BS EN 14399-1:2015

BSI Standards Publication

High-strength structural bolting assemblies for preloading

Part 1: General requirements

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National foreword

This British Standard is the UK implementation of EN 14399-1:2015. It supersedes BS EN 14399-1:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee FME/9/-/2, Fasteners for structural bolting.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 14399-1:2015) has been prepared by Technical Committee CEN/TC 185 “Fasteners”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2015 and conflicting national standards shall be withdrawn at the latest by November 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14399-1:2005.

In comparison with EN 14399-1:2005, the following modifications have been made:

— the standard was revised to meet the new format for harmonized standards and in relation to the Regulation (EU) No. 305/2011 (CPR);

— the requirements of this standard only relate to the product characteristics of bolting assemblies which are necessary for CE marking;

— all clauses dealing with further technical or other requirements have been transferred to EN 14399-2;

— the table containing the overview of the composition of bolting assemblies and component marking has been transferred to EN 14399-2.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports basic work requirements of Regulation (EU) No. 305/2011.

For relationship with Regulation (EU) No. 305/201, see informative Annex ZA, which is an integral part of this document.

EN 14399 consists of the following parts, under the general title *High-strength structural bolting assemblies for preloading*:

— *Part 1: General requirements* (the present document);

— *Part 2: Suitability for preloading*;

— *Part 3: System HR — Hexagon bolt and nut assemblies*;

— *Part 4: System HV — Hexagon bolt and nut assemblies*;

— *Part 5: Plain washers*;

— *Part 6: Plain chamfered washers*;

— *Part 7: System HR — Countersunk head bolt and nut assemblies*;

— *Part 8: System HV — Hexagon fit bolt and nut assemblies*;

— *Part 9: System HR or HV — Direct tension indicators for bolt and nut assemblies*;

— *Part 10: System HRC — Bolt and nut assemblies with calibrated preload*.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This document on structural bolting assemblies reflects the situation in Europe where two technical solutions exist to achieve the necessary ductility of bolting assemblies. These solutions utilize different bolting assemblies (system HR, HV and HRC). Both systems are well proven and it is the responsibility of the experts for structural connections whether they use the one or the other system.

It is however important for the performance of the bolting assembly to avoid mixing up the components of both systems. Therefore, the bolts and nuts for both systems are standardized in one single part of this European Standard each and the marking of the components of the same system is consistent.

1 Scope

This European Standard specifies the general requirements for bolt/nut/washer(s) assemblies for high-strength structural bolting, which are suitable for preloading.

The intended use of bolting assemblies in accordance with this European Standard is structural metallic works.

NOTE 1 High-strength structural bolting assemblies in accordance with EN 14399-2 to EN 14399-10 are designed to fulfil the requirements of this European Standard.

NOTE 2 High-strength structural bolting assemblies are suitable for preloading in accordance with EN 1090-2 in steel structures.

High-strength structural bolting assemblies smaller than M12 are not designed to be preloaded.

High-strength structural bolting assemblies are not designed to be welded.

Railway rail fasteners are not covered by this standard.

2 Normative references

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

EN 1090-2:2008+A1:2011, *Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures*

EN 14399-2:2015, *High-strength structural bolting assemblies for preloading - Part 2: Suitability for preloading*

EN 14399-3:2015, *High-strength structural bolting assemblies for preloading - Part 3: System HR - Hexagon bolt and nut assemblies*

EN 14399-4:2015, *High-strength structural bolting assemblies for preloading - Part 4: System HV - Hexagon bolt and nut assemblies*

EN 14399-5, *High-strength structural bolting assemblies for preloading - Part 5: Plain washers*

EN 14399-6, *High-strength structural bolting assemblies for preloading - Part 6: Plain chamfered washers*

EN 14399-7:2007, *High-strength structural bolting assemblies for preloading - Part 7: System HR - Countersunk head bolt and nut assemblies*

EN 14399-8:2007, *High-strength structural bolting assemblies for preloading - Part 8: System HV - Hexagon fit bolt and nut assemblies*

EN 14399-9:2009, *High-strength structural bolting assemblies for preloading - Part 9: System HR or HV - Direct tension indicators for bolt and nut assemblies*

EN 14399-10:2009, *High-strength structural bolting assemblies for preloading - Part 10: System HRC - Bolt and nut assemblies with calibrated preload*

EN ISO 225, *Fasteners - Bolts, screws, studs and nuts - Symbols and descriptions of dimensions (ISO 225)*

EN ISO 898-1:2013, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread (ISO 898-1:2013)*

EN ISO 898-2:2012, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread (ISO 898-2:2012)*

EN ISO 4759-1, *Tolerances for fasteners - Part 1: Bolts, screws, studs and nuts - Product grades A, B and C (ISO 4759-1)*

EN ISO 4759-3, *Tolerances for fasteners - Part 3: Plain washers for bolts, screws and nuts - Products grades A and C (ISO 4759-3)*

EN ISO 6507-1, *Metallic materials - Vickers hardness test - Part 1: Test method (ISO 6507-1)*

EN ISO 6508-1, *Metallic materials - Rockwell hardness test - Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-1)*

EN ISO 10684, *Fasteners - Hot dip galvanized coatings (ISO 10684)*

ISO 888, *Fasteners - Bolts, screws and studs - Nominal lengths and thread lengths*

ISO 965-2, *ISO general purpose metric screw threads - Tolerances - Part 2: Limits of sizes for general purpose external and internal screw threads - Medium quality*

ISO 965-5, *ISO general purpose metric screw threads - Tolerances - Part 5: Limits of sizes for internal screw threads to mate with hot-dip galvanized external screw threads with maximum size of tolerance position h before galvanizing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1090-2:2008+A1:2011 and the following apply.

