



## **DRAFT EAST AFRICAN STANDARD**

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**DEAS 412-2:2018- Steel for the reinforcement of concrete —  
Part 2: Ribbed bars**

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**EAST AFRICAN COMMUNITY**

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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.

DEAS 412-2:2018 was prepared by Technical Committee EASC/TC 035 *TC Steel and Steel Products*

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## Steel for the reinforcement of concrete —Part 2: Ribbed bars

### 1 Scope

This part of East Africa Draft Standard specifies technical requirements for ribbed bars to be used as reinforcement in concrete.

This part of East Africa Draft Standard covers ten steel grades not intended for welding which are B300A-R, B300B-R, B300C-R, B300D-R, B400A-R, B400B-R, B400C-R, B500A-R, B500B-R and B500C-R, and eleven steel grades intended for welding which are B300DWR, B350DWR, B400AWR, B400BWR, B400CWR, B400DWR, B420DWR, B500AWR, B500BWR, B500CWR, B500DWR, B550DWR and B600DWR. 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 East Africa Draft Standard 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.

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

ISO/TS 4949, *Steel names based on letter symbols*

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 East Africa Draft Standard are listed in Table 1.

**Table 1 — Symbols**

Symbol	Unit	Description	Reference
$a$	mm	Rib height	4.10, Clause 6
$A_5$	%	Percentage elongation after fracture	8.1, 9.1
$A_{gt}$	%	Percentage total elongation at maximum force	8.1, 9.1
$A_n$	mm <sup>2</sup>	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,
$\Sigma f_i$	mm	Ribless perimeter	4.12, Clause 6
$f_k$	—	Required characteristic value	12.3.2.3
$f_R$	—	Relative rib area	4.9, Clause 6
$k, k'$	—	Indices	12.3.2.3.1
$\bar{m}_n$	—	Mean value of $n$ individual values	12.3.2.3.1
$n$	—	Number of individual values	12.3.2.3.1
$R_{eH}$	N/mm <sup>2</sup>	Upper yield strength	8.1
$R_m$	N/mm <sup>2</sup>	Tensile strength	8.1
$R_{p0.2}$	N/mm <sup>2</sup>	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
$\alpha$	degree	Transverse-rib flank inclination	4.14, Clause 6
$\beta$	degree	Angle between the axis of a transverse rib and the bar axis	4.15, Clause 6

### 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/her own procedures

#### 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

**4.3****characteristic value**

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

NOTE 2 A nominal value is used as the characteristic value in some circumstances.

**4.4****core**

part of the cross-section of the bar containing neither ribs nor indentations

**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  $A_5$

NOTE See Table 6.

**4.6****longitudinal rib**

uniform continuous rib parallel to the axis of the bar

**4.7****nominal cross-sectional area**

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

**4.8****product analysis**

chemical analysis carried out on the product

**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

**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<sub>c</sub>

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 $\Sigma f_i$

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

#### 4.13

##### Transverse rib

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

#### 4.14

##### transverse-rib flank inclination $\alpha$

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.

#### 4.15

##### transverse-rib inclination $\beta$

angle between the rib and the longitudinal axis of the bar

NOTE 1 See Figures 1, 3 and 4.

## 5 Dimensions, mass per unit length and permissible deviations

Dimensions, mass per unit length and permissible deviations are given in Table 2. However, manufacturer and purchaser may agree on special ordered diameter upon notification to the regulator.

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

Nominal bar diameter <sup>a</sup>	Nominal cross-sectional area <sup>b</sup>	Mass per unit length	
		Requirement <sup>c</sup>	Permissible deviation <sup>d</sup>
$d$ mm	$A_n$ mm <sup>2</sup>	kg/m	%
6	28,3	0,222	±6
8	50,3	0,395	±6
10	78,5	0,617	±5
12	113	0,888	±5
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 such bars shall be ± 4 %.

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

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

d Permissible deviation refers to a single bar.

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

, the permissible deviation on delivery lengths from rolling mill shall be  $+100$   
0mm .

