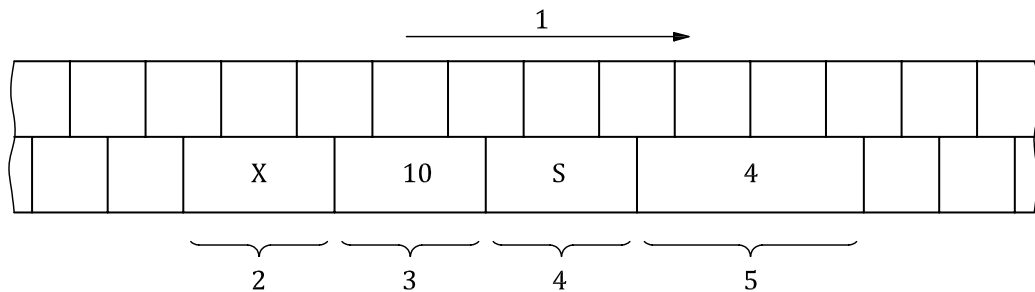
Arabic number corresponding to bar designation number (nominal diameter).

A.4.3.3 Type of steel

Letter *S*, if the bar is produced according to specification ASTM A615/A615M, or letter *W*, if the bar is produced according to specification ASTM A706/A706M. For Grades 420 and 550, letters *S* and *W* indicating that the bar was produced to meet both ASTM A615/A615M and ASTM A706/A706M.

A.4.3.4 Minimum yield designation

For Grade 420, either the number 4 or a single continuous longitudinal line through at least five deformation (transverse rib) spaces offset from the centre of the bar side. For Grade 550, either the number 6 or three continuous longitudinal lines through at least five deformation (transverse rib) spaces. (No marking designation for Grade 280 bars.)



Key

- 1 direction of reading
- 2 mill designation
- 3 bar size
- 4 according to ASTM
- 5 steel grade

Figure A.2 — Marking according to ASTM A615/A615M-15a and ASTM A706/A706M-14

A.5 Example No. 3: System according to JIS G 3112:2004

A.5.1 The ribbed reinforcing bars shall be marked as specified in the standard.

A.5.2 Marking on each reinforcing bar

The ribbed reinforcing bars shall indicate the markings identifying the grade in accordance with [Table A.2](#).

Table A.2 — Marking method for grade identification

Steel grade	Marking method for grade identification	
	Marking by rolling mark	Marking by colouring
B300D-R	Without rolling mark	Not applied
B300DWR	1 or	White (on one side section)
B350DWR	Number of protrusions, one piece (•)	Yellow (on one side section)
B400DWR	Number of protrusions, two pieces (••)	Green (on one side section)
B500DWR	Number of protrusions, three pieces (•••)	Blue (on one side section)

In the case of bars with diameter of 8 mm or less, marking by colouring may be applied instead of marking by rolling mark.

A.5.3 Marking on each bundle

The ribbed reinforcing bars shall be marked with the following details by appropriate means:

- a) symbol of grade;
- b) heat number or inspection number;
- c) diameter or designation;
- d) manufacturer's name or its abbreviation.

A.6 Example No. 4: System according to GB 1499.2-2007

A.6.1 Each ribbed bar shall be marked according to the following specification.

A.6.2 The steel grade, the abbreviation of the name of steel works (or trademark) and the diameter of ribbed bars shall be rolled onto the surface of ribbed bars.

For ribbed bars with diameter less than and equal to 10 mm, the rolling marks should not be used. Only tags should be attached on the bars.

A.6.2.1 The steel grade shall be designated as: Arabic number, or Arabic number plus alphabet, in accordance with [Table A.3](#).

Table A.3 — Marking method for grade identification

Steel grade in GB 1499.2:2007	Number designation
HRB 335	3
HRB 400	4
HRB 500	5
HRBF335	C3
HRBF400	C4
HRBF500	C5
HRB335E	E3
HRB400E	E4
HRB500E	E5

A.6.2.2 The marking for the name of the steel works shall be the abbreviation of its name (2 characters) or trademark.

A.6.2.3 The diameter of ribbed bars shall be designated as an Arabic number in millimetres.

EXAMPLE The rolling mark of the ribbed bars (steel grade: HRB 400, manufactured by ABC Steel Company, with diameter 25 mm):

4 AS 25

where

4 is the steel grade: HRB 400;

AS is the steel works: "ABC Steel Company";

25 is the diameter: 25 mm.

Annex B (informative)

Options for agreement between the manufacturer and purchaser

For convenience, the provisions for which this part of ISO 6935 indicates that additional or deviating requirements can be agreed between the manufacturer and purchaser are listed below:

- a) diameter > 50 mm ([Table 2](#) and [Clause 9](#));
- b) delivery length ([Clause 5](#));
- c) longitudinal ribs ([Clause 6](#));
- d) specified minimum/maximum values ([8.1](#) and [12.3.3](#));
- e) rebending properties ([8.3](#));
- f) fatigue properties ([8.4](#));
- g) organization of delivery testing ([12.3.2.1](#)).

The list does not imply any restriction on agreements concerning other provisions.

Bibliography

- [1] ISO 3534-1, *Statistics — Vocabulary and symbols — Part 1: General statistical terms and terms used in probability*
- [2] ISO 6935-1, *Steel for the reinforcement of concrete — Part 1: Plain bars*
- [3] ISO 16020, *Steel for the reinforcement and prestressing of concrete — Vocabulary*
- [4] ISO/IEC Guide 2, *Standardization and related activities — General vocabulary*
- [5] EN 10080:2005, *Steel for the reinforcement of concrete — Weldable reinforcing steel — General*
- [6] ASTM A615/A615M-15a, *Standard specification for deformed and plain carbon-steel bars for concrete reinforcement*
- [7] ASTM A706/A706M-14, *Standard specification for low-alloy steel deformed and plain bars for concrete reinforcement*
- [8] JIS G 3112:2004, *Steel bars for concrete reinforcement*
- [9] GB 1499.2-2007, *Steel for the reinforcement of concrete — Part 2: Hot rolled ribbed bars*