3.1
bolting assembly
matching bolt, nut, washer(s) and if relevant, direct tension indicator and nut face washer or bolt face washer

3.2
single bolting assembly lot
bolting assembly lot containing:

— bolts from a single manufacturing lot;

— nuts from a single manufacturing lot;

— washers from a single manufacturing lot;

and, if relevant:

— direct tension indicators from a single manufacturing lot;

— nut face washers from a single manufacturing lot;

— bolt face washers from a single manufacturing lot

3.3
extended bolting assembly lot
bolting assembly lot containing:

— the component with the main influence on the result of the suitability test from a single manufacturing lot;

— the complementary components from several manufacturing lots

Note 1 to entry: The component having the main influence (either nut or direct tension indicator) is determined on the basis of test results.

Note 2 to entry: An extended bolting assembly lot contains bolts, nuts and washers and, if relevant, direct tension indicators and nut face washers or bolt face washers.

3.4
manufacturing lot (for bolting assemblies components)
quantity of components of a single designation including product grade, property class, type, and size, manufactured from bar, wire, rod or flat product from a single cast, processed through the same or similar steps at the same time or over a continuous time period, through the same heat treatment, coating and/or lubrication process, if any

Note 1 to entry: Same process means:

— for a continuous process, the same treatment cycle without any setting modification;

— for a discontinuous process, the same treatment cycle for identical consecutive loads (batches).

Note 2 to entry: The manufacturing lot may be split into a number of manufacturing batches for processing purposes and then re-assembled into the same manufacturing lot.

4 Product characteristics

4.1 General

The performance of the high-strength structural bolting assemblies depends on the type of the bolting assemblies and on properties of their specific components (bolts, nuts, washers, and direct tension indicators if provided). Therefore, the requirements specified in 4.2 to 4.5 are assessed through the verification of the properties of the involved components and/or bolting assemblies, as applicable.

4.2 Type (bolting assemblies)

4.2.1 General

Type covers the axial load expected from design and margin against overtightening. The Type is relevant for the ability of the bolting assembly to be tightened by different tightening methods given in EN 1090-2 in order to provide the declared performances of the bolting assemblies.

There are two types of bolting assemblies:

— Type HR (systems HR with or without direct tension indicators, if provided, and HRC) designed to obtain ductility predominantly by plastic elongation of the bolt (minimum nut height ≥ 0,9 D and thread length of the bolt according to ISO 888);

— Type HV (system HV with or without direct tension indicators, if provided) designed to obtain ductility predominantly by plastic deformation of the engaged threads (nut height at approximately 0,8 D and bolt with short thread length).

4.2.2 Angle to failure during tightening (bolting assemblies)

Bolting assemblies shall be assessed in accordance with 5.2.1. The results shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8, EN 14399-9 or EN 14399-10 for the relevant type.

4.2.3 Axial load (bolting assemblies)

Bolting assemblies shall be assessed in accordance with 5.2.2. The results for the axial load during tightening ($F_{\text{bi max}}$) shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8 or EN 14399-10 for the relevant Type.

4.2.4 Compression load (bolting assemblies with direct tension indicators)

Bolting assemblies shall be assessed in accordance with 5.2.3. The results for compression load of bolting assemblies with direct tension indicators shall meet the requirements specified in EN 14399-9.

4.2.5 Calibrated preload (bolting assemblies with calibrated preload)

Bolting assemblies shall be assessed in accordance with 5.2.4. The results for calibrated preload (F_{ri}) shall meet the requirements specified in EN 14399-10.

4.3 Property class (bolting assemblies)

4.3.1 General

Property class expresses in a concise way a set of mechanical characteristics of the components. It is relevant for the ability of components to be matched together in order to obtain the declared performances of the bolting assemblies.

4.3.2 Elongation (bolts)

Bolts shall be assessed in accordance with 5.3.2. The results for elongation shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8 or EN 14399-10 for the relevant property class.

4.3.3 Tensile strength (bolts)

Bolts shall be assessed in accordance with 5.3.3. The results for tensile strength shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8 or EN 14399-10 for the relevant property class.

4.3.4 Strength under wedge loading (bolts)

Bolts shall be assessed in accordance with 5.3.4. The results for strength under wedge loading shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8 or EN 14399-10 for the relevant property class.

