

Prestressing steel — Part 1: General requirements

Spannstähle — Teil 1: Allgemeine Anforderungen

Armatures de précontrainte — Partie 1: Prescriptions générales

ICS:

Descriptors:

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Foreword

This document prEN 10138-1 has been prepared by Technical Committee ECISS/TC 19 “Concrete reinforcing and prestressing steels - Properties, dimensions, tolerances and specific tests”, the secretariat of which is held by DIN.

This document is currently submitted to the COCOR Vote.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, B, C or D, which is an integral part of this document.

EN 10138 is published in four parts, the other parts being:

EN 10138-2, *Prestressing steels — Part 2: Wire*;

EN 10138-3, *Prestressing steels — Part 3: Strand*;

EN 10138-4, *Prestressing steels — Part 4: Bars*.

1 Scope

This Part of this European Standard specifies general requirements for uncoated high tensile strength steel products, which are used widely for the prestressing of concrete and are also used for other tensile applications in the construction field. The standard applies only to products in the condition as supplied by the producer.

The specific requirements for technical classes (strength classes) of wire, strand and bars are given in Parts 2 to 4 of this European Standard.

NOTE Specific requirements may complement those in Parts 2 to 4 of this European Standard which may be agreed between the purchaser and the producer.

This specification may also be understood to cover other technical (strength) classes of uncoated high tensile strength steel products whose details are not stated in this specification or Annex A but whose properties and evaluation and control are carried out consistent with those specified herein.

2 Normative references

This European Standard incorporates by dated and undated reference, provisions from other publications. The normative references are cited at the appropriate places in the text and the publications are listed hereafter. For date references, subsequent amendments to or revisions of any of the publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 10016, *Non-alloy steel rod for drawing and/or cold rolling*

Part 1: General requirement;

Part 2: Specific requirements for general purposes rod;

Part 3: Specific requirements for rimmed and rimmed substitute low carbon steel rod;

Part 4: Specific requirements for rod for special applications.

EN 10020, *Definition and classification of grades of steel*

prEN 10138-2:2002, *Prestressing steels — Part 2: Wire*

prEN 10138-3:2002, *Prestressing steels — Part 3: Strand*

prEN 10138-4:2002, *Prestressing steels — Part 4: Bars*

EN 10204:1994, *Metallic products - Types of inspection documents*

EN ISO 377, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing.*

EN ISO 15630-3:2002, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 3: Prestressing steels.*

EN ISO 9001:2000, *Quality systems - Model for quality assurance in design/development, production, installation and servicing.*

3 Terms and definitions

For the purposes of this European Standard the terms and definitions given in Parts 2 to 4 of this European Standard and the following apply.

prEN 10138-1:2002 (E)

3.1

product type

specific delivery form of prestressing steel, i.e. wire, strand or bar

3.2

wire rod

hot rolled steel delivered in coils, used for cold working treatment such as wire drawing

3.3

wire

product manufactured by cold working one unit of wire rod that is in a suitable metallurgical condition for cold working and which is given a final thermo-mechanical treatment

NOTE The surface of the wire is plain or indented. It may be covered by a residue of drawing lubricant. The wire is wound into large diameter coils (see 11.3.1) or delivered in bundles of cut lengths

3.4

strand

product consisting of a number of wires spun together in the same direction and with the same lay length which is given a final thermo-mechanical treatment and is then wound into large diameter coils (see 11.3.2)

NOTE A strand may be described by the number of wires as follows:

- a) 3-wire strand: Three wires spun together over a theoretical common axis;
- b) 7-wire strand: A straight core wire around which are spun six wires in one layer;
- c) 7-wire compacted strand: 7-wire strand that has been drawn through a die, or compressed by other means, before the final thermo-mechanical treatment;
- d) Indented 3-wire strand or 7-wire strand is produced from indented wires. The central wire may be plain with no indentations.

3.5

bar

product manufactured in straight lengths in a hot rolling mill

NOTE It may be plain, deformed, threaded or present ribs or threads.

3.6

processed bar

bar treated after production by accelerated cooling, cold stretching or additional tempering, either singly or in combination

NOTE It may be plain, deformed, threaded or present ribs or threads.

3.7

unit of manufacture

quantity of product of the same nominal diameter and technical class (strength class) which is manufactured according consistent manufacturing conditions

NOTE The physical limits on unit of manufacture depends on each product type, see 8.1.3.

3.8

unit of product

quantity of product coming from a sub-division of a unit of manufacture, generally in the form as delivered to a customer

NOTE The physical limits on unit of product depends on each product type, see 8.1.3.

3.9**unit of inspection**

quantity of product coming from a unit of manufacture and presented at any one time for examination and release purposes

NOTE The physical limits on unit of inspection depends on each product type, see 8.1.3.

3.10**consignment (delivery batch)**

total amount of the product in the same delivery to a customer, which may consist of several units of manufacture

3.11**characteristic value**

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

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

3.12**inspection**

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

3.13**product family**

group of products for which the given characteristics are considered to be the same [i.e. of the same technical class (strength grade) (see Annex A)]

3.14**factory production control**

permanent internal production control exercised by the manufacturer

3.15**standard properties**

properties prescribed in this European Standard as part of the factory production control requirements for every unit of inspection and considered part of routine product testing

3.16**special properties**

properties prescribed in this European Standard which are not determined as part of the factory production control requirements for every unit of inspection and considered for special testing

3.17**maximum value**

the value which no test result shall exceed

3.18**minimum value**

the value below which no test result shall fall

3.19**production or manufacturing unit**

the site at which the product test properties under measurement are produced by processing

3.20**testing laboratory**

laboratory carrying out the various tests required to evaluate the products

NOTE It may be located at the manufacturer's production area, located on the manufacturer's site or located remote to the manufacturer's site independent to the manufacturer and considered impartial.

3.21 technical class

Products of the same type and family having the same strength. Their surface configuration may vary :e.g. plain or indented.

4 Symbols

The symbols used in this Part of this European Standard and the corresponding designations are given in Table 1.

Table 1 — Symbols and corresponding designations

Symbol	Units	Designation
α	%	Statistically reliable failure rate .
d	mm	Nominal diameter of the product
S_n	mm ²	Nominal cross-sectional area of the product
M	g	Nominal mass per metre of the product
F_m	kN	Specified characteristic value of maximum force
$F_{m, max}$	kN	Specified maximum value of maximum force
$F_{p0,1}$	kN	Specified characteristic 0,1 % proof force
A_{gt}	%	Specified minimum value of percentage total elongation at maximum force
F_{ma}	kN	Actual maximum force, in the tensile test, determined on a test piece adjacent to the test piece submitted to special property test
F_{up}	kN	Upper force in the axial load fatigue test
F_r	kN	Fluctuating force range in the axial load fatigue test
f	Hz	Frequency of load cycles in the axial load fatigue test
D	%	Maximum permitted value of the average coefficient of reduction of the maximum force in the deflected tensile test
m_r	kN	Average value of the test results for maximum force or 0,1 % proof force
k		Coefficient function of the number of test results
n		Number of test results for maximum force or 0,1 % proof force

s	kN	Estimated standard deviation of the test results for maximum force or 0,1 % proof force
C_V	kN	Specified characteristic value for maximum force or 0,1 % proof force
m	g	Mass of the test piece

5 Classification and designation

5.1 Classification

All steels covered by this European Standard are classified as special steels according to EN 10020.

5.2 Designation

The products covered by this European standard shall be designated in the following sequence:

- a) description of the product type, i.e. wire, strand, bar;
- b) the number of this European Standard;
- c) the details concerning the nominal geometrical properties and the technical class.

NOTE These details may be replaced by the designation of the product as given in Parts 2 to 4 of this European Standard.

6 Information to be supplied by the purchaser

The following information shall be supplied by the purchaser at the time of enquiry and order:

- a) designation of the product in accordance with 5.2;
- b) the packaging and protection requirements and in the case of products supplied in bundles the maximum mass of the individual bundle;
- c) the requirements concerning documentary information to accompany the delivery (e.g. delivery certificate, type and content of inspection document, copies of force/extension diagrams);
- d) special requirements for labelling;
- e) nominal depth of indentations for indented wire.

7 Requirements

7.1 General

7.1.1 Steelmaking Processes

The steel may be made by any process except that air or mixed air-oxygen bottom blown processes shall not be used.

7.1.2 Primary Incoming materials

The primary products (billets, wire rod) shall be manufactured according to 7.1.1 and associated processes, which will ensure products fully conforming to requirements. The wire rod shall conform to the appropriate part of EN 10016.

7.1.3 Freedom from defects

The finished product shall be free from any defects likely to impair its performance.

Products with rusted steel shall not be supplied unless the rust is a thin film. The underlying steel surface shall appear to be smooth to the unaided eye. Bars may be covered by a layer of scale.

7.1.4 Welds

Wire and bars shall contain no welds in the product as supplied by the manufacturer. Strands with normal production lengths may contain welds made in the individual wires before cold working, but shall not contain any welds made during or after cold working.

7.2 Standard properties

7.2.1 Geometrical properties

The geometrical properties shall be defined by a nominal diameter (d), a nominal cross-sectional area (S_n) and a nominal mass per metre (M) and for indented wire and strands, the nominal dimensions of indentations, for strands, the lay length, and for bars the nominal dimensions of ribs or threads. The admissible deviations from the nominal mass per metre shall be:

- for wire and strands: $\pm 2\%$;
- for bars: $- 2\%$, $+ 6\%$.

The requirements for the surface configuration of the product and the product straightness shall be as given in the relevant Part of this European Standard.

7.2.2 Standard mechanical properties

The standard mechanical properties are:

- the maximum force (F_m);
- the 0,1% proof force ($F_{p0,1}$);
- the total percentage elongation under maximum force (A_{gt});
- the ductility properties appropriate to the product type (i.e. percentage reduction of area, resistance to reverse bending and /or bending).

The specified values of the standard mechanical properties for technical (strength) classes shall be as specified in Parts 2 - 4 of this European Standard.

Tensile properties shall be recorded as force in force units. Where stress is used for designation purposes, calculation of stress shall be based on the actual cross-sectional area of the product.

7.2.2.1 The specified maximum force is the specified characteristic value of maximum force (F_m).

7.2.2.2 The maximum value of maximum force ($F_{m,max}$) shall not be greater than 1,15 times the specified maximum force (F_m).

7.2.2.3 The specified proof force value is the specified characteristic 0,1 % proof force ($F_{p0,1}$).

7.2.2.4 The specified minimum value of percentage total elongation at maximum force (A_{gt}) shall not be lower than 3,5 %.

7.2.2.5 The prestressing steel shall be proved to have suitable ductility by means of the test(s) applicable to the specific product type.

These tests shall be:

- for wires, the reverse bend test and examination of the constriction at break;
- for strand, examination of the constrictions at break and deflected tensile test for strands $\geq 12,5$ mm nominal diameter;
- for bars, the bend test.

7.3 Special properties

The special properties of prestressing steels are: isothermal relaxation, fatigue behaviour, deflected tensile and stress corrosion resistance.

These shall be the subject of periodic testing.

7.3.1 Isothermal stress relaxation

Curves for relaxation of force shall be established, at a nominal temperature of 20 °C, for a period of 1000 h from an initial force of 70 % of the actual maximum force (F_{ma}), in the tensile test, determined on an adjacent test piece.

NOTE If verification of established values is required, tests of 120 h from an initial force of 70 % of actual maximum force (F_{ma}), extrapolated to 1000 h may be accepted, provided that proof of a satisfactory correlation between 1000 h tests and extrapolation of 120 h tests can be demonstrated.

