DRAFT EAST AFRICAN STANDARD

Steel for the reinforcement of concrete —
Part 2:

Ribbed bars
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Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in the East African Community. It is envisaged that through harmonized standardization, trade barriers that are encountered when goods and services are exchanged within the Community will be removed.

In order to achieve this objective, the Community established an East African Standards Committee mandated to develop and issue East African Standards.

The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

EAS 412-2:2005 was prepared by Technical Committee EAS/TC 000, TC035.
Steel for the reinforcement of concrete —
Part 2:
Ribbed bars

1 Scope
This part of EAS 412 specifies technical requirements for ribbed bars to be used as reinforcement in concrete.

This part of EAS 412 covers ten steel grades not intended for welding which are B400A-R, B400B-R, B400C-R, B500A-R, B500B-R and B500C-R, and eleven steel grades intended for welding which are B400AWR, B400BWR, B400CWR, B400DWR, B420DWR, B500AWR, B500BWR, B500CWR and B500DWR. The steel grades are designated with steel names allocated in accordance with ISO/TS 4949.

NOTE The first “B” stands for steel for reinforcing concrete. The next 3 digits represent the specified characteristic value of 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.

This part of EAS 412 covers products delivered in straight lengths.

The production process is at the discretion of the manufacturer.

Ribbed bars produced from finished products, such as plates and railway rails, are excluded.

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.


3 Symbols
The symbols used in this part of ISO 6935 are listed in Table 1.
Table 1 — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Unit</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>mm</td>
<td>Rib height</td>
<td>4.10, Clause 6</td>
</tr>
<tr>
<td>A5</td>
<td>%</td>
<td>Percentage elongation after fracture</td>
<td>8.1, 9.1</td>
</tr>
<tr>
<td>Agt</td>
<td>%</td>
<td>Percentage total elongation at maximum force</td>
<td>8.1, 9.1</td>
</tr>
<tr>
<td>An</td>
<td>mm²</td>
<td>Nominal cross-sectional area</td>
<td>Clause 5, 9.1</td>
</tr>
<tr>
<td>c</td>
<td>mm</td>
<td>Rib spacing</td>
<td>4.11, Clause 6</td>
</tr>
<tr>
<td>d</td>
<td>mm</td>
<td>Nominal diameter of the bar</td>
<td>Clause 5, Clause 6, 9.1, 9.2, 9.3, Clause 10, 11.2,</td>
</tr>
<tr>
<td>Σfᵢ</td>
<td>mm</td>
<td>Ribless perimeter</td>
<td>4.12, Clause 6</td>
</tr>
<tr>
<td>fk</td>
<td>—</td>
<td>Required characteristic value</td>
<td>12.3.2.3</td>
</tr>
<tr>
<td>ftᵣ</td>
<td>—</td>
<td>Relative rib area</td>
<td>4.9, Clause 6</td>
</tr>
<tr>
<td>k, k'</td>
<td>—</td>
<td>Indices</td>
<td>12.3.2.3.1</td>
</tr>
<tr>
<td>mn</td>
<td>—</td>
<td>Mean value of n individual values</td>
<td>12.3.2.3.1</td>
</tr>
<tr>
<td>n</td>
<td>—</td>
<td>Number of individual values</td>
<td>12.3.2.3.1</td>
</tr>
<tr>
<td>ReH</td>
<td>N/mm²</td>
<td>Upper yield strength</td>
<td>8.1</td>
</tr>
<tr>
<td>Rm</td>
<td>N/mm²</td>
<td>Tensile strength</td>
<td>8.1</td>
</tr>
<tr>
<td>Rp₀.₂</td>
<td>N/mm²</td>
<td>0.2 % proof strength, non-proportional extension</td>
<td>8.1</td>
</tr>
<tr>
<td>sn</td>
<td>—</td>
<td>Standard deviation for n individual values</td>
<td>12.3.2.3.1</td>
</tr>
<tr>
<td>xi</td>
<td>—</td>
<td>Individual value</td>
<td>12.3.2.3.1</td>
</tr>
<tr>
<td>α</td>
<td>degree</td>
<td>Transverse-rib flank inclination</td>
<td>4.14, Clause 6</td>
</tr>
<tr>
<td>β</td>
<td>degree</td>
<td>Angle between the axis of a transverse rib and the bar axis</td>
<td>4.15, Clause 6</td>
</tr>
</tbody>
</table>

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 his own procedures

[ISO 16020:2005]

4.2 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

characteristic value

value having a prescribed probability of not being attained in a hypothetical unlimited test series [ISO 16020:2005]
4.4 *core*

part of the cross-section of the bar containing neither ribs nor indentations NOTE Adapted from ISO 16020:2005.