4.3.5 Tensile yield strength (bolts)

Bolts shall be assessed in accordance with 5.3.5. The results for the tensile yield strength shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8 or EN 14399-10 for the relevant property class.

4.3.6 Proof load (nuts and bolts)

Bolts and nuts shall be assessed in accordance with 5.3.6. The results for proof load shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8 or EN 14399-10 for the relevant property class.

4.3.7 Impact strength (bolts)

Bolts shall be assessed in accordance with 5.3.7. The results for impact strength shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8 or EN 14399-10 for the relevant property class.

4.3.8 Hardness (bolts, nuts, washers and, if provided, direct tension indicators)

Bolts, nuts, washers and direct tension indicators if provided, shall be assessed in accordance with 5.3.8.

For bolts and nuts, the results shall meet the requirements specified in EN 14399-3, EN 14399-4, EN 14399-7, EN 14399-8 or EN 14399-10 for the relevant property class.

For plain washers and plain chamfered washers, the results shall meet the requirements specified in EN 14399-5 or EN 14399-6.

For nut face washers, bolt face washers and direct tension indicators the results shall meet the requirements specified in EN 14399-9.

4.3.9 Compression load (direct tension indicators)

Direct tension indicators shall be assessed in accordance with 5.3.9. The results for the compression load of direct tension indicators shall meet the requirements specified in EN 14399-9 for the relevant property designation.

4.4 Product grade (bolts, nuts, washers and, if provided, direct tension indicators)

4.4.1 General

Product grade covers tolerances on dimensions and shape for bolts, nuts and washers. Product grade covers three critical features for direct tension indicators. It is relevant for the ability of components to be matched together in order to provide the declared performances of the bolting assemblies.

4.4.2 Bolts and nuts

Bolts and nuts shall be assessed in accordance with 5.4.2.

The thread tolerance classes shall be:

— 6g in accordance with ISO 965-2 for bolts without coating;

— 6g in accordance with ISO 965-2 for bolts before coating;

— 6H in accordance with ISO 965-2 for nuts without coating;

— 6AZ in accordance with ISO 965-5 for nuts with hot dip galvanized coating in accordance with EN ISO 10684;

— 6H (in accordance with ISO 965-2) to 6AZ (in accordance with ISO 965-5) for nuts with other coatings (the thread tolerance class shall be related to the applicable coating specifications).

The tolerances on dimensions and shape shall meet the requirements specified in EN ISO 4759-1 in accordance with the relevant product grade.

4.4.3 Washers

Washers shall be assessed in accordance with 5.4.3. The tolerances on dimensions and shape shall meet the requirements specified in EN ISO 4759-3, in accordance with the relevant product grade.

4.4.4 Direct tension indicators

Direct tension indicators shall be assessed in accordance with 5.4.4. The three critical features and tolerances shall meet the requirements specified in EN 14399-9.

4.5 *k*-class and *k*-factor (bolting assemblies)

k-class expresses in a concise way the ability of the bolting assemblies to be tightened by the torque control method or combined method by means of the *k*-factor.

The *k*-factor is determined according to 5.5 and the results shall comply:

— for type HR with EN 14399-3:2015, 7.5, for hexagon bolt and nut assemblies or EN 14399-7:2007, 8.5, for countersunk head bolt and nut assemblies;

— for type HV with EN 14399-4:2015, 7.5, for hexagon bolt and nut assemblies or EN 14399-8:2007, 8.5, for hexagon fit bolt and nut assemblies;

— for type HRC with EN 14399-10:2009, 8.4, for bolt and nut assemblies with calibrated preload.

The *k*-class shall be expressed as per Table 1.

Table 1 — *k*-class and *k*-factor

k-class	*k*-factor
K0	—
K1	$0{,}10 \le k_i \le 0{,}16$
K2	$0{,}10 \le k_m \le 0{,}23$ $\quad V_k \le 0{,}06$

5 Testing and assessment methods

5.1 General

The geometry of test specimens, test apparatus, testing procedure and evaluation of test results are specified in supporting standards for each component of the bolting assembly and for their combinations as bolting assemblies.

5.2 Type (bolting assemblies)

5.2.1 Angle to failure during tightening (bolting assemblies)

Bolting assemblies shall be tested according to EN 14399-2:2015, 6.5, to evaluate the margin against overtightening $\Delta\theta_2$ generally and in addition $1{,}1 \times \Delta\theta_{2min}$ for direct tension indicators, if provided, for the relevant type.

5.2.2 Axial load (bolting assemblies)

Suitability for preloading of bolting assemblies shall be carried out in accordance with EN 14399-2:2015, Clause 6.

5.2.3 Compression load (bolting assemblies with direct tension indicators)

Compression load testing of assemblies which include direct tension indicators shall be carried out in accordance with EN 14399-9:2009, 5.3.

5.2.4 Calibrated preload (bolting assemblies with calibrated preload)

The suitability test for calibrated preload for bolting assemblies with calibrated preload shall be carried out in accordance with EN 14399-10:2009, 8.3.