7.3.2 Fatigue behaviour

Products intended for use as prestressing steels shall withstand without failure two million load cycles under conditions of stable upper force (F_{up}) and frequency (f) where the stable upper force is defined by 80% of the actual maximum force (F_{ma}) determined in a tensile test on a contiguous test piece. The fluctuating force range (F_r) shall not be less than the values specified in Table 2.

Table 2 — Fluctuating force ranges for various types of prestressing steels in the axial load fatigue test

Product	Fluctuating force range, F_r kN	
Plain wire	$200 \times S_n$	
Indented wire	$180 \times S_n$	
Plain strand	$190 \times S_n$	
Indented strand	$170 \times S_n$	
Plain bars	$200 \times S_n$	
Ribbed bars	$180 \times S_n$	

7.3.3 Deflected tensile behaviour

The maximum permitted deflection percentage reduction value (D) for all strands with nominal diameter $\geq 12,5$ mm shall be equal to or lower than the value specified in Table 3 of prEN 10138-3:2002.

7.3.4 Stress corrosion resistance

The minimum individual and median values of life-time to failure shall be determined using the solution A of thiocyanate specified in EN ISO 15630-3:2002 . These values shall not be less than the values specified in prEN 10138-2 to 4:2002.

Note An alternative stress corrosion test regime is defined in Annex B

8 Evaluation of conformity

NOTE In conjunction with this clause, Annex ZA has to be taken into account on attestation of conformity.

8.1 Factory production control

8.1.1 General

Prestressing steels according to this European Standard shall be produced under a permanent system of factory production control which shall ensure the same level of confidence in the conformity of the finished product, whatever the manufacturing process.

The system of factory production control shall include evaluation of property requirements given in 8.1.3.

Manufacturers which have a factory production control system which meets the requirements of EN ISO 9001 and addresses the requirements of this European Standard are recognized as satisfying the factory production control requirements of this standard.

8.1.2 Purchased materials

Material purchased for further processing from a supplier whose factory production control system satisfies the relevant requirements of this European Standard should be considered satisfactory with no further work.

Manufacturers purchasing materials from suppliers whose factory production control system is not certificated to the relevant requirements of this European Standard should ensure confidence in the resulting finished product by the following:

- a) inspection of the incoming material appropriate to the form of this material;
- b) testing of the finished product at a frequency greater than three times that described in Tables 3, 4 or 5 dependent on the final product. This frequency may be reduced if the factory production control procedures of the manufacturer result in the level of confidence described in the earlier paragraphs of this section.

8.1.3 Sampling and testing

8.1.3.1 Units of manufacture, units of product, units of inspection

Definitions are illustrated in a tabular form in table 3

8.1.3.1.1 Wire

The unit of manufacture is the product from one rod coil. .

NOTE It is either the unit of manufacture or a smaller coil cut from a unit of manufacture.

The unit of product is the coil of wire or bundle of lengths as delivered to the customer.

Cut lengths in a bundle shall come from the same steel heat or cast.

The unit of inspection shall be composed of all units of manufacture from the same heat or cast manufactured at any one time.

8.1.3.1.2 Strand

The unit of manufacture is the product of one set of coils of wire placed in the stranding machine.

NOTE Such a unit of manufacture is often designated as mother coil.

The unit of product is the coil of strand as delivered to the customer.

The unit of inspection shall be composed of all units of product coming from the same unit of manufacture.

8.1.3.1.3 Bar

The unit of manufacture is the quantity of bars of the same nominal diameter and technical class from the same cast or heat manufactured at any one time.

The unit of product is 5 tons of bars coming from a unit of manufacture.

The unit of inspection shall be composed of the unit of manufacture.

Table 3 — Definition of unit of manufacture, unit of product and unit of inspection

Type of product	Unit of manufacture	Unit of product	Unit of delivery	Unit of inspection
Wire	A coil of wire produced from one coil of rod	For coils ; the unit of manufacture For cut lengths ; a bundle or bundles from one unit of manufacture	The unit of product or smaller wire coils cut from the unit of product For cut lengths a bundle or bundles from one unit of manufacture	All the units of products coming from the same cast or heat of steel.
Strand	A mother strand coil	All the coils cut from a single mother coil	The unit of product	All the units of products coming from the same unit of manufacture
Bars	Bars of the same nominal diameter and the same cast of steel.	5 tonnes of bars in a unit of manufacture	Bundles of bars of the same unit of manufacture	All the units of products from the same cast of steel

8.1.3.1.4 Frequency of sampling and inspection for factory production control

The finished product shall be sampled and tested in accordance with Tables 4 ,5 and 6 for wire, strand and bar respectively.

Table 4 — Frequency of sampling and testing for factory production control of wire

Property	Frequency of sampling and testing
Maximum force Inspection of visible tensile test fracture ^a Diameter (for plain wire) Cross-sectional area (for indented wire)	One test every unit of manufacture
0,1% proof force Total percentage elongation at maximum force Reverse bending	One test every 5 units of manufacture
Straightness	One test every 10units of manufacture
Indentation depth (Indented wire only)	One test every 10 units of manufacture
a In case of doubt about the type of rupture the percentage of reduction in area shall be checked.	

Table 5— Frequency of sampling and testing for factory production control of strand

Property	Frequency of sampling and testing
Maximum force 0,1 %proof force Total percentage elongation at maximum force Straightness Inspection of visible tensile test fracture ^a Indentation depth (Indented strand only)	Two tests from the beginning and end of the unit of inspection and one further test at an intermediate point if the number of units of product is greater than 2
Mass per metre Lay length	One test per unit of inspection
Diameter relationship core to outer wires (plain and indented strands only)	One test per unit of inspection
a In case of doubt about the type of rupture the percentage of reduction in area for individual wires shall be checked.	

Table 6— Frequency of sampling and testing for factory production control of bars

Property	Frequency of sampling and testing
Cross-sectional area Maximum force 0,1 % proof force Rib or thread height Total percentage elongation at maximum force Inspection of visible tensile test fracture ^a	One test per unit of product
Bend test on a 10 <i>d</i> mandrel Straightness	One test in three units of product
a In case of doubt about the type of rupture the percentage of reduction in area shall be checked.	

8.1.3.2 Evaluation of test results of a unit of inspection

The unit of inspection shall be deemed to comply with the requirements of this European Standard if all the results of tests are greater than or equal to the specified value for the mechanical properties (except maximum value of maximum force) and within the tolerances for maximum force and the geometrical properties. If these conditions are not met then the following procedure shall apply:

- 1) When one or more results for maximum force and/or 0,1% proof force are below the corresponding specified value(s) all units not initially tested in the unit of inspection shall be tested. The mean value of all individual results from the unit of inspection for either parameter shall be calculated. The unit of inspection shall be deemed to comply with this standard requirements if the mean values calculated are equal to or greater than the respective specified values. See Figure 1.
- 2) When results for other properties specified by a minimum and or a maximum value do not conform to specifications then two additional samples shall be taken from the unit of product concerned by each failed result and these shall be tested for the property concerned. If the two additional results conform to the specification then the unit of product shall be deemed to conform to this standard.

If one or more of these additional tests does not conform to the specifications the unit of product concerned shall be rejected. And all units of product from the last good result until the next good result shall be tested for the defective properties with the exception where the deficiency relates to the maximum of the maximum force.

All units of product with non conforming results shall be rejected and the producer shall immediately take measures to determine the reason and rectify any faults.

8.1.3.3 Assessment of the long term quality level

The results of tests on all units of inspection of the continuous production shall be collated product per product and statistically evaluated for maximum force and 0,1 % proof force using data based on a 6 months operation (or a 12 months operation if the production quantity is limited and the number of values is below 60).

The following requirement shall be satisfied for maximum force and 0,1% proof force : $m - ks \geq C_V$

NOTE The specified characteristic value is a 5% fractile.

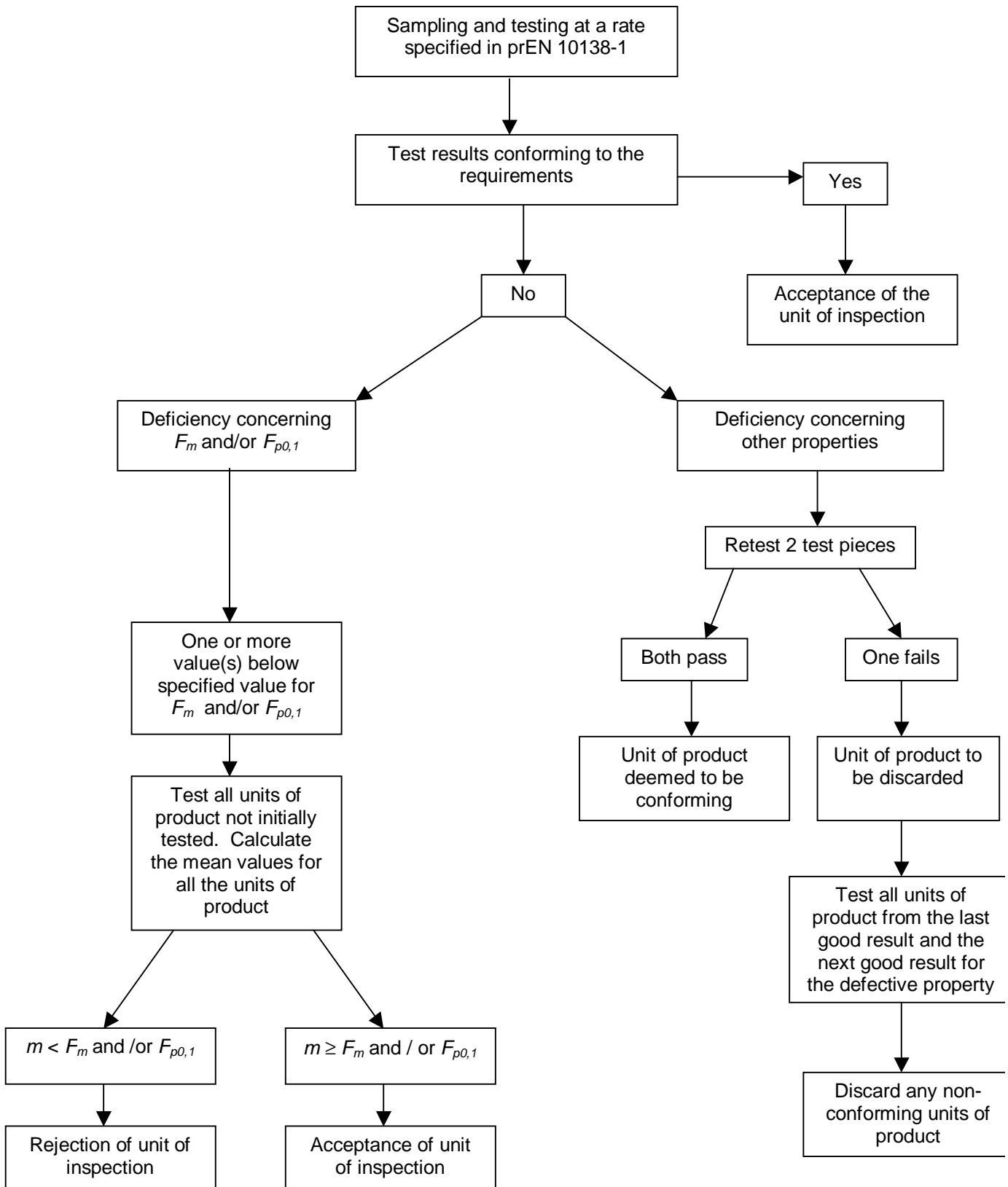


Figure 1 — Evaluation of tests results and a unit of inspection testing route

Table 7 — Coefficient *k* as a function of a number (*n*) of the test results for a reliable failure rate of 5% ($p=0,95$) at a probability of 95%

<i>n</i>	<i>k</i>	<i>n</i>	<i>k</i>
5	4,21	30	2,22
6	3,71	40	2,13
7	3,40	50	2,07
8	3,19	60	2,02
9	3,03	70	1,99
10	2,91	80	1,97
11	2,82	90	1,94
12	2,74	100	1,93
13	2,67	150	1,87
14	2,61	200	1,84
15	2,57	250	1,81
16	2,52	300	1,80
17	2,49	400	1,78
18	2,45	500	1,76
19	2,42	1 000	1,73
20	2,40		

The foregoing is based on the assumption that the distribution of a large number of results is normal. However, it is not a requirement of this standard that the distribution is normal.