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 $A_s$. NOTE See Table 6.

4.6 *longitudinal rib*

uniform continuous rib parallel to the axis of the bar NOTE Adapted from ISO 16020:2005.

4.7 *nominal cross-sectional area*

cross-sectional area equivalent to the area of a circular plain bar of the nominal diameter NOTE Adapted from ISO 16020:2005.

4.8 *product analysis*

chemical analysis carried out on the product [ISO 16020:2005]

4.9 *relative rib area*

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 NOTE Adapted from ISO 16020:2005.

4.10 *rib height*

a

distance from one point on the rib to the surface of the core, to be measured normal to the axis of the bar NOTE 1 See Figure 2.

4.11 *rib spacing*

c

distance between the centres of two consecutive transverse ribs measured parallel to the axis of the bar NOTE 1 See Figure 1

4.12 *ribless perimeter*

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Σrif the 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

NOTE Adapted from ISO 16020:2005.

4.13 transverse rib

rib at an angle, either perpendicular or oblique, to the longitudinal axis of the bar NOTE Adapted from ISO 16020:2005.

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 See Figure 2.
NOTE 2 Adapted from ISO 16020:2005.

4.15 transverse-rib inclination

β

angle between the rib and the longitudinal axis of the bar NOTE 1 See Figures 1, 3 and 4.
NOTE 2 Adapted from ISO 16020:2005.

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.

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

<table>
<thead>
<tr>
<th>Nominal bar diameter d</th>
<th>Nominal cross-sectional area A</th>
<th>Mass per unit length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Requirement c</td>
<td>Permissible deviation δ</td>
</tr>
<tr>
<td>mm</td>
<td>mm²</td>
<td>kg/m</td>
</tr>
<tr>
<td>6</td>
<td>28.3</td>
<td>0.222</td>
</tr>
<tr>
<td>8</td>
<td>50.3</td>
<td>0.395</td>
</tr>
<tr>
<td>10</td>
<td>73.5</td>
<td>0.617</td>
</tr>
<tr>
<td>12</td>
<td>113</td>
<td>0.688</td>
</tr>
<tr>
<td>14</td>
<td>154</td>
<td>1.21</td>
</tr>
<tr>
<td>16</td>
<td>201</td>
<td>1.58</td>
</tr>
<tr>
<td>20</td>
<td>314</td>
<td>2.47</td>
</tr>
<tr>
<td>25</td>
<td>491</td>
<td>3.85</td>
</tr>
<tr>
<td>28</td>
<td>616</td>
<td>4.34</td>
</tr>
<tr>
<td>32</td>
<td>304</td>
<td>6.31</td>
</tr>
<tr>
<td>40</td>
<td>1,257</td>
<td>9.58</td>
</tr>
<tr>
<td>60</td>
<td>1,964</td>
<td>15.42</td>
</tr>
</tbody>
</table>
Diameters larger than 5D mm should be agreed between the manufacturer and purchaser. The permissible deviation on such bars shall be ± A %.

\[ A_n = 0.755 \times A \]

Mass per unit length: \( 7.85 \times 10^{-3} \times A_n \)

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 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 ribs**

<table>
<thead>
<tr>
<th>Rib parameter</th>
<th>Nominal diameter ( d ) mm</th>
<th>Ribs of uniform height</th>
<th>Crescent-shaped ribs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rib height, ( a ) Minimum</td>
<td>All</td>
<td>0.05( d )</td>
<td>0.065( d )</td>
</tr>
<tr>
<td>Rib spacing, ( c ) Range</td>
<td>6 ≤ ( d ) &lt; 10</td>
<td>0.5( d ) ≤ ( c ) ≤ 0.7( d )</td>
<td>0.5( d ) ≤ ( c ) ≤ 1.0( d ) ≤ 0.5( d ) ≤ ( c ) ≤ 0.8( d )</td>
</tr>
<tr>
<td>Transverse-rib inclination, ( \beta )</td>
<td>All</td>
<td>35° ≤ ( \beta ) ≤ 90°</td>
<td>35° ≤ ( \beta ) ≤ 75°</td>
</tr>
<tr>
<td>Transverse-rib flank inclination, ( \alpha )</td>
<td>All</td>
<td>( \alpha ) ≤ 45°</td>
<td>( \alpha ) ≤ 45°</td>
</tr>
<tr>
<td>Ribless perimeter, ( \Sigma ) Maximum</td>
<td>All</td>
<td></td>
<td>0.25( d \pi )</td>
</tr>
</tbody>
</table>