5.3 Property class (bolting assemblies)

5.3.1 General

The applicability of each test procedure is specified in EN ISO 898-1:2013, Clause 9 and EN ISO 898-2:2012, Clause 9, depending on the size of the components. Even if a single property is not listed in the following clauses or cannot be tested due to its size, all the requirements apply and may be demonstrated by means of the internal production control for comparable manufacturing lots.

5.3.2 Elongation (bolts)

Tensile testing shall be carried out in accordance with EN ISO 898-1:2013, 9.7.

5.3.3 Tensile strength (bolts)

Tensile testing shall be carried out in accordance with EN ISO 898-1:2013, 9.2 or 9.7.

5.3.4 Strength under wedge loading (bolts)

Tensile test under wedge loading shall be carried out in accordance with EN ISO 898-1:2013, 9.1.

5.3.5 Tensile yield strength (bolts)

Tensile testing shall be carried out in accordance with EN ISO 898-1:2013, 9.7.

5.3.6 Proof load (nuts and bolts)

Proof load testing of nuts shall be carried out in accordance with EN ISO 898-2:2012, 9.1.

Proof load testing of bolts shall be carried out in accordance with EN ISO 898-1:2013, 9.6.

5.3.7 Impact strength (bolts)

Impact testing shall be carried out in accordance with EN ISO 898-1:2013, 9.14.

5.3.8 Hardness (bolts, nuts, washers and, if provided, direct tension indicators)

Hardness testing of bolts shall be carried out in accordance with EN ISO 898-1:2013, 9.9.

Hardness testing of nuts shall be carried out in accordance with EN ISO 898-2:2012, 9.2.

Hardness testing of washers shall be carried out in accordance with EN ISO 6507-1 or EN ISO 6508-1.

Hardness testing of direct tension indicators shall be carried out in accordance with EN ISO 6507-1.

5.3.9 Compression load (direct tension indicators)

Compression load testing shall be carried out in accordance with EN 14399-9:2009, 3.4.

5.4 Product grade (bolts, nuts, washers and, if provided, direct tension indicators)

5.4.1 General

Each individual characteristic covered by product grade or specified as critical feature for direct tension indicators needs to be checked by means of appropriate measuring or gauging as relevant.

5.4.2 Bolts and nuts

Assessment shall be carried out in accordance with EN ISO 4759-1 before any coating of the components; the thread shall also be checked after coating, if any.

The tolerances of the components shall be checked by appropriate gauges or measuring equipment of the required accuracy as specified in Table 2 and Table 3.

Table 2 — Bolts

Dimension[a]	Accuracy mm	Method
Width across flats (s) or head diameter (d_k)	≤ 0,05	Measurement
Width across corners (e)	≤ 0,05	Measurement
Head height (k)	≤ 0,05	Measurement
Shank diameter (d_s)	≤ 0,05	Measurement
Length (l)	≤ 0,1	Measurement
Length of unthreaded shank (l_s)	≤ 0,1	Measurement
Distance from the bearing face to the first full form (full profile) thread (l_g)	≤ 0,1	Measurement
Thread dimensions	— [b]	Gauge
Underhead radius (r)	— [b]	Gauge
Head angle (of countersunk bolts) (α)	≤ 0,5°	Measurement
Slot depth (t)	≤ 0,1	Measurement
Width across flats of spline end (s_b)	≤ 0,05	Measurement
Width across corners of spline end (e_b)	≤ 0,05	Measurement
Break off length of spline end (F_2)	≤ 0,1	Measurement

[a] Symbols and descriptions of dimensions as defined in EN ISO 225.

[b] The use of GO/NO-GO gauges does not permit the specification of a value of accuracy.

Table 3 — Nuts

Dimension[a]	Accuracy mm	Method
Width across flats (s)	≤ 0,05	Measurement
Width across corners (e)	≤ 0,05	Measurement
Nut height (m)	≤ 0,05	Measurement
Thread dimensions	— [b]	Gauge

[a] Symbols and descriptions of dimensions as defined in EN ISO 225.

[b] The use of GO/NO-GO gauges does not permit the specification of a value of accuracy.

5.4.3 Washers

Assessment shall be carried out in accordance with EN ISO 4759-3 before any coatings.

The tolerances of the components shall be checked by standard gauges or measuring equipment of the required accuracy as specified in Table 4.

Table 4 — Washers

Dimension[a]	Accuracy mm	Method
Hole diameter (d_1)	≤ 0,1/—[b]	Measurement/Gauge
Outer diameter (d_2)	≤ 0,1	Measurement
Thickness (h)	≤ 0,05	Measurement

[a] Symbols and descriptions of dimensions as defined in EN 14399-5, EN 14399-6 or EN 14399-9.

[b] The use of GO/NO-GO gauges does not permit the specification of a value of accuracy.

5.4.4 Direct tension indicators

Assessment shall be carried out in accordance with EN 14399-9:2009, 3.1, before any coatings.