## 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.



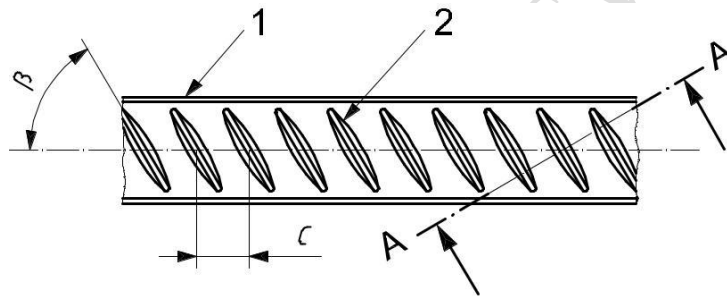
Table 3 — Requirements for ribs

	Nominal diameter $d$ mm	Ribs of uniform height	Crescent-shaped ribs
Rib height, $a$ Minimum	All	$0,05d$	$0,065d$
Rib spacing, $c$ Range	$6 \leq d < 10$ $d \leq 10$	$0,5d \leq c \leq 0,7d$ $0,5d \leq c \leq 0,7d$	$0,5d \leq c \leq 1,0d$ $0,5d \leq c \leq 0,8d$
Transverse-rib inclination, $\beta$	All	$35^\circ \leq \beta \leq 90^\circ$	$35^\circ \leq \beta \leq 75^\circ$
Transverse-rib flank inclination, $\alpha$	All	$\alpha \leq 45^\circ$	$\alpha \leq 45^\circ$
Ribless perimeter, $\Sigma f_i$ Maximum	All		$0,25d\pi$

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.

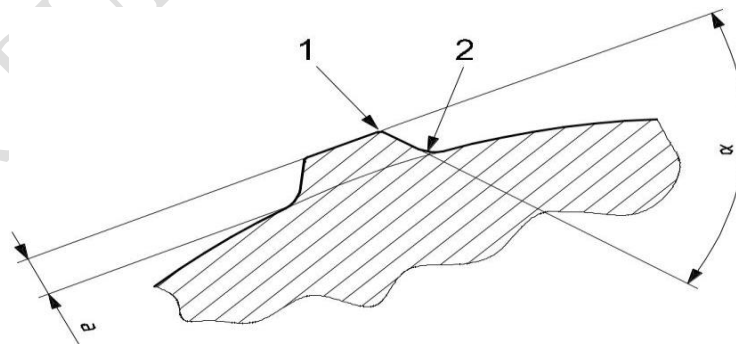
When longitudinal ribs are present, their height shall not exceed  $0,15d$ .



**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,  $\alpha$ , and rib height,  $a$  — Section A-A from Figure 1

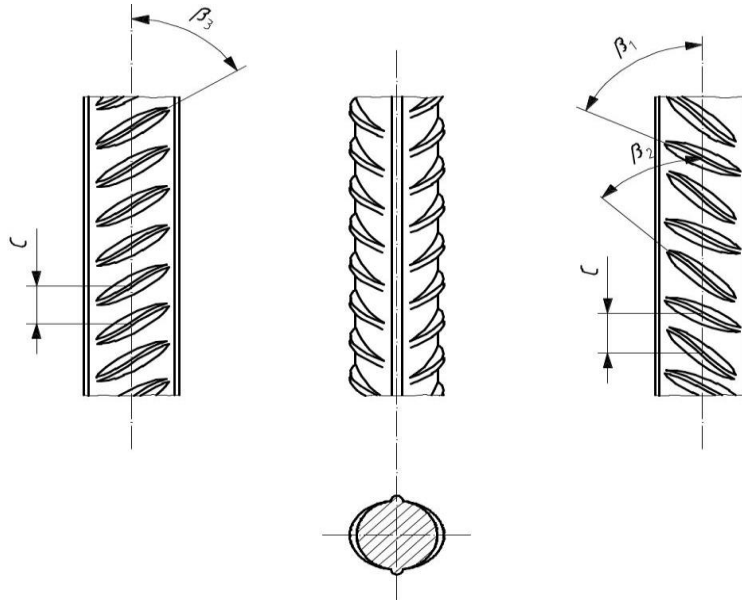


Figure 3 — Example of bar with varying rib inclinations to the longitudinal axis

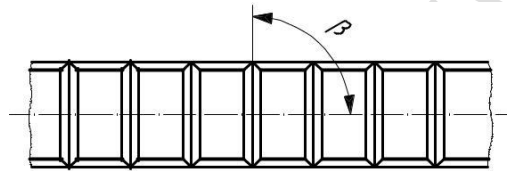


Figure 4 — Example of bar with transverse ribs of uniform height ( $\beta = 90^\circ$ )

## 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.

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

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 are given in Table 5.