Requirements for rib parameters may be specified by the relative rib area, 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

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Figure 1 — Ribbed bar — Definitions of geometry

Key
1 rib 2 rounded transition

Figure 2 — Rib flank inclination, \( \alpha \), 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. The carbon equivalent, CEV, is calculated according to the following formula.

\[
CEV = C + \frac{Mn}{65} + \frac{(Cr + V + Mo)}{15} + \frac{(Cu + Ni)}{65}
\]

(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 are given in Table 5.

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

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>N</th>
<th>CEV a, c</th>
</tr>
</thead>
<tbody>
<tr>
<td>B400A-R</td>
<td></td>
<td></td>
<td></td>
<td>0.060</td>
<td>0.060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B400B-R</td>
<td></td>
<td></td>
<td></td>
<td>0.060</td>
<td>0.060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B400C-R</td>
<td></td>
<td></td>
<td></td>
<td>0.060</td>
<td>0.060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B500A-R</td>
<td>0.22</td>
<td>0.60</td>
<td>1.60</td>
<td>0.050</td>
<td>0.050</td>
<td>0.012</td>
<td>0.50</td>
</tr>
<tr>
<td>B500B-R</td>
<td>0.22</td>
<td>0.60</td>
<td>1.60</td>
<td>0.050</td>
<td>0.050</td>
<td>0.012</td>
<td>0.50</td>
</tr>
<tr>
<td>B500C-R</td>
<td>0.22</td>
<td>0.60</td>
<td>1.60</td>
<td>0.050</td>
<td>0.050</td>
<td>0.012</td>
<td>0.50</td>
</tr>
<tr>
<td>B400AWR d</td>
<td>0.27</td>
<td>0.55</td>
<td>1.60</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.51</td>
</tr>
<tr>
<td>B400BWR</td>
<td>0.27</td>
<td>0.55</td>
<td>1.60</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.51</td>
</tr>
<tr>
<td>B400CWR</td>
<td>0.27</td>
<td>0.55</td>
<td>1.60</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.51</td>
</tr>
<tr>
<td>B500AWR</td>
<td>0.32</td>
<td>0.55</td>
<td>1.80</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.56</td>
</tr>
<tr>
<td>B500BWR</td>
<td>0.32</td>
<td>0.55</td>
<td>1.80</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.56</td>
</tr>
<tr>
<td>B500CWR</td>
<td>0.32</td>
<td>0.55</td>
<td>1.80</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.56</td>
</tr>
<tr>
<td>B350DWR</td>
<td>0.27</td>
<td>0.55</td>
<td>1.60</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.51</td>
</tr>
<tr>
<td>B400DWR</td>
<td>0.29</td>
<td>0.55</td>
<td>1.80</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.56</td>
</tr>
<tr>
<td>B420DWR d</td>
<td>0.30</td>
<td>0.55</td>
<td>1.50</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.56</td>
</tr>
<tr>
<td>B500DWR</td>
<td>0.32</td>
<td>0.55</td>
<td>1.80</td>
<td>0.040</td>
<td>0.040</td>
<td>0.012</td>
<td>0.61</td>
</tr>
</tbody>
</table>

a 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 %.

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

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

d 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 — Chemical composition based on product analysis — Permissible deviation of the product analysis in percentage by mass**

<table>
<thead>
<tr>
<th>Elements</th>
<th>Specified maximum value in cast analysis in Table 4 %</th>
<th>Permissible deviation in product analysis from the specified limits of the cast analysis in Table 4 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>u 0.25</td>
<td>+ 0.02</td>
</tr>
<tr>
<td></td>
<td>&gt; 0.25</td>
<td>+ 0.03</td>
</tr>
<tr>
<td>Si</td>
<td>u 0.60</td>
<td>+ 0.05</td>
</tr>
<tr>
<td>Mn</td>
<td>u 1.65</td>
<td>+ 0.06</td>
</tr>
<tr>
<td></td>
<td>&gt; 1.65</td>
<td>+ 0.08</td>
</tr>
<tr>
<td>P</td>
<td>u 0.05</td>
<td>+ 0.008</td>
</tr>
</tbody>
</table>
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 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 – α = 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