8.2 Initial type testing

For each product family where there is a range of sizes the sampling shall include the extreme sizes of the dimensional range for test.

NOTE Annex A gives the list of product families available at the time of issue of this standard.

The samples to be taken per size shall permit the determination of geometrical properties, standard mechanical properties and special properties. Sampling shall permit witness testing in the manufacturer's testing laboratory and testing by an impartial testing laboratory, with retests on any invalid results due to inappropriate testing procedure where necessary.

Where a number of sizes in a product family are submitted for test and one or more of the sizes does not acquire the required values then only the sizes which do pass the test shall be certified. If these constitute a size range then only this limited size range shall be certified.

Where a manufacturer wishes to increase the size range of his approved products, (i.e. because of previous failures or a change to manufacturing ability) the upper and lower limits of the extended range of sizes shall be selected for test.

The samples shall be taken as random samples from the production material presented for testing. Care should be taken to ensure that the samples genuinely reflect the properties of the products to be tested. Two samples shall be taken from each of four units of products from each of two heats, i.e. a total of sixteen samples. Any sample preparation shall be in accordance with EN ISO 377.

For a product family, the type and number of initial tests to be carried out shall be in accordance with Table 8.

Table 8 — Type and number of tests for the initial type testing

Frequency	Type and number of tests				
	Geometrical and mechanical properties	Special properties			
		Stress-relaxation	Fatigue resistance	Deflective tensile behaviour ^a	Stress-corrosion resistance
Once for each selected dimension	16 tests (2x4 per heat)	2 tests (1 per heat)	6 tests (3 per heat)	2 tests series (1 per heat)	2 test series (1 per heat)
^a Only for 7-wire strand and 7-wire compacted strand with a nominal diameter $\geq 12,5$ mm.					

8.3 Continuous Surveillance

8.3.1 General

The purpose of continuous surveillance is to:

- confirm that the system of factory production control continues to comply with the requirements of 8.1;
- select samples for audit testing according to Table 8.

Table 9 — Type and number of tests for the continuous surveillance

Frequency	Type and number of tests				
	Geometrical and mechanical properties	Special properties			
		Stress-relaxation	Fatigue resistance	Deflective tensile behaviour ^a	Stress-corrosion resistance
Yearly for each product type	8 tests	1 test	1 test	1 test series	1 test series
^a Only for 7 wire strand and 7 wire compacted strand with nominal diameter ≥ 12,5 mm.					

8.3.2 Audit testing

All properties (geometrical, mechanical and special) shall be tested by taking samples of the products at the factory as indicated in Table 9.

These tests are carried out on one product family taken at random per product type. Where several product families of a product type are produced, the sampling shall be done in such a way to cover all product families in not more than 5 years.

9 Evaluation, reporting and action

The results of the manufacturer long term quality level assessment shall be evaluated every six months.

The result of continuous surveillance shall be recorded in a supervision report, which shall be produced within a period of 6 weeks after the inspection.

If the results show that the production does not conform to the requirements, appropriate measures shall be taken. The measures will depend on the type and significance of the deficiencies noted but shall include:

- a) intensification of supervision (increase the frequency of testing);
- b) suggestion to change the conditions of production.

10 Test methods

Test methods for specified tests shall be in accordance with prEN ISO 15630-3:2001.

NOTE Where the actual cross-sectional area is required, this shall be obtained by taking a test piece of suitable length, measured to an accuracy of 3 significant figures. The mass (*m*) of the test piece shall be determined to the nearest 1 g for *m* ≥ 500 g and to the nearest 0,1 g for *m* < 500 g.

Using the equation:

$$\text{area (mm}^2\text{)} = \frac{\text{mass (g)}}{\text{length (m) x density (kg/dm}^3\text{)}}$$

11 Delivery conditions

11.1 Identification

Each coil or bundle of wire or strand or quantity of bars shall carry a label giving:

- a) the designation of the product given in Parts 2 – 4 of this European Standard;
- b) the coil number or bar batch number;
- c) the manufacturer's name and plant;
- d) specific agreed requirements according to 6 b and d.

11.2 Delivery documentation

Each consignment shall be accompanied by documentation containing:

- a) all the information necessary to identify the units of product within the consignment;
- b) an inspection certificate type 3.1B in accordance with EN 10204:1994;
- c) all information previously agreed with the purchaser see 6c.

NOTE Specific documentary information to accompany the delivery should be as previously agreed (i.e. delivery certificate, type and content of inspection document, copies of force/extension diagrams etc.)

11.3 Dimensions and mass of unit of product

11.3.1 Wire

The mass of a unit of product shall not exceed 2,5 t.

Where the product is supplied in coil form the diameter of the coil shall be at least 150 times the nominal diameter.

Where the product is supplied in straight lengths the maximum mass of the bundles shall be agreed at the time of ordering with the purchaser.

11.3.2 Strand

The mass of a unit of manufacture shall not exceed 24 t.

Where the product is supplied in coil form the diameter of the coil shall be not less than 50 times the strand nominal diameter for 7-wire strand or 75 times the strand nominal diameter for 3-wire strand.

Where the product is supplied in straight lengths the maximum mass of the bundle shall be shall be agreed at the time of ordering with the purchaser.

11.3.3 Bar

The mass of the unit of manufacture shall not exceed 50 t.

The dimensions of a product supplied in straight lengths shall be agreed at the time of ordering with the purchaser.

11.4 Packaging and handling

Where the product is supplied in a coil form then coils shall be formed in such a way that the material is held firmly by restraining bands or ties. In case of reopening the coils special caution shall be taken to contain the energy contained to avoid personal injuries.

Where the product is supplied in straight lengths then the material shall be held firmly by retaining ties and adequately supported to avoid any degradation of straightness.

Packaging for all products shall be selected to ensure no damage or collapse occurs during transportation. Agreements between suppliers and customers, at the time of purchase may be made to define particular conditions of packaging consistent with the likely conditions to be encountered by the products before application. (i.e core, packing paper, paperboard, protection by water soluble oil film etc.)

11.5 Transport and storage

Prestressing steels in transport and storage shall be protected against damage and contamination, particularly from substances or liquids, which are likely to produce or encourage corrosion.

Annex A

Product families (normative)

Table A.1 defines the product families for products defined in Parts 2— 4 of this European Standard.

Types of prestressing steel	Product family Number	Products in the product family		Surface Configuration		
		Steel name	Nominal diameter (mm)	Plain..	Indented..	Ribbed
Cold drawn wire	1	Y1860 C	3,0-4,0-5,0	X	X	
	2	Y1770C	3,0-3,2-4,0-4,5-5,0-5,5-6,0	X	X	
	3	Y1670C	5,0-5,5-6,0-6,5-6,9-7,0-7,5-8,0	X	X	
	4	Y1570C	7,0-8,0-8,5-9,4-9,5-10,0-10,5-11,0	X	X	
3-wire strand	7	Y1960S3	4,8-5,2-6,5	X	X	
	8	Y1860S3	4,5-4,85-6,5-6,8-7,5-8,6			
	5	Y2160S3	5,2-6,85	X	X	
	6	Y2060S3	5,2			
7-wire strand	12	Y1860S7	6,9-7,0-8,0-9,0-9,3-9,6-11,0-11,3-12,5-12,9- 13,0-15,2-15,7-16,0	X	X	
	13	Y1770S7	6,0-9,0-9,3-9,6-11,0-12,5-12,9-15,2-15,3-15,7-16,0-17,7-18,0			
	9	Y2160S7	6,85			
	10	Y2060S7	6,4-6,85- 7,0 - 8,6-11,3	X	X	
	11	Y1960S7	6,85- 9,0- 9,3			
	18	Y1670S7	15,2			
7-wire strand compacted	14	Y1860S7G	12,7-15,2	X		
	15	Y1820S7G	15,2			
	16	Y1700S7G	18,0			
Bars	18	Y1100H	15,0 and 20,0	X		X
	19	Y1030H	25,0-26,5-32,0-36,0-40,0-50,0-75,0			
	17	Y1230H	26,0 to 40,0			

Other product families based on steel name and/or nominal diameter are permitted in addition to those listed in table A1.

Annex B (normative)

Alternative test procedures for stress corrosion

Stress corrosion resistance:

Where required the alternative test solution B defined in EN ISO 15630-3:2002 shall be used for initial type testing only. In this case the time of the test procedures applied shall be as indicated in the Annex in parts 2, 3 and 4 of this European Standard.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives.

ZA.1 General

This European standard has been prepared under mandate M115 given to by [CEN] by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 89/106/EEC.

WARNING : Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

The clauses of this Part of this European Standard, shown in Table ZA.1, meet the requirements of the mandate given under the EU Construction Products Directive (89/106).

Compliance with these clauses confers a presumption of fitness of the construction products covered by the European Standard for its intended use(s).

Construction product(s): Prestressing steel in wire, strand, bar.

Intended uses: Concrete structures

Table ZA.1 — Clauses of this European Standard addressing the provisions of EU Construction Products Directive

Requirement/Characteristic from the mandate	Requirement clause(s) in this or other European Standard(s)
Stress ratio (ultimate tensile strength/tensile yield strength)	7.2.2.1 (maximum force)
Tensile yield strength	7.2.2.3 (0,1 % proof force)
Elongation at maximum force	7.2.2.4
Relaxation	7.3.1
Sections and tolerances on sizes	7.2.1
Surface geometry	7.2.1
Fatigue	7.3.2.1
Durability	7.3.4 (stress corrosion resistance)

ZA.2 Procedure(s) for the attestation of conformity of products

ZA.2.1 For the products and intended uses listed below, the system of attestation of conformity shall be in accordance with Table ZA.2.

Table ZA.1 — Products, intended uses and attestation of conformity system

Products	Intended use(s)	Attestation of conformity system(s)
<p>Prestressing steel products</p> <p>-wires (stress relieved cold drawn wires, smooth wires, indented wire)</p> <p>-strands(multi-wire strands, multi-wire compacted strands, indented and high bond strand)</p> <p>-bars (hot rolled and processed bar threaded bars, ribbed or plain or smooth bars)</p>	used for the prestressing of concrete	1+ ^a
<p>^a System 1+ : See CPD Annex III.2.(i) with audit testing of samples taken at the factory</p>		

ZA.2.2 For products under system 1, regarding the initial type testing of the product (see Annex III.1.a of the CPD), the task for the laboratory shall be limited to the assessment of the following characteristics:

- maximum force;
- 0,1% proof force;
- D value in the deflected tensile test (for strands with nominal diameter $\geq 12,5$ mm);
- elongation at maximum force;
- relaxation;
- stress corrosion resistance;
- sections and tolerances on sizes;
- surface geometry;

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- modulus of elasticity;
- fatigue.