The critical features of the components shall be checked by standard gauges or measuring equipment of the required accuracy as specified in Table 5.

Table 5 — Direct Tension Indicators

Dimension[a]	Accuracy mm	Method
Hole diameter (d_1)	≤ 0,1/—[b]	Measurement/Gauge
Protrusion tangential diameter (d_3)	≤ 0,1/—[b]	Measurement/Gauge
Height of protrusions (h_3)	≤ 0,1/—[b]	Measurement/Gauge

[a] Symbols and descriptions of dimensions as defined in EN 14399-9.

[b] The use of GO/NO-GO gauges does not permit the specification of a value of accuracy.

5.5 k-class and k-factor (bolting assemblies)

Assessment of the k-class and k-factor shall be carried out in accordance with EN 14399-2:2015, Clause 6.

6 Assessment and Verification of Constancy of Performance (AVCP)

6.1 General

The compliance of high-strength structural bolting assemblies for preloading with the requirements of this standard and with the performances declared by the manufacturer in the Declaration of Performance (DoP) shall be demonstrated by:

— determination of the product type (type testing);

— factory production control by the manufacturer, including product assessment.

The manufacturer shall always retain the overall control and shall have the necessary means to take responsibility for the conformity of the product with its declared performance(s).

6.2 Type testing

6.2.1 General

All performances related to characteristics included in this standard shall be determined when the manufacturer intends to declare the respective performances unless the standard gives provisions for declaring them without performing tests (e.g. use of previously existing data, classification without further testing and conventionally accepted performance).

Assessment previously performed in accordance with the provisions of this standard, may be taken into account provided that they were made to the same or a more rigorous test method, under the same AVCP system on the same product or products of similar design, construction and functionality, such that the results are applicable to the product in question.

For the purposes of assessment, the manufacturer's products may be grouped into families, where it is considered that the results for one or more characteristics from any one product within the family are representative for that same characteristics for all products within that same family.

Products may be grouped in different families for different characteristics.

Reference to the assessment method standards should be made to allow the selection of a suitable representative sample.

In addition, the determination of the product-type shall be performed for all characteristics included in the standard for which the manufacturer declares the performance:

— at the beginning of the production of a new or modified high-strength structural bolting assemblies for preloading (unless a member of the same product range); or

— at the beginning of a new or modified method of production (where this may affect the stated properties); or

— it shall be repeated for the appropriate characteristic(s), whenever a change occurs in the high-strength structural bolting assemblies for preloading design, in the raw material or in the supplier of the components, or in the method of production (subject to the definition of a family), which would affect significantly one or more of the characteristics.

Where components are used whose characteristics have already been determined, by the component manufacturer, on the basis of assessment methods of other product standards, these characteristics need not be re-assessed. The specifications of these components shall be documented.

Products bearing regulatory marking in accordance with appropriate harmonized European specifications may be presumed to have the performances declared in the DoP, although this does not replace the responsibility on the high-strength structural bolting assemblies for preloading manufacturer to ensure that the high-strength structural bolting assemblies for preloading as a whole is correctly manufactured and its component products have the declared performance values.

6.2.2 Test samples, testing and compliance criteria

The number of samples of high-strength structural bolting assemblies for preloading to be tested and/or assessed shall be in accordance with Table 6.

Table 6 — Number of samples to be tested and/or assessed compliance criteria

Characteristic	Requirement	Assessment method	Number of samples	Compliance criteria
Type	4.2	5.2	[a]	All samples tested shall pass the test.
Property class	4.3	5.3	[b]	All samples tested shall pass the test.
Product grade	4.4	5.4	[b]	All samples tested shall pass the test.
k-class and k-factor	4.5	5.5	[a]	All samples tested shall pass the test.

[a] 5 tests for each required characteristic:
- 4 different nominal diameters which should reflect the different manufacturing methods (if any);
- each property class/property designation;
- each type of coating;
- each type and source of material.

[b] 5 tests for each required characteristic of all components except direct tension indicators which shall be 8 tests:
- 4 different nominal diameters which should reflect the different manufacturing methods (if any);
- each property class/property designation;
- each type of coating;
- each type and source of material.

6.2.3 Test reports

The results of the determination of the product-type shall be part of the test reports. All test reports shall be retained by the manufacturer for at least 10 years after the last date of production of the high-strength structural bolting assemblies for preloading to which they relate.

6.3 Factory production control (FPC)

6.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market comply with the declared performance(s) related to the essential characteristics.

The FPC system shall consist of procedures, regular inspection and tests and/or assessment and the use of the results to control raw and other incoming materials and components, equipment, the production process and the product.

All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures.

This factory production control system documentation shall ensure a common understanding of the evaluation of the constancy of performance and shall enable the achievement of the required product performances and the effective operation of the production control system to be checked. Factory production control therefore brings together operational techniques and all measures allowing maintenance and control of the compliance of the product with the declared performance(s) related to the essential characteristics.