<table>
<thead>
<tr>
<th>Ductility class</th>
<th>Steel grade</th>
<th>Specified characteristic value of upper yield strength ReH N/mm²</th>
<th>Specified characteristic value of Rm/ReH</th>
<th>Specified characteristic value of elongation a %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B400A-R</td>
<td>400</td>
<td>1.02</td>
<td>Minimum 14</td>
</tr>
<tr>
<td></td>
<td>B400AWR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B500A-R</td>
<td>400</td>
<td>1.02</td>
<td>Minimum 14</td>
</tr>
<tr>
<td></td>
<td>B500AWR _500</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>B400B-R</td>
<td>400</td>
<td>1.08</td>
<td>Minimum 14</td>
</tr>
<tr>
<td></td>
<td>B400BWR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B500B-R</td>
<td>400</td>
<td>1.08</td>
<td>Minimum 14</td>
</tr>
<tr>
<td></td>
<td>B500BWR _500</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>B400C-R</td>
<td>400</td>
<td>1.15</td>
<td>Minimum 14</td>
</tr>
<tr>
<td></td>
<td>B400CWR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B500C-R</td>
<td>400</td>
<td>1.15</td>
<td>Minimum 14</td>
</tr>
<tr>
<td></td>
<td>B500CWR _500</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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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 \( \sigma_{p0,2} \) shall be determined.

### 8.2 Bending properties

If required by the purchaser, the bend test shall be performed in accordance with 9.2. 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 fifteen 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, the rebend test shall be performed in accordance with 9.3.

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 9.4.

The specified number(s) of stress cycles, stress range(s) \( 2\sigma_a \) and maximum stress(es) \( \sigma_{max} \) 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 elongation after fracture, \( \Lambda_5 \), the original gauge length shall be 5 times the nominal diameter.

For the determination of percentage total elongation at maximum force, \( \Lambda_{gt} \), equidistant marks shall be made on the free length of the test piece. The distance between the marks shall be 20 mm, 10 mm or 5 mm, depending on the bar diameter.

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

#### 9.2 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 7.

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Table 7 — Mandrel diameter to be used for the bend test

<table>
<thead>
<tr>
<th>Nominal diameter (d)</th>
<th>Mandrel diameter (max.) (a, b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(u 16)</td>
<td>3d</td>
</tr>
<tr>
<td>(16 &lt; d u 32)</td>
<td>6d</td>
</tr>
<tr>
<td>(32 &lt; d u 50)</td>
<td>7d</td>
</tr>
</tbody>
</table>

\(a\) 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.

9.3 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 8.

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 8 — Mandrel diameter to be used for the rebend test

<table>
<thead>
<tr>
<th>Nominal diameter (d)</th>
<th>Mandrel diameter (max.) (a, b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(u 16)</td>
<td>5d</td>
</tr>
<tr>
<td>(16 &lt; d u 25)</td>
<td>8d</td>
</tr>
<tr>
<td>(25 &lt; d u 50)</td>
<td>10d</td>
</tr>
</tbody>
</table>

\(a\) 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.

9.4 Fatigue test

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

9.5 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/TS 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 marks introduced during rolling which indicate
a) the steel grade,
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 shall be performed a) in accordance with a certification scheme monitored by an external body, or b) according to testing of a specific delivery.

12.2 Certification scheme

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

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 a certification 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

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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 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:

\[
m_{15} - 2.33 \times s_{15} \geq f_k
\]  

(2)

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 % (\( 1 - \alpha = 0.90 \)).

\[
s_{15} = \sqrt{\frac{\sum (x_i - m_{15})^2}{14}}
\]  

(3)

If the condition stated above is not fulfilled, the index

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

(4)

is determined from the test results available. Where \( k' \geq W 2 \), 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:

\[
m_{60} - 1.93 \times s_{60} \geq f_k
\]  

(5)

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.

c) 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.

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

e) 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 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.
Bibliography

[2] ISO 16020, Steel for the reinforcement and prestressing of concrete — Vocabulary