ZA.2.3 For products under systems 1, for the continuous surveillance, assessment and approval of the factory production control [see Annex III.1.g of the CPD], parameters related to the following characteristics shall be of the interest of the notified body ¹⁾:

- maximum force;
- 0,1 % proof force;
- D value in the deflected tensile test. (for strands with nominal diameter $\geq 12,5$ mm);
- elongation at maximum force;
- relaxation;
- stress corrosion resistance;
- sections and tolerances on sizes;
- surface geometry;
- modulus of elasticity;
- fatigue.

ZA.2.4 Methods of test

The methods of test shall be those defined on section 10 of this standard.

ZA.2.5 For the initial inspection of the factory and of the factory production control (see Annex III.1.f of the CPD), parameters related to all the relevant characteristics shall be of interest to the notified body.

ZA.3 Procedure for conformity

ZA.3.1 General

The procedure for conformity of the product(s) covered by this European Standard shall be addressed according to the certification procedure described in ZA.3.2.

ZA.3.2 Certification procedure

Assessment of the producer's system of factory production control and the resultant product produced in accordance with this European Standard, which includes external supervision and testing, shall be carried out by the notified body acting either with its own resources or with inspection bodies or testing laboratories authorised by it. Certification for production of product meeting the requirements of this European Standard shall be given for a product family with defined diameters after the steps described in ZA.3.3 and ZA.3.4 and Figure ZA.1 have been taken.

¹⁾ In this case the notified body.

ZA.3.3 Application

An application for approval shall be made by the manufacturer to the notified body which shall be accompanied by a technical file, setting out the manufacturing processes and methods and a quality manual, setting out the general policies, procedures and practices of the manufacturer.

ZA.3.4 Initial assessment

The initial assessment shall be performed by the notified body. This shall consist of initial type testing of the products described in this European Standard and an assessment of the manufacturer's system for factory production control. This shall include sampling and testing of the product as described in clause 8.2. The samples shall be taken in the presence of the notified body. Geometrical and mechanical properties shall be assessed by both the manufacturer and an impartial laboratory. Special properties shall be assessed by an impartial laboratory.

NOTE When agreed with the notified body independent testing for special properties may be carried out in the manufacturer's laboratory under the supervision of the notified body.

Successful performance in the initial assessment shall result in certification of the product or product range(s) of the manufacturer.

ZA.3.5 Continuous surveillance and audit testing

Continuous surveillance inspections and audit testing shall be performed by the notified body which shall act to ensure on-going compliance of the system of factory production control and of the product in accordance with this European Standard. These inspections shall include sampling and testing of the product as described in 7.3.2. The provisions given in ZA.3.4 apply to these tests. Maintenance of approval shall be subject to:

- d) Continued satisfactory operation of the system of factory production control as verified by the notified body at the initial assessment;
- e) Continued production of the product(s) described in this European Standard in the product families covered by the certification.

Continuous Surveillance inspections shall be performed twice a year. This frequency may be increased if necessary in accordance with 8.1 (see also Parts 2 – 4 of this European Standard).

ZA.3.6 Re-assessment and renewal of certification

The duration of certification, based on satisfactory maintenance of approval as described in ZA.3 shall be for a period of 5 years from the issue of the certificate. After this period the manufacturer's system of factory production control shall be subject to a re-assessment which shall include all elements of the system at this stage. Sampling and testing of the product at this stage shall be at the continuous surveillance level described in 8.3. Renewal of certification will be subject to compliance with the requirements of ZA.3. Re assessment due to initial failure by the manufacturer to obtain certification of the full product range offered for original assessment or when certification of an extension of the manufacturing range is sought shall be by request of the manufacturer.

ZA.4 CE marking and labelling

The CE marking and the accompanying information shall be placed on a label firmly attached to each unit of delivery.

The CE marking shall include the identification number of the notified body.

The information which accompanies the CE marking shall consist of:

- f) the name and address of the producer;

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- g) the last two digits of the year in which the marking was affixed;
- h) the number of the EC certificate of conformity;
- i) the reference to this European Standard i.e. EN 10138-1 and:

either

— the designation of the product in accordance with the relevant Part of this European Standard, when the product complies with the requirements of one of the technical (strength) classes defined in Parts 2 – 4 of this European Standard (see example 1);

or

— the description of the product form and the nominal dimensions of the product followed by, for all the relevant performance characteristics in table ZA.1, successively the symbols of the property, the test result obtained on the relevant test unit and the corresponding specified value, when it is not referred to technical (strength) classes (see example 2).

NOTE If more than one value is obtained for the test unit, the mean value shall be indicated.

EXAMPLE 1:

CE 0123
Any Co. Ltd. PO Box 23 B-1070 99 0123-CPD-0001
EN 10138-1 Strand -EN 10138-3 – Y1860S7-16,0

EXAMPLE 2:

CE 0123
Any Co. Ltd. PO Box 23 B-1070 99 0123-CPD-0001
EN 10138-4 Plain Bar -25 x 14000 F_m : 550 kN(500 kN) $F_{p0,1}$: 430 kN(400 kN) A_{gt} : 5,2% (3,5%) Ductile Break Mass deviation : +2,3% (-2% ; +6%) Relaxation : 3,2% (4%) Fatigue : Pass Stress Corrosion : min 80h(60h) median 300h (250h)

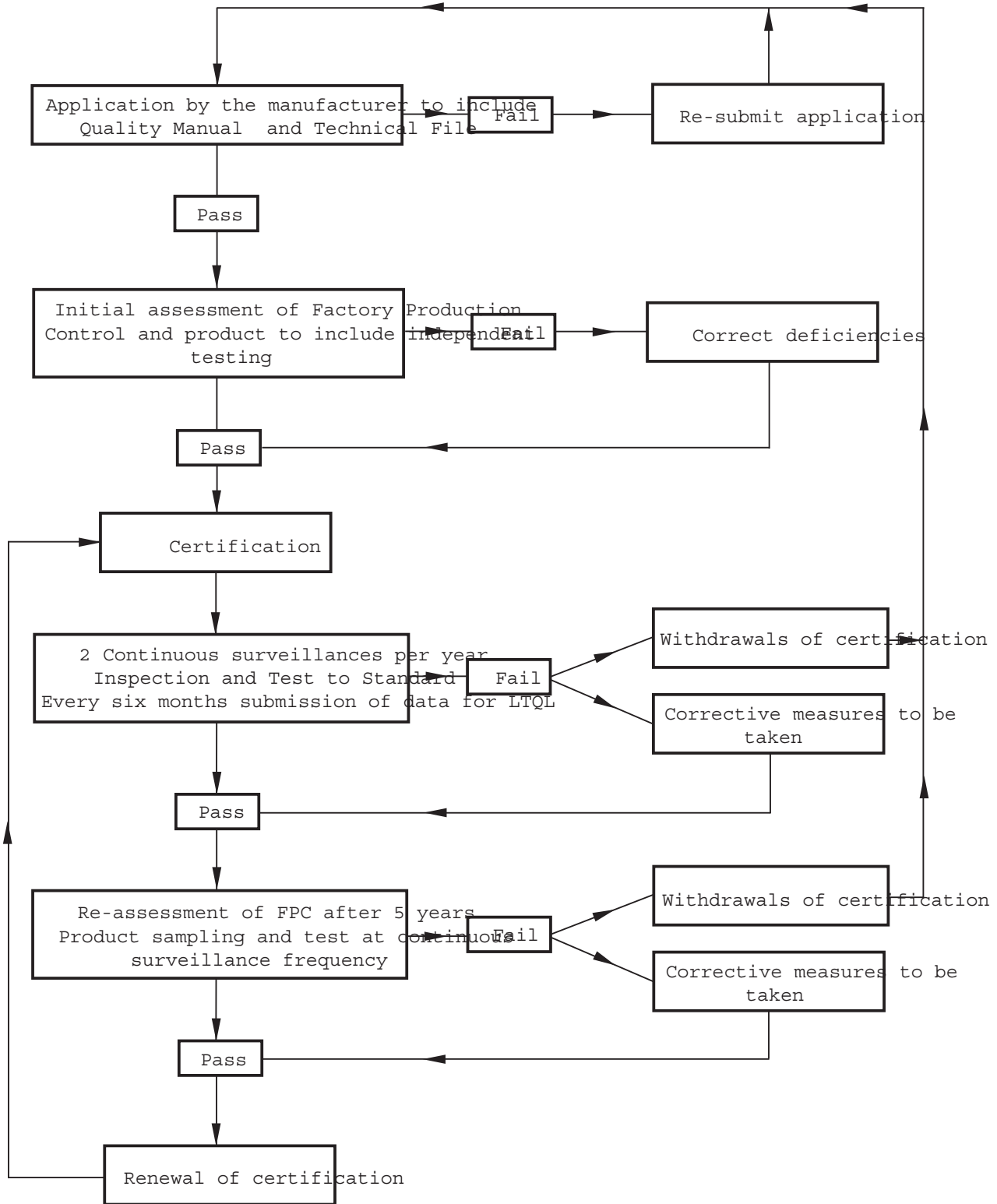


Figure ZB.1 — Certification procedure

Öngörme çelikleri – Bölüm 2: Tel

Spannstähle — Teil 2: Draht

Armatures de précontrainte en acier — Partie 2 : Fils

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Önsöz

Bu belge prEN 10138-2, sekretaryası DIN tarafından tutulan Teknik Komite ECISS / TC 104 "Beton takviye ve öngerme çelikleri" tarafından hazırlanmıştır..

Bu belge şu anda CEN Soruşturmasına gönderilmektedir.

Bu belge şu anda Resmi Oylamaya sunulmuştur.

Bu Avrupa Standardı, Öngerme çelikleri genel başlığı altında aşağıdaki bölümlerden oluşur::

- Bölüm 1: Genel gereksinimler;
- Bölüm 2: Tel;
- Bölüm 3: Strand;
- Bölüm 4: Bar.

1 Kapsam

PrEN 10138'in bu Bölümü, düz veya nervürlü gerilim giderilmiş soğuk çekilmiş yüksek gerilimli çelik telin teknik (mukavemet) sınıfları için özel gereksinimleri belirtir.

Düzleştirilmiş ve gerilimi giderilmiş ve daha sonra bobin şeklinde veya kesilmiş uzunlukta demetler halinde tedarik edilen tellere uygulanabilir.

NOT Genel gereksinimler prEN 10138-1'de verilmiştir.

2 Referans dökümanlar

Aşağıdaki atıfta bulunulan belgeler, bu belgenin uygulanması için zorunludur. Tarihli referanslar için sadece alıntı yapılan baskı geçerlidir. Tarihsiz referanslar için, atıfta bulunulan belgenin son baskısı (herhangi bir değişiklik dahil) geçerlidir.