6.3.2 Requirements

6.3.2.1 General

The manufacturer is responsible for organizing the effective implementation of the FPC system in line with the content of this European standard. Tasks and responsibilities in the production control organization shall be documented and this documentation shall be kept up-to-date.

The responsibility, authority and the relationship between personnel that manages, performs or verifies work affecting product constancy, shall be defined. This applies in particular to personnel that need to initiate actions preventing product non-constancies from occurring, actions in case of non-constancies and to identify and register product constancy problems.

Personnel performing work affecting the constancy of performance of the product shall be competent on the basis of appropriate education, training, skills and experience for which records shall be maintained.

In each factory the manufacturer may delegate the action to a person having the necessary authority to:

— identify procedures to demonstrate constancy of performance of the product at appropriate stages;

— identify and record any instance of non-constancy;

— identify procedures to correct instances of non-constancy.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control. The manufacturer's documentation and procedures should be appropriate to the product and manufacturing process. The FPC system should achieve an appropriate level of confidence in the constancy of performance of the product. This involves:

a) the preparation of documented procedures and instructions relating to factory production control operations, in accordance with the requirements of the technical specification to which reference is made;

b) the effective implementation of these procedures and instructions;

c) the recording of these operations and their results;

d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of non-constancy of performance.

Where subcontracting takes place, the manufacturer shall retain the overall control of the product and ensure that he receives all the information that is necessary to fulfill his responsibilities according to this European Standard.

If the manufacturer has part of the product designed, manufactured, assembled, packed, processed and/or labelled by subcontracting, the FPC of the subcontractor may be taken into account, where appropriate for the product in question.

The manufacturer who subcontracts all of his activities may in no circumstances pass the above responsibilities on to a subcontractor.

NOTE Manufacturers having an FPC system, which complies with EN ISO 9001 standard and which addresses the provisions of the present European Standard, are considered as satisfying the FPC requirements of the Regulation (EU) No 305/2011.

6.3.2.2 Equipment

6.3.2.2.1 Testing

All weighing, measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures, frequencies and criteria.

6.3.2.2.2 Manufacturing

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process. Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

6.3.2.3 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their compliance.

6.3.2.4 Traceability and marking

Individual components of high-strength structural bolting assemblies as well as their packages shall be identifiable and traceable with regard to their manufacture (manufacturer's identification mark). The manufacturer shall have written procedures ensuring that processes related to affixing traceability codes on labels and markings on high-strength structural bolting assemblies are inspected regularly.

6.3.2.5 Controls during manufacturing process

The manufacturer shall plan and carry out production under controlled conditions.

6.3.2.6 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the stated values of the characteristics he declares are maintained. The characteristics and the means of control are specified in Table 7:

— Type: shall be subject to the tests specified in 5.2, the minimum frequency of testing shall be as specified in Table 7.

— Property class: shall be subject to the tests specified in 5.3, the minimum frequency of testing shall be as specified in Table 7.

— Product grade: shall be subject to the tests specified in 5.4, the minimum frequency of testing shall be as specified in Table 7.

— k-class and k-factor: shall be subject to the tests specified in 5.5, the minimum frequency of testing shall be as specified in Table 7.

Table 7 — Frequency of testing for product testing and evaluation as part of FPC

Characteristic		Clause for relevant test	Minimum number of samples and minimum test frequency	
			Delivery condition for single bolting assembly lot	Delivery condition for extended bolting assembly lot
Type	**Bolting assemblies** Margin against over tightening ($\Delta\theta_2$)	5.2.1[a]	5 bolting assemblies per bolting assembly lot	1 bolting assembly per bolt manufacturing lot but at least 5 bolting assemblies per extended bolting assembly lot independent of bolt length (i.e. the extended bolting assembly lot may include different bolt lengths but shall only include one manufacturing lot of nuts)
	Axial load ($F_{bi\ max}$)	5.2.2[a]		
	Compression load for DTI containing assemblies	5.2.3		
	Suitability for calibrated preload (F_{ri}), if any	5.2.4		
Property class	**Bolts** Strength under wedge loading or Hardness	5.3.6 or 5.3.8	1 piece per hour for continuous heat treatment or 1 piece per batch	1 piece per hour for continuous heat treatment or 1 piece per batch
	Nuts Proof load or Hardness	5.3.5 or 5.3.8		
	Washers Hardness	5.3.8		
	Direct tension indicators Compression load	5.3.9	8 samples per batch	8 samples per batch
Product grade	**Bolting assemblies**	5.4	no mandatory testing	no mandatory testing
k-class and k-factor	**Bolting assemblies** Suitability for preloading (relevant k-class and k-factor)	5.5	5 bolting assemblies per bolting assembly lot	1 bolting assembly per bolt manufacturing lot, but at least 5 bolting assemblies per extended bolting assembly lot independent of bolt length (i.e. the extended bolting assembly lot may include different bolt lengths but shall only include one manufacturing lot of nuts)

[a] Both of these properties can be determined during a test in accordance with EN 14399-2.

6.3.2.7 Non-complying products

The manufacturer shall have written procedures which specify how non-complying products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures.