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

Steel grade	C <sup>a</sup>	Si	Mn	P	S	N <sup>b</sup>	CEV <sup>a, c</sup>
B300A-R B300B-R B300C-R B400A-R B400B-R B400C-R B500A-R B500B-R B500C-R	—	—	—	0,060	0,060	—	—
B400AWR <sup>d</sup> B400BWR B400CWR B500AWR B500BWR B500CWR	0,22	0,60	1,60	0,050	0,050	0,012	0,50
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 <sup>d</sup>	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
B550DWR	0,25			0,035	0,040		
B600DWR	0,30			0,035	0,040		

<sup>a</sup> 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 %.

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

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

<sup>d</sup> 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**

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	u 0,25	+ 0,02
	> 0,25	+ 0,03
Si	u 0,60	+ 0,05
Mn	u 1,65	+ 0,06
	> 1,65	+ 0,08
P	u 0,05	+ 0,008
	> 0,05	+ 0,010
S	u 0,05	+ 0,008
	> 0,05	+ 0,010
N	u 0,012	+ 0,002

## 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 East Africa Draft Standard, 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 $R_{eH}$ N/mm <sup>2</sup>		Ductility properties		
				Specified characteristic value of $R_m/R_{eH}$	Specified characteristic value of elongation <sup>a</sup> %	
		Minimum	Maximum	Minimum	$A_5$ Minimum	$A_{gt}$ Minimum
A	B300A-R	300	—	1,02	16	2
	B400A-R B400AWR	400	—		14	
	B500A-R B500AWR	500	—			
B	300B-R	300	—	1,08	16	5
	B400B-R B400BWR	400	—		14	
	B500B-R B500BWR	500	—			
C	B300C-R	300	—	1,15	16	7
	B400C-R B400CWR	400	—		14	
	B500C-R B500CWR	500	—			
D	B300D-R	300	—	1,25	$17^b$	8
	B300DWR		$1,3 \times R_{eH}(\text{min.})$			
	B350DWR	350				
	B400DWR	400				
	B420DWR	420				
	B500DWR	500				
			$16^b$			
			$13^b$			

<sup>a</sup> By agreement between the manufacturer and purchaser, the type of elongation shall be selected between  $A_5$  and  $A_{gt}$ . If the type of elongation is not specified by agreement,  $A_{gt}$  should be used.

<sup>b</sup> 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 %.

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

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,  $A_5$ , the original gauge length shall be 5 times the nominal diameter.

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. 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.

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

Dimensions in millimetres

Nominal diameter <i>d</i>	Mandrel diameter <sup>a, b</sup> (max.)
$\leq 16$	$3d$
$16 < d \leq 32$	$6d$
$32 < d \leq 50$	$7d$
<sup>a</sup> For nominal diameters larger than 50 mm, the mandrel diameter in bend tests shall be agreed between the manufacturer and purchaser. <sup>b</sup> 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**

Dimensions in millimetres

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

## 10 Designation

Ribbed bars according to this part of East Africa Draft Standard shall be designated in the following order:

- a) reinforcing steel; denoted (B)
- b) a reference to this part of East Africa Draft Standard (e.i CD/TZ/5:2016);
- c) the nominal diameter, in millimetres, according to Table 2;
- d) the steel grade.

EXAMPLE Reinforcing steel DEAS 412-2 – 12 B500CWR

## 11 Marking

### 11 Marking

Each bar and each bundle shall be legibly and indelibly marked as follows;

Each bar shall be marked with manufacturers name or logo, steel grade and nominal diameter

Each bundle shall be marked with manufacturers name or logo, steel grade, nominal diameter and batch / cast number

Special orders bars in addition to the above marking shall bear the marking SP

## 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

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 East Africa Draft Standard (DEAS 412-2.)

### 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:

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

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



$$s_{15} = \sqrt{\frac{(x_i - m_{15})^2}{14}} \quad (3)$$

If the condition stated above is not fulfilled, the index

$$k' = \frac{m_{15} - f_k}{s_{15}} \quad (4)$$

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

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

$$m_{60} - 1,93 \times s_{60} > f_k \quad (5)$$

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 East Africa Draft Standard<sup>5</sup>. 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 East Africa Draft Standard.

#### 12.3.3 Evaluation of specified minimum/maximum values

Tests shall be carried out according to the following.

- Bars of the same cast shall constitute one group. For every 50 t or fraction thereof, one tensile test and one bend/rebend test shall be carried out for each bar diameter.
- 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.
- 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 East Africa Draft Standard are fulfilled.

#### **12.3.4 Test report**

The test report shall contain the following information:

designation of the reinforcing steel in accordance with this part of East Africa Draft Standard

- a) marking on the reinforcing steel;
- b) date of testing;
- c) mass of the test unit;
- d) test results.

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