EN 10027-1, Çelikler için gösterim sistemleri - Bölüm 1: Çelik isimleri

EN 10027-2, Çelikler için gösterim sistemleri - Bölüm 2: Sayısal sistem

prEN 10138-1, Öngerme çelikleri - Bölüm 1: Genel gereksinimler

EN ISO 15630-3, Betonun güçlendirilmesi ve ön gerilmesi için çelik - Test yöntemleri - Bölüm 3: Öngerme çeliği

EN ISO 16120-1, Tele dönüştürme için alaşımsız çelik filmaşın - Bölüm 1: Genel gereksinimler

EN ISO 16120-2, Tele dönüştürme için alaşımsız çelik filmaşın - Bölüm 2: Genel amaçlı filmaşın için özel gereksinimler

EN ISO 16120-4, Tele dönüştürme için alaşımsız çelik filmaşın - Bölüm 4: Özel uygulamalar için filmaşın için özel gereksinimler

ISO 7801, Metalik malzemeler - Tel - Ters bükme testi

3 Terimler ve tanımlar

Bu belgenin amaçları doğrultusunda, prEN 10138-1'de verilen terimler ve tanımlar ve aşağıda geçerlidir.

3.1

Nervür uzunluğu, l
tel eksenini yönünde ölçülen bireysel nervürlerin uzunluğu

3.2

Nervür derinliği, amax
tel yüzeyinden radyal olarak ölçülen maksimum bireysel nervür derinliği

3.3

Nervür aralığı, c
tel eksenini yönünde ölçülen (veya alınan) iki ardışık nervürün merkezi arasındaki mesafe

NOT Şekil 1 ve 2'ye bakın.

3.4

Nervür mesafesi, e
iki bitişik nervür satırı arasındaki ortalama boşluk

NOT Şekil 2 ve 4'e bakın.

3.5

ortalama çap
Biri muayene ile bulunan maksimum çap olmak üzere iki dikey yönde ölçülen çapların ortalaması

3.6

ovallık
herhangi bir bölümdeki maksimum ve minimum çaplar arasındaki fark

4 Semboller

PrEN 10138'in bu Bölümünde kullanılan semboller ve ilgili gösterimler Tablo 1'de verilmiştir..

Tablo 1 - Semboller ve ilgili gösterimler

Sembol	Birim	Tanım
a_{max}	mm	Nervür derinliği
c	mm	Nervür boşluğu
l	mm	Nervür boyu
d	mm	Ürünün nominal çapı
S_n	mm ²	Ürünün nominal kesit alanı
m	g/m	Ürünün nominal birim ağırlığı
F_m	kN	Maksimum kuvvetin belirtilen karakteristik değeri
$F_{m, max}$	kN	Maksimum kuvvetin belirtilen maksimum değeri
$F_{p0,1}$	kN	% 0,1 uzamadaki kuvvetinin belirtilen karakteristik değeri
σ	—	Gerilme oranı - nihai çekme dayanımının gerilme akma dayanımına bölümü
A_{gt}	%	Maksimum kuvvette yüzde toplam uzamanın belirtilen minimum değeri
L_o	mm	A_{gt} tayini için ekstansometrenin orijinal ölçü uzunluğu
F_{ma}	kN	Çekme testinde, özel özellik testine sunulan test parçasına bitişik bir test parçası üzerinde belirlenen gerçek maksimum kuvvet
F_{up}	kN	Eksenel kuvvet yorulma testinde üst kuvvet
F_r	N	Eksenel kuvvet yorulma testinde kuvvet aralığı
e	mm	Nervür mesafesi
E	GPa	Elastik modül
R_m	MPa	Nominal çekme mukavemeti

5 Tanım

5.1 prEN 10138'in bu Bölümü kapsamındaki çelik kaliteleri için, çelik isimleri EN 10027-1'e uygun olarak tahsis edilecektir; çelik numaraları EN 10027-2'ye göre tahsis edilecektir.

5.2 Tanımlar şu şekilde olacaktır:

- a) prEN 10138'in bu Kısmının numarası;;
- b) aşağıdakilerden oluşan çelik adı:
 - 1) ön gerilme çeliği için Y harfi;
 - 2) MPA cinsinden nominal çekme mukavemeti;
 - 3) Soğuk çekilmiş tel için C harfi;
- c) Telin mm cinsinden nominal çapı (bkz. Tablo 4);
- d) Gerektiğinde nervür türü (T1, T2, T3 ve T4, bkz. Tablo 2, 3, 4 ve 5);
- e) Gevşeme sınıfı (R1 or R2);
- f) Yorulma sınıfı (F1 or F2);
- g) Gerilme korozyon sınıfı (varsa C1, C1L veya C2) (bkz. Tablo 7).

EXAMPLE

	EN 10138-2	Y	1770	C	5,0	T1	R1	F1	C1
EN 10138'in bu kısmının Numarası									
Öngerme çeliği									
Nominal çekme mukavemeti (MPa)									
Soğuk çekilmiş tel									
Nominal çap (mm)									
Nervür türü									
Gevşeme sınıfı									
Yorulma sınıfı									
Gerilme korozyon sınıfı									

i.e. EN 10138-2-Y1770C-5,0-T1-R1-F1-C1

Not: Çelik adı çelik numarası yerine kullanılabilir, yani EN 10138-2-1.1352-5,0-T1-R1-F1-C1

6 İmalatı

6.1 Genel

Tel, EN ISO 16120-1 ve EN ISO 16120-2 veya EN ISO 16120-1 ve EN ISO 16120-4'e göre filmaşın ve prEN 10138-1'e uygun çelikten imal edilecektir.

6.2 Nervürlü tel: Nervür türü

Nervürlü tel için, nervür boyutları aşağıdakilerden birine uygun olacaktır:

- T1 için: Tablo 2 ve Şekil 1;
- T2 için: Tablo 3 ve Şekil 2;
- T3 için: Tablo 4 ve Şekil 3; yada
- T4 için: Tablo 5 ve Şekil 4.

T1, T2 ve T4 Tipi Nervürlü tel için, bir nervürleme hattı diğerlerine ters bir açıda olacaktır.

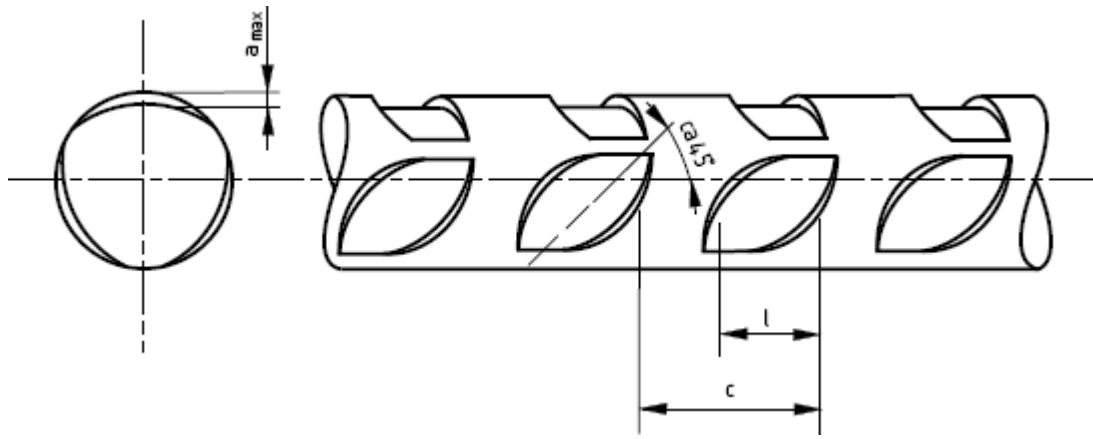
Nominal nervür derinliği Tablo 2, 3, 4 veya 5'te verilen sınırlar dahilinde seçilecektir.

Tablo 2 — T1 nervür tipi için belirtilen nervür boyutları

Çap birimi mm 'dir.

Nominal tel çapı d	Nervür derinliği a_{max}		Seçilen nominal derinlikte tolerans	Boyu l	Boşluğu c
	Nominal değerler aralığı min	mak			
≤ 5	0,06	0,13	$\pm 0,03$	$3,5 \pm 0,5$	$5,5 \pm 0,5$
> 5 to 8	0,09	0,16	$\pm 0,04$	$5,0 \pm 0,5$	$8,0 \pm 0,5$
> 8 to 11	0,10	0,20	$\pm 0,05$	$5,0 \pm 0,5$	$8,0 \pm 0,5$

Tipik ölçümler için Şekil 1'e bakınız. Boyut çizgileri, ölçümlerin nereden alınacağına dair tipik örnekler olarak gösterilmektedir, ancak pratikte, örneğin, ölçümler, nervür sayısına bölünen daha uzun bir uzunluk üzerinden yapılabilir (EN ISO 15630'a göre 3).

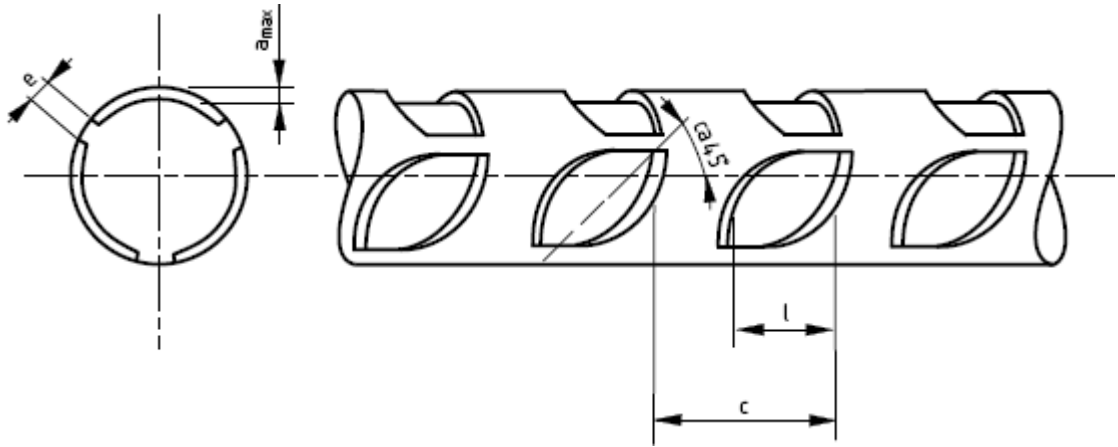


Şekil 1 — T1 Nervür tipi

Tablo 3 — T2 nervür tipi için belirtilen nervür boyutları

Çapların birimi mm'dir						
Nominal tel çapı d	Nervür derinliği A_{max}			Boy l	Boşluğu c	Nervür mesafelerinin toplamı Σe
	Nominal değerler aralığı		Seçilen nominal derinlikte tolerans			
	Min	Mak				
> 5 to 6	0,10	0,20	$\pm 0,05$	$3,5 \pm 0,5$	$5,5 \pm 0,5$	$\Sigma e \leq 0,2 \pi d$
> 6 to 11	0,12	0,22	$\pm 0,05$	$3,5 \pm 0,5$	$5,5 \pm 0,5$	$\Sigma e \leq 0,2 \pi d$

Tipik ölçümler için bkz. Şekil 2. Boyut çizgileri, ölçümlerin nereden alınacağına dair tipik örnekler olarak gösterilmektedir, ancak pratikte, örneğin, ölçümler, nervür sayısına bölünen daha uzun bir uzunluk üzerinden yapılabilir (EN ISO 15630'a göre 3.).