Where the product fails to satisfy the acceptance criteria, the provisions for non-complying products shall apply, the necessary corrective action(s) shall immediately be taken and the products or lots not complying shall be isolated and properly identified.

Once the fault has been corrected, the test or verification in question shall be repeated.

The results of controls and tests shall be properly recorded. The product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the records under the signature of the person responsible for the control/test.

With regard to any control result not meeting the requirements of this European Standard, the corrective measures taken to rectify the situation (e.g. a further test carried out, modification of manufacturing process, scrapping or rectification of product) shall be indicated in the records.

6.3.2.8 Corrective action

The manufacturer shall have documented procedures that instigate action to eliminate the cause of non-conformities in order to prevent recurrence.

6.3.2.9 Handling, storage and packaging

The manufacturer shall have procedures providing methods of product handling and shall provide suitable storage areas preventing damage or deterioration.

6.3.3 Product specific requirements

The FPC system shall address this European Standard and ensure that the products placed on the market comply with the declaration of performance.

The FPC system shall include a product specific FPC, which identifies procedures to demonstrate compliance of the product at appropriate stages, i.e.:

a) the controls and tests to be carried out prior to and/or during manufacture according to a frequency laid down in the FPC test plan, and/or

b) the verifications and tests to be carried out on finished products according to a frequency laid down in the FPC test plan.

If the manufacturer carries out verifications and tests only on finished products, the operations under b) shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

If the manufacturer carries out parts of the production himself, the operations under b) may be reduced and partly replaced by operations under a). Generally, the more parts of the production that are carried out by the manufacturer, the more operations under b) may be replaced by operations under a).

In any case the operation shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

NOTE Depending on the specific case, it can be necessary to carry out the operations referred to under a) and b), only the operations under a) or only those under b).

The operations under a) refer to the intermediate states of the product as on manufacturing machines and their adjustment, and measuring equipment, etc. These controls and tests and their frequency shall be chosen based on product-type and composition, the manufacturing process and its complexity, the sensitivity of product features to variations in manufacturing parameters, etc.

The manufacturer shall establish and maintain records that provide evidence that the production has been sampled and tested. These records shall show clearly whether the production has satisfied the defined acceptance criteria and shall be available for at least three years.

6.3.4 Initial inspection of factory and of FPC

Initial inspection of factory and of FPC shall be carried out when the production process has been finalized and in operation. The factory and FPC documentation shall be assessed to verify that the requirements of 6.3.2 and 6.3.3 are fulfilled.

During the inspection it shall be verified:

a) that all resources necessary for the achievement of the product characteristics included in this European Standard are in place and correctly implemented, and

b) that the FPC-procedures in accordance with the FPC documentation are followed in practice, and

c) that the product complies with the product-type samples, for which compliance of the product performance to the DoP has been verified.

All locations where final assembly or at least final testing of the relevant product is performed shall be assessed to verify that the above conditions a) to c) are in place and implemented. If the FPC system covers more than one product, production line or production process, and it is verified that the general requirements are fulfilled when assessing one product, production line or production process, then the assessment of the general requirements does not need to be repeated when assessing the FPC for another product, production line or production process.

All assessments and their results shall be documented in the initial inspection report.

6.3.5 Continuous surveillance of FPC

Surveillance of the FPC shall be undertaken once per year. The surveillance of the FPC shall include a review of the FPC test plan(s) and production processes(s) for each product to determine if any changes have been made since the last assessment or surveillance. The significance of any changes shall be assessed.

Checks shall be made to ensure that the test plans are still correctly implemented and that the production equipment is still correctly maintained and calibrated at appropriate time intervals.

The records of tests and measurement made during the production process and to finished products shall be reviewed to ensure that the values obtained still correspond with those values for the samples submitted to the determination of the product-type and that the correct actions have been taken for non-compliant products.

6.3.6 Procedure for modifications

If modifications are made to the product, production process or FPC system that could affect any of the product characteristics declared according to this standard, then all the characteristics for which the manufacturer declares performance, which may be affected by the modification, shall be subject to the type testing, as described in 6.2.1.

Where relevant, a re-assessment of the factory and of the FPC system shall be performed for those aspects, which may be affected by the modification.

All assessments and their results shall be documented in a report.

Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Regulation

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under Mandate M/120 “Structural metallic products and ancillaries” given to CEN by the European Commission and the European Free Trade Association.

If this European Standard is cited in the Official Journal of the European Union (OJEU), the clauses of this standard, shown in this annex, are considered to meet the provisions of the relevant mandate, under the Regulation (EU) No. 305/2011.

This annex deals with the CE marking of the high-strength structural bolting assemblies for preloading intended for the uses indicated in Table ZA.1 and shows the relevant clauses applicable.

This annex has the same scope as in Clause 1 of this standard related to the aspects covered by the mandate and is defined by Table ZA.1.

Table ZA.1 — Relevant clauses for product and intended use

Product:	High-strength structural bolting assemblies for preloading		
Intended use:	Structural metallic works		
Essential Characteristics	**Clauses in this and other European Standard(s) related to essential characteristics**	**Regulatory classes**	**Notes**
Type	4.2	—	Type
Property class	4.3	—	Class
Product grade	4.4	—	Grade
k-class and k-factor	4.5	—	Class

The declaration of the product performance related to certain essential characteristics is not required in those Member States (MS) where there are no regulatory requirements on these essential characteristics for the intended use of the product.

In this case, manufacturers placing their products on the market of these MS are not obliged to determine nor declare the performance of their products with regard to these essential characteristics and the option “No performance determined” (NPD) in the information accompanying the CE marking and in the declaration of performance (see ZA.3) may be used for those essential characteristics.

ZA.2 Procedure for Assessment and Verification of Constancy of Performance (AVCP) of high-strength structural bolting assemblies for preloading

ZA.2.1 System of AVCP

The AVCP system of high-strength structural bolting assemblies for preloading indicated in Table ZA.1, established by EC Decision(s) 98/214/EC (OJEU L80 of 18.3.1998) as amended by EC Decision 2001/596/EC (OJEU L209 of 2.8.2001) is shown in Table ZA.2 for the indicated intended use.

Table ZA.2 — System(s) of AVCP

Product(s)	Intended use(s)	Level(s) or class(es) of performance	AVCP system(s)
High-strength structural bolting assemblies for preloading	Structural metallic works	not applicable	System 2+
System 2+: See Regulation (EU) No. 305/2011 (CPR) Annex V, 1.3 including certification of the factory production control by a notified production control certification body on the basis of initial inspection of the manufacturing plant and of factory production control as well as of continuous surveillance, assessment and evaluation of factory production control.			

The AVCP of the high-strength structural bolting assemblies for preloading in Table ZA.1 shall be in accordance with the AVCP procedures indicated in Table ZA.3 resulting from application of the clauses of this or other European Standard indicated therein. The content of tasks of the notified body shall be limited to those essential characteristics as provided for, if any, in Annex III of the relevant mandate and to those that the manufacturer intends to declare.

Table ZA.3 — Assignment of AVCP tasks for high-strength structural bolting assemblies for preloading under system 2+

Tasks		Content of the task	AVCP clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.3
	Determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product	Parameters related to essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.2.1
	Further testing of samples taken at factory in accordance with the prescribed test plan	Essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.3.2.6, Table 7
Tasks for the notified production control certification body	Initial inspection of the manufacturing plant and of FPC	Parameters related to essential characteristics of Table ZA.1, relevant for the intended uses which are declared. Documentation of the FPC.	6.3.4
	Continuous surveillance, assessment and evaluation of FPC	Parameters related to essential characteristics of Table ZA.1, relevant for the intended uses which are declared. Documentation of the FPC.	6.3.5

ZA.2.2 Declaration of performance (DoP)

ZA.2.2.1 General

The manufacturer draws up the DoP and affixes the CE marking on the basis of the different AVCP systems set out in Annex V of the Regulation (EU) No 305/2011 on the basis of:

a) the determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product; the factory production control and the testing of samples taken at the factory in accordance with the prescribed test plan, carried out by the manufacturer; and

b) the certificate of conformity of the factory production control, issued by the notified production control certification body on the basis of:

   1) initial inspection of the manufacturing plant and of factory production control;

   2) continuous surveillance, assessment and evaluation of factory production control.

ZA.2.2.2 Content

The model of the DoP is provided in Annex III of the Regulation (EU) No 305/2011.

In accordance with this Regulation, the DoP shall contain, in particular, the following information:

— the reference of the product-type for which the declaration of performance has been drawn up;

— the AVCP system or systems of the construction product, as set out in Annex V of the CPR;

— the reference number and date of issue of the harmonized standard which has been used for the assessment of each essential characteristic;

— where applicable, the reference number of the Specific Technical Documentation used and the requirements with which the manufacturer claims the product complies.

The DoP shall in addition contain:

a) the intended use for the construction product, in accordance with the applicable harmonized technical specification;

b) the list of essential characteristics, as determined in the harmonized technical specification for the declared intended use;

c) the performance of at least one of the essential characteristics of the construction product, relevant for the declared intended use;

d) where applicable, the performance of the construction product, by levels or classes, or in a description, if necessary based on a calculation in relation to its essential characteristics determined in accordance with the Commission determination regarding those essential characteristics for which the manufacturer shall declare the performance of the product when it is placed on the market or the Commission determination regarding threshold levels for the performance in relation to the essential characteristics to be declared;

e) the performance of those essential characteristics of the construction product which are related to the intended use, taking into consideration the provisions in relation to the intended use where the manufacturer intends the product to be made available on the market;

f) for the listed essential characteristics for which no performance is declared, the letters “NPD“ (No Performance Determined).

Regarding the supply of the DoP, Article 7 of the Regulation (EU) No 305/2011 applies.

The information referred to in Article 31 or, as the case may be, in Article 33 of Regulation (EC) No