Şekil 2 —T2 Nervür tipi

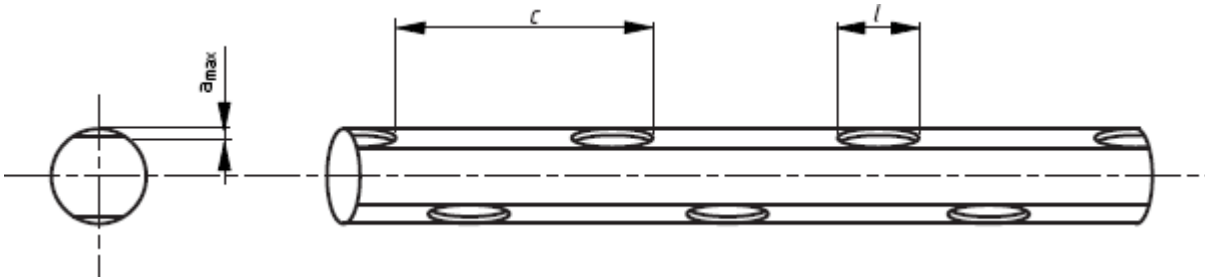
Tablo 4 — T3 nervür tipi için belirtilen nervür boyutları

Çapların birimi mm'dir.

Nominal tel çapı d	Nervür derinliği a_{max}		Seçilen nominal derinlikte tolerans	Boyut l	Boşluğu c
	Nominal değerler aralığı				
	min	mak			
5	0,06	0,16	$\pm 0,04$	$5,0 \pm 1,0$	8 to 18
7	0,06	0,16	$\pm 0,04$	$5,4 \pm 1,0$	10 to 20

Tipik ölçümler için Şekil 3'e bakın. Boyut çizgileri, ölçümlerin nereden alınacağına dair tipik örnekler olarak gösterilmektedir, ancak pratikte, örneğin, ölçümler, nervür sayısına bölünen daha uzun bir uzunluk üzerinden yapılabilir (EN ISO 15630 uyarınca 3).

NOT Nervür tipi T3, agregaların, iletim uzunluğunun Şekil 1 ve 2'de belirtilen nervür modelinin ürettiğinden biraz daha uzun olmasını gerektirdiği durumlarda kullanılır. Bir taraftaki nervürler, karşı yüzdeki nervür konumlarının ortasında olmalıdır. (bkz. Şekil 3).



Şekil 3 —T3 Nervür tipi

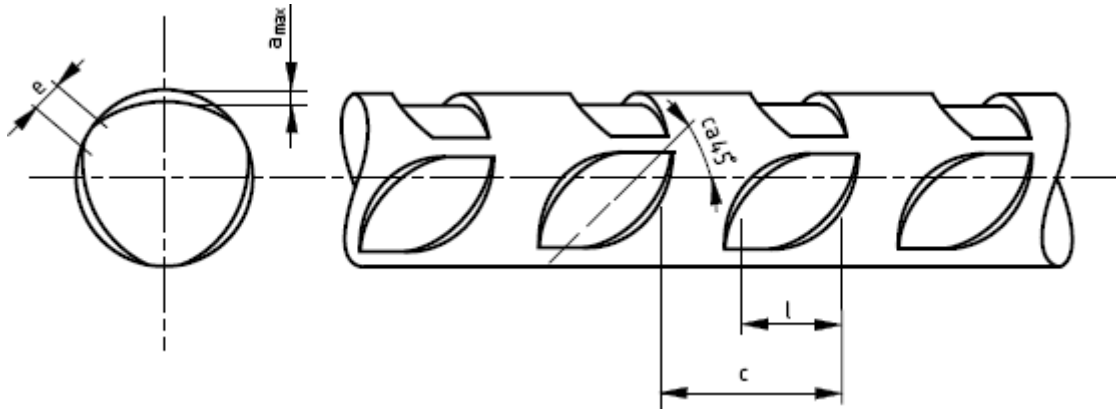
Tablo 5 —T4 nervür tipi için belirtilen nervür boyutları

Çapların birimi mm'dir.

Nominal tel çapı d	Nervür derinliği a_{max}		Boyu l	Boşluğu c	Nervür mesafelerinin toplamı Σe
	Nominal değerler aralığı				
	min	mak			
≤ 5	0,06	0,13	$\pm 0,03$	$3,5 \pm 0,5$	$5,5 \pm 0,5$
> 5 to 8	0,09	0,16	$\pm 0,04$	$5,0 \pm 0,5$	$8,0 \pm 0,5$
> 8 to 11	0,10	0,20	$\pm 0,05$	$5,0 \pm 0,5$	$8,0 \pm 0,5$

$\Sigma e \leq 0,2 \pi d$

Tipik ölçümler için Şekil 4'e bakın. Boyut çizgileri, ölçümlerin nereden alınacağına dair tipik örnekler olarak gösterilmektedir, ancak pratikte, örneğin, ölçümler, nervür sayısına bölünen daha uzun bir uzunluk üzerinden yapılabilir (EN ISO 15630 uyarınca 3).



Şekil 4 —T4 Nervür tipi

7 Gereksinimler

7.1 Genel

PrEN 10138'in bu Kısımının kapsadığı teknik sınıflar, Tablo 6 ve 7'de belirtilen nominal ve belirtilen özelliklere sahip olacaktır.

7.2 Geometrik özellikler

7.2.1 Genel

Anma çapı d , nominal kesit alanı S_n ve metre başına anma kütlesi Tablo 6'da verildiği gibi olacaktır.

prEN 10138-2:2012 (E)

7.2.2 Düz yuvarlak tel

Ovallik 0,01 d'den büyük olmayacaktır.

Tartılarak kontrol yapılmasına gerek yoktur. Ortalama çap, ± 1 % toleransla nominal çapa eşit olmalıdır.

7.2.3 Doğruluk

Doğruluk, EN ISO 15630-3'e göre belirlenmelidir. Eğrinin içinden ölçülen 1 m uzunluğundaki taban çizgisinden maksimum yay yüksekliği, tüm tel çapları için 25 mm'den fazla olmamalıdır.

Not - Sipariş sırasında üretici ve alıcı arasında EN ISO 15630-3'teki yöntemi kullanan kesme uzunlukları da dahil olmak üzere alternatif anlaşmalar yapılabilir..

Tablo 6 — Tellerin çapları ve özellikleri

Nominal		Nominal ^a				Belirtilen			
Çelik adı	Çelik numarası	Çap ^b <i>d</i> mm	Kesit alanı ^c <i>S_n</i> mm ²	Çekme mukavemeti <i>R_m</i> MPa	Birim ağırlık ^c <i>m</i> g/m	Metre başına nominal kütlede izin verilen sapma	Maksimum kuvvetin karakteristik değeri	Maksimum kuvvetin maksimum değeri	% 0,1 uzama kuvvetinin karakteristik değeri ^d
						%	<i>F_m</i> kN	<i>F_{m,max}</i> kN	<i>F_{p0,1}</i> kN
Y1570C	1.1350	5,0	19,6	1 570	153,1	± 2	30,8	35,4	27,1
		6,0	28,3		221,0		44,4	51,1	39,1
		7,0	38,5		300,7		60,4	69,5	53,2
		8,0	50,3		392,8		79,0	90,9	69,5
		8,5	56,7		442,8		89,0	102	77,4
		8,8	60,8		474,8		95,5	110	83,1
		9,0	63,6		496,7		99,9	115	86,9
		9,4	69,4		542,0		109	125	94,8
		9,5	70,9		553,7		111	128	96,6
		9,7	73,9		577,2		116	133	101
		10,0	78,5		613,1		123	141	107
		10,5	86,6		676,3		136	156	118
		11,0	95,0		742,0		149	171	130
		12,2	117,0		913,0		184	211	161
Y1620C	1.1349	4,5	15,9	1 620	124,2	± 2	25,8	29,7	22,7
		7,11	39,7		310,1		64,3	73,9	56,6
Y1670C	1.1351	4,0	12,6	1 670	98,4	± 2	21,0	24,2	18,5
		5,0	19,6		153,1		32,7	37,6	28,8
		5,5	23,8		185,9		39,7	45,7	34,9
		6,0	28,3		221,0		47,3	54,4	41,6
		6,5	33,2		259,3		55,4	63,7	48,8
		6,9	37,4		292,1		62,5	71,9	55,0
		7,0	38,5		300,7		64,3	73,9	56,6
		7,5	44,2		345,2		73,8	84,9	64,9
		8,0	50,3		392,8		84,0	96,6	73,9
Y1770C	1.1352	3,0	7,10	1 770	55,5	± 2	12,6	14,5	11,1
		3,2	8,00		62,5		14,2	16,3	12,5
		4,0	12,6		98,4		22,3	25,6	19,6
		4,5	15,9		124,2		28,1	32,3	24,7

Tablo 6 — Tellerin çapları ve özellikleri

Nominal		Nominal ^a				Belirtilen			
Çelik adı	Çelik numarası ¹	Çap ^b <i>d</i> mm	Kesit alanı ^c <i>S_n</i> mm ²	Çekme mukavemeti <i>R_m</i> MPa	Birim ağırlık ^c <i>m</i> g/m	Metre başına nominal kütlede izin verilen sapma %	Maksimum kuvvetin karakteristik değeri <i>F_m</i> kN	Maksimum kuvvetin maksimum değeri <i>F_{m,max}</i> kN	% 0,1 uzama kuvvetinin karakteristik değeri ^d <i>F_{p0,1}</i> kN
		5,0	19,6		153,1		34,7	39,9	30,5
		5,5	23,8		185,9		42,1	48,4	37,0
		6,0	28,3		221,0		50,1	57,6	44,1
		7,0	38,5		300,7		68,1	78,3	59,9
Y1860C	1.1353	3,0	7,10	1 860	55,5	± 2	13,2	15,2	11,7
		4,0	12,6		98,4		23,4	26,9	20,8
		5,0	19,6		153,1		36,5	42,0	32,5
		6,0	28,3		221,0		52,6	60,50	46,80
		7,0	38,5		300,7		71,6	82,3	63,7
Y1960C	1.1354	2,5	4,9	1 960	38,3	± 2	9,6	11,05	8,45

^a Elastik modülü (*E*) GPa (kN/mm²)'ya eşit olarak Kabul edilebilir.

^b Düz teller nominal çapın ≤ 1 % kadar ovaliteye sahip olacaktır. .

^c Metre başına nominal kütle, nominal kesit alanından 7,81 kg/dm³ kullanılarak yoğunluğu hesaplanır.

^d 0,1 % uzamadaki kuvveti karakteristik değeri şu şekilde hesaplanır :

— Y1570C kalite için, 8 mm'den büyük çaplarda maksimum kuvvetin belirtilen karakteristik değerinin %87 si kadar;

— Y1860C kalite için tüm çaplar için maksimum kuvvetin belirtilen karakteristik değerinin %89'u kadar;;

— Diğer tüm kaliteler ve çaplar için, maksimum kuvvetin belirtilen karakteristik değerinin% 88'i kadar..

Tablo 7 — Ön germeli tel için ek gereksinimler

Özellik		Belirtilen		
Yük oranı σ	$d \geq 2,5$ mm	1,05 to 1,18		
Maksimum kuvvette minimum yüzde toplam uzama, $L_0 \geq 100$ mm ile A_{gt} .		3,5 %		
Kırılma alanındaki azalma		Çıplak gözle görülebilen sünek kırılma ^a		
En az ters eğme sayısı	- Düz tel için - Nervürlü tel için	4 3 ^f		
Maximum relaxation at 1 000 h ^b Class R1	For initial force corresponding to 70 % F_{ma} 80 % F_{ma}	2,5 % 4,5 % ^b		
1000 saatteki en fazla gevşeme ^c Sınıf R2	70 % F_{ma} değerine karşılık gelen ilk kuvvet ile.	8,0 %		
Yorulma yük oranı F_r üst limit ile F_r gerçek maksimum yük %70'e eşittir. (F_{ma}) Sınıf F1	- düz tel için	≥ 200 MPa $\times S_n$ for $\geq 2 \times 10^6$ cycles		
	- nervürlü tel için	≥ 180 MPa $\times S_n$ for $\geq 2 \times 10^6$ cycles		
Yorulma yük oranı F_r üst limit ile F_r gerçek maksimum yük %80'e eşittir. (F_{ma}) Sınıf F2	- düz tel için	≥ 200 MPa $\times S_n$ for $\geq 2 \times 10^6$ cycles		
	- nervürlü tel için	≥ 180 MPa $\times S_n$ for $\geq 2 \times 10^6$ cycles		
Gerilmeli korozyon testi ^e 80 % maksimum gerçek yük (F_{ma})	Sınıf C1	Test solüsyonu A	Minimum (h)	Ortalama (h)
			2,0	5,0
	Sınıf C1L		1,5	4,0
	Sınıf C2 ^d	Test solüsyonu A	2,0	5,0
Test solüsyonu B			2 000	-
<p>^a Kopma ucunda çatlaklar olmayacaktır. Anlaşmazlık durumunda, kesit daralması yüzdesi belirlenecek ve değer düz tel için \geq %25 ve nervürlü tel için \geq %20 olacaktır.</p> <p>^b 70 % F_{ma} gereksinimi zorunludur. Özel uygulamalar için alıcı ve üretici arasında % 80 F_{ma} değeri için bir gereklilik üzerinde anlaşmaya varılabilir.</p> <p>^c Sınıf R2, yalnızca maksimum 4 mm / uzunluk yay yüksekliği olan, oldukça düzleştirilmiş boy kesme telleri için kullanılacaktır.</p> <p>Gerilme korozyonu için düzenleyici gereklilikler mevcutsa, EN ISO 15630-3'te tanımlanan ilk tip testi için ek test çözümü B, prEN 10138-1'de tanımlandığı gibi kullanılmalıdır..</p> <p>Yasal gerekliliklerin olmadığı durumlarda, ürünler Sınıf C0 olarak atanabilir</p> <p>T2 tipi için, minimum ters eğme sayısı iki olacaktır.</p>				

8 Uygunluğun deęerlendirilmesi

PrEN 10138-1 gereklilikleri uygulanacaktır..

9 Test yöntemleri

Tablo 6 ve 7'de verilen tüm özellikler için test yöntemleri EN ISO 15630-3'e uygun olacaktır.

ISO 7801'e göre ters bükme testi için çapı $d < 10$ mm olan tel için, silindirik desteğin $r < 5 d$ yarıçapı alınmalıdır..

$10 \text{ mm} \leq d < 12,5$ mm nominal çaplı tel için, ISO 7801:1984'de tanımlandığı gibi $r = (30 \pm 1)$ mm, $h = 125$ mm, $d_g = 11$ mm veya 13 mm olduğunda test ekipmanı için aşağıdaki koşullar geçerlidir..

T3 tipi girintili tel bükme testi için, telin, girintilerin bükülme düzlemine 90° olacak şekilde test edilmesi bir gerekliliktir..

10 Teslimat koşulları

10.1 Kimlik - etiket

PrEN 10138-1'deki gereksinimler karşılanmalıdır.

10.2 Ürün paketlerinin boyutları

Bunlar, imalatçı ile sipariş sırasında prEN 10138-1 kısıtlaması ile mutabık kalınacaktır.

Prestressing steels — Part 3: Strand

Spannstähle — Teil 3: Litze

Armatures de précontrainte en acier — Partie 3 : Torons

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Foreword

This document prEN 10138-3 has been prepared by Technical Committee ECISS/TC 104 “Concrete reinforcing and prestressing steels”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document is currently submitted to the Formal Vote.

- *Part 1: General requirements;*
- *Part 2: Wire;*
- *Part 3: Strand;*
- *Part 4: Bar.*

1 Scope

This Part of prEN 10138 gives specific requirements for technical classes of high tensile steel wire strand, which has been given a stress relieving heat treatment.

It is applicable to the following products:

- a) 2-wire strand;
- b) 3-wire strand;
- c) indented 3-wire strand;
- d) 7-wire strand;
- e) indented 7-wire strand;
- f) 7-wire compacted strand.

NOTE General requirements are given in prEN 10138-1.

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.

EN 10027-1, *Designation systems for steels — Part 1: Steel names*

EN 10027-2, *Designation systems for steels — Part 2: Numerical system*

prEN 10138-1, *Prestressing steels — Part 1: General requirements*

EN ISO 15630-3, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 3: Prestressing steel*

EN ISO 16120-1, *Non-alloy steel wire rod for conversion to wire — Part 1: General requirements*

EN ISO 16120-2, *Non-alloy steel wire rod for conversion to wire — Part 2: Specific requirements for general-purpose wire rod*

EN ISO 16120-4, *Non-alloy steel wire rod for conversion to wire — Part 4: Specific requirements for wire rod for special applications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 10138-1 and the following apply.

3.1

indentation length, l

length of individual indentations measured in the direction of the wire axis

3.2**indentation depth, a_{max}**

maximum depth of individual indentations measured radially from wire surface

3.3**indentation spacing, c**

distance between the centre of two successive indentations measured (or taken) in the direction of the wire axis

NOTE See Figure 1.

3.4**indentation distance, e**

average gap between two adjacent indentation rows

NOTE See Figure 1.

4 Symbols and designations

Symbols used in this Part of prEN 10138 and the corresponding designations are listed in Table 1.

Table 1 — Symbols and corresponding designations

Symbol	Unit	Designation
a_{max}	mm	Indentation depth
c	mm	Indentation spacing
l	mm	Indentation length
d	mm	Nominal diameter of the product
D	%	Maximum permitted value of the average percentage reduction of the maximum force in the deflected tensile test
S_n	mm ²	Nominal cross-sectional area of the product
m	g/m	Nominal mass per metre of the product
F_m	kN	Specified characteristic value of maximum force
$F_{m, max}$	kN	Specified maximum value of maximum force
$F_{p0,1}$	kN	Specified characteristic value of 0,1 % proof force
σ	—	Stress ratio - ultimate tensile strength divided by the tensile yield strength
A_{gt}	%	Specified minimum value of percentage total elongation at maximum force
L_o	mm	Original gauge length of the extensometer for the determination of A_{gt}
F_{ma}	kN	Actual maximum force, in the tensile test, determined on a test piece adjacent to the test piece submitted to special property test
F_{up}	kN	Upper force in the axial force fatigue test
F_r	N	Force range in the axial force fatigue test
d_{sw}	mm	Nominal diameter of a constitutive wire of a strand

Symbol	Unit	Designation
R_m	MPa	Nominal tensile strength
e	mm	Indentation distance
E	GPa	Modulus of elasticity

5 Designation

5.1 For the steel grades covered by this Part of prEN 10138, the steel names shall be allocated in accordance with EN 10027-1; the steel numbers shall be allocated in accordance with EN 10027-2.

5.2 The designation shall consist of:

- a) the number of this Part of prEN 10138;
- b) the steel name consisting of:
 - 1) the letter Y for prestressing steel;
 - 2) the nominal tensile strength in MPa;
 - 3) the letter S for strand;
 - 4) the number 2, 3 or 7 to indicate the number of wires in the strand;
 - 5) where appropriate, the letter G to indicate compacted strand;
- c) the nominal diameter of the strand in mm (see Table 3);
- d) where necessary the letter I to indicate indented;
- e) Relaxation (R1);
- f) Fatigue class (F1 or F2);
- g) Stress corrosion class (C0, C1, C1L or C2).

EXAMPLE

	EN 10138-3	Y	1860	S	7	15,7	I	R1	F1	C1
Number of this Part of EN 10138										
Prestressing steel										
Nominal tensile strength (MPa)										
Strand										
Number of wires										
Nominal diameter (mm)										
Indented										
Relaxation class										
Fatigue class										
Stress corrosion class										

i.e. EN 10138-3-Y1860S7-15,7-I-R1- F1-C1

NOTE The steel number can be used instead of the steel name i.e. EN 10138-3-1.1366-15,7-I-R1-F1-C1.

6 Manufacture

6.1 General

The strand shall be manufactured from wire produced from wire rod conforming to [EN ISO 16120-1](#) and [EN ISO 16120-2](#) or [EN ISO 16120-1](#) and [EN ISO 16120-4](#) and from steel in accordance with prEN 10138-1.

6.2 Stranding process

6.2.1 2-wire strand

The strand shall consist of two wires of the same nominal diameter, spun together in helical form over a theoretical common axis with a lay length of 14 to 22 times the nominal strand diameter.

6.2.2 3-wire strand

The strand shall consist of three wires of the same nominal diameter, spun together in helical form over a theoretical common axis with a lay length of 14 to 22 times the nominal strand diameter.

6.2.3 7-wire strand

The strand shall include a straight central wire, called a core wire around which are spun six wires in one layer. The outer wires shall be tightly spun around the central wire with a lay length between 14 and 18 times the nominal strand diameter. The diameter of the central wire shall be at least 3,0 % greater than the diameter of the outer helical wires.

6.2.4 7-wire compacted strand

Seven-wire strand which after stranding has been compacted by drawing or rolling before stress relief treatment. When stranding and compacting are carried out simultaneously, the straight central wire shall be at least the same diameter as the outer helical wires. The latter shall have a lay length of 14 to 18 times the nominal strand diameter.

6.3 Indented strand

Indentation of wires of 3-wire strand or the indented outer wires of 7-wire strand shall be completed before stranding.

NOTE The centre wire of indented 7-wire strand is normally plain.

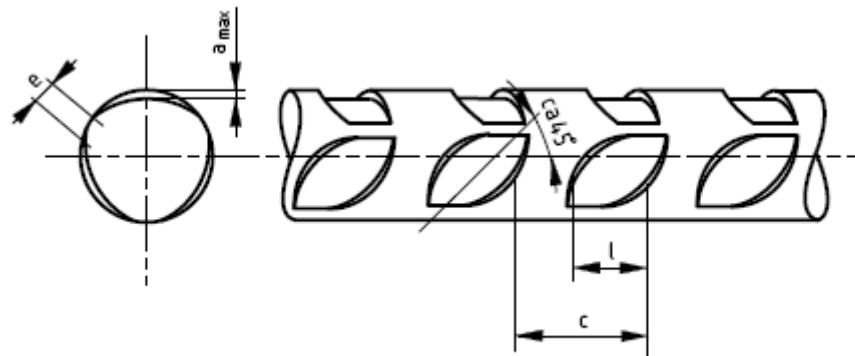
The dimensions of the indentation shall be in accordance with Table 2 and Figure 1. One line of indentations shall be at a contrary angle to the others.

Table 2 — Specified indentation

Dimensions in mm

Nominal strand diameter <i>d</i>	Indentation depth <i>a_{max}</i>	Length <i>l</i>	Spacing <i>c</i>
≤ 12	0,06 ± 0,03	3,5 ± 0,5	5,5 ± 0,5
> 12	0,07 ± 0,03	3,5 ± 0,5	5,5 ± 0,5

For typical measurements see Figure 1. The dimension lines are shown as typical examples of where to take the measurements from but in practice, for example, measurements may be made over a longer length divided by the number of indentations (in accordance with EN ISO 15630-3).



$$\sum e \leq 0,4 \pi \cdot d_{sw}$$

Figure 1 — Indentation

7 Requirements

7.1 General

Nominal and specified properties shall be in accordance with Tables 3, 4 and 5.

7.2 Behaviour during cutting

When the strand is cut with a disc cutter, the individual wires either shall not unravel or shall be capable of being repositioned without difficulty.

7.3 Straightness

Straightness shall be determined in accordance with EN ISO 15630-3. The maximum bow height from a base line 1 m in length, measured from the inside of the curve, shall be not greater than 25 mm for all strand diameters.

NOTE Alternative agreements on straightness including for cut lengths using the method in EN ISO 15630-3 may be made between producer and purchaser at the time of ordering.

Table 3 — Dimensions and properties of 2 and 3 wire strands

Steel designation		Nominal ^a				Specified			
Steel name	Steel number	Diameter	Tensile strength	Cross-sectional area ^b	Mass per metre ^b	Permitted deviation on nominal mass per metre	Characteristic value of maximum force	Maximum value of maximum force	Characteristic value of 0,1 % proof force
		<i>d</i> mm	<i>R_m</i> MPa	<i>S_n</i> mm ²	<i>m</i> g/m	%	<i>F_m</i> kN	<i>F_{m, max}</i> kN	<i>F_{p0,1}</i> ^c kN
Y1770S2	1.1345	5,6	1 770	9,70	75,8	± 2	17,2	19,8	15,1
		6,0		15,1	117,9		26,7	30,7	23,5
Y1770S3	1.1359	7,5	1 770	29,0	226,5	± 2	51,3	59,0	45,1
Y1860S2	1.1346	4,5	1 860	7,95	62,1	± 2	14,8	17,0	13,0
Y1860S3	1.1360	4,85	1 860	11,9	92,9	± 2	22,1	25,4	19,4
		6,5		21,2	165,6		39,4	45,3	34,7
		6,9		23,4	182,8		43,5	50,0	38,3
		7,5		29,0	226,5		53,9	62,0	47,4
		8,6		37,4	292,1		69,6	80,0	61,2
Y1920S3	1.1357	6,3	1 920	19,8	154,6	± 2	38,0	43,7	33,4
		6,5		21,2	165,6		40,7	46,8	35,8
Y1960S3	1.1361	4,8	1 960	12,0	93,7	± 2	23,5	27,0	20,9
		5,2		13,6	106,2		26,7	30,7	23,8
		6,5		21,2	165,6		41,6	47,8	37,0
		6,85		23,6	184,3		46,3	53,2	41,2
Y2060S3	1.1362	5,2	2 060	13,6	106,2	± 2	28,0	32,2	24,9
Y2160S3	1.1363	5,2	2 160	13,6	106,2	± 2	29,4	33,8	26,2

^a The modulus of elasticity (*E*) may be taken to be 195 GPa (kN/mm²).

^b The nominal mass per metre is calculated from the cross-sectional area and a density of 7,81 kg/dm³.

^c The specified characteristic value of the 0,1 % proof force is calculated:
— For the grades Y1770S2, Y1770S3, Y1860S2, Y1860S3 and Y1920S3 for all diameters as 88 % of the specified characteristic value of the maximum force;
— For the grades Y1960S3, Y2060S3 and Y2160S3 for all diameters as 89 % of the specified characteristic value of the maximum force.

Table 4 — 7 wire strand - Dimensions and properties

Steel designation		Nominal ^a				Specified			
Steel name	Steel number	Diameter	Tensile strength	Cross-sectional area ^b	Mass per metre ^b	Permitted deviation on nominal mass per metre	Characteristic value of maximum force	Maximum value of maximum force	Characteristic value of 0,1 % proof force ^c
		<i>d</i> mm	<i>R_m</i> MPa	<i>S_n</i> mm ²	<i>m</i> g/m	%	<i>F_m</i> kN	<i>F_{m, max}</i> kN	<i>F_{p0,1}</i> kN
Y1670S7	1.1364	15,2	1 670	139	1 086	± 2	232	267	204
Y1700S7G	1.1370	18,0	1 700	223	1 742	± 2	379	436	334
Y1770S7	1.1365	6,9	1 770	29,0	226,5	± 2	51,3	59,0	45,1
		9,0		50,0	390,5		88,5	102	77,9
		9,3		52,0	406,1		92,0	106	81,0
		9,6		55,0	429,6		97,4	112	85,7
		11,0		70,0	546,7		124	143	109
		12,5		93,0	726,3		165	190	145
		12,9		100	781,0		177	204	156
		15,2		139	1 086		246	283	216
		15,3		140	1 093		248	285	218
		15,7		150	1 172		266	306	234
		18,0		200	1 562		354	407	312
		Y1820S7G		1.1371	15,2		1 820	165	1 289
Y1860S7	1.1366	6,9	1 860	29,0	226,5	± 2	53,9	62,0	47,4
		7,0		30,0	234,3		55,8	64,2	49,1
		8,0		38,0	296,8		70,7	81,3	62,2
		9,0		50,0	390,5		93,0	107	81,8
		9,3		52,0	406,1		96,7	111	85,1
		9,6		55,0	429,6		102	117	89,8
		11,0		70,0	546,7		130	150	114
		11,3		75,0	585,8		140	161	123
		12,5		93,0	726,3		173	199	152
		12,9		100	781,0		186	214	164
		13,0		102	796,6		190	219	167
		15,2		139	1 086		259	298	228
		15,3		140	1 093		260	299	229

Table 4 — 7 wire strand - Dimensions and properties

Steel designation		Nominal ^a				Specified			
Steel name	Steel number	Diameter	Tensile strength	Cross-sectional area ^b	Mass per metre ^b	Permitted deviation on nominal mass per metre	Characteristic value of maximum force	Maximum value of maximum force	Characteristic value of 0,1 % proof force ^c
		<i>d</i> mm	<i>R_m</i> MPa	<i>S_n</i> mm ²	<i>m</i> g/m	%	<i>F_m</i> kN	<i>F_{m, max}</i> kN	<i>F_{p0,1}</i> kN
		15,7		150	1 172		279	321	246
Y1860S7G	1.1372	12,7	1 860	112	874,7	± 2	208	239	183
		15,2		165	1 289		307	353	270
Y1960S7	1.1367	9,0	1 960	50,0	390,5	±2	98,0	113	87,2
		9,3		52,0	406,1		102	117	90,8
		9,6		55,0	429,6		108	124	96,1
		11,0		70,0	546,7		137	158	122
		11,3		75,0	585,8		147	169	131
		12,5		93,0	726,3		182	209	162
		12,9		100	781,0		196	225	174
		13,0		102	796,6		200	230	178
		15,2		139	1086		272	313	242
		15,3		140	1093		274	315	244
		15,7		150	1172		294	338	262
		Y2060S7		1.1368	6,4		2 060	25,0	195,3
6,85	28,2		220,2		58,1	66,8		51,7	
7,0	30,0		234,3		61,8	71,1		55,0	
8,6	45,0		351,5		92,7	107		82,5	
11,3	75,0		585,8		155	178		138	
12,5	93,0		726,3		192	221		171	
12,9	100		781,0		206	237		183	
Y2160S7	1.1369	6,85	2 160	28,2	220,2	± 2	60,9	70,0	54,2

^a The modulus of elasticity (*E*) may be taken to be 195 GPa (kN/mm²).

^b The nominal mass per metre is calculated from the nominal cross-sectional area and a density of 7,81 kg/dm³.

^c The specified characteristic value of the 0,1 % proof force is calculated:

— For the grades Y1670S7, Y1700S7G, Y1770S7, Y1820S7G, Y1860S7 and Y1860S7G for all diameters as 88 % of the specified characteristic value of the maximum force;

— For the grades Y1960S7, Y2060S7 and Y2160S7 for all diameters as 89 % of the specified characteristic value of the maximum force.

Table 5 — Additional requirements for prestressing strand

Property		Specification				
Stress ratio σ^f	$d_{sw} \geq 3$ mm	1,05 to 1,18				
	$d_{sw} < 3$ mm	1,03 to 1,18				
Minimum percentage total elongation at maximum force, A_{gt} , with $L_o \geq 500$ mm		3,5 %				
Reduction in area at break		Ductile wire breaks visible to the unaided eye ^a				
Maximum relaxation at 1 000 h ^b Class R1	For initial force corresponding to 70 % F_{ma}	2,5 %				
	80 % F_{ma}	4,5 % ^b				
Fatigue force range F_r with upper limit F_{up} according to 70 % actual maximum force (F_{ma}) Class F1	- for plain strand - for indented strand	190 MPa $\times S_n$ for $\geq 2 \times 10^6$ cycles 170 MPa $\times S_n$ for $\geq 2 \times 10^6$ cycles				
Fatigue force range F_r with upper limit F_{up} according to 80 % actual maximum force (F_{ma}) Class F2	- for plain strand - for indented strand	200 MPa $\times S_n$ for $\geq 2 \times 10^6$ cycles 180 MPa $\times S_n$ for $\geq 2 \times 10^6$ cycles				
Stress corrosion resistance ^{e f} 80 % actual max. force (F_{ma})	Class C1	Test solution A		Minimum (h)	Median (h)	
			$d_{sw} \geq 3,2$ mm	2,0	5,0	
				$d_{sw} < 3,2$ mm	1,5	3,0
	Class C1L	Test solution A	$d_{sw} \geq 3,2$ mm	1,5	4,0	
			$d_{sw} < 3,2$ mm	2,0	5,0	
	Class C2 ^c	Test solution A	$d_{sw} \geq 3,2$ mm	1,5	3,0	
$d_{sw} < 3,2$ mm			2 000	-		
	Test solution B					
Maximum D-value of deflected tensile test applies to: - 7-wire strand and - 7-wire compacted strand with a nominal diameter $d \geq 12,5$ mm.		28 % ^d				
<p>^a Ruptures in "arrow head" are prohibited. In case of dispute the percentage reduction of area shall be determined and the value shall be ≥ 25 % for plain wire and ≥ 20 % for indented wire.</p> <p>^b The requirement for 70 % F_{ma} is mandatory. A requirement for a value of 80 % F_{ma} may be agreed between purchaser and manufacturer for specific applications.</p> <p>^c When regulatory requirements for stress corrosion exist, the additional test solution B for initial type testing defined in EN ISO 15630-3 shall be used as defined in prEN 10138-1.</p> <p>^d For specific applications the requirement may be varied by agreement between producer and purchaser but the maximum D-value cannot be more than 28 %.</p> <p>^e Where there are no regulatory requirements, the products may be assigned as Class C0.</p> <p>^f This refers to a testing of strand where the diameter of the outer wires is designated.</p>						

8 Evaluation of conformity

The requirements in prEN 10138-1 shall be met.

9 Test methods

The test methods for all properties as given in Tables 3, 4 and 5 shall be in accordance with EN ISO 15630-3.

10 Delivery conditions

10.1 Identification

The requirements in prEN 10138-1 shall be met.

10.2 Delivery documentation

The requirements in prEN 10138-1 shall be met.

NOTE Where documents refer to the steel heat for strands, the heat shall be that of the predominate heat in the constituent wires of the strands.

10.3 Dimensions and mass of unit of product

The dimensions and mass of the unit of product shall be agreed at the time of ordering between the purchaser and the producer consistent with the restrictions in prEN 10138-1. The producer shall state the coil dimensions.

10.4 Packaging

The coils shall be correctly conditioned (restraining bands) so as not to be damaged (collapse) during transport. The coils shall be marked with the direction of unwinding. A particular conditioning (e.g. core for the coil, packing paper or paperboard, protection by a water-soluble oil film) may be agreed between the purchaser and the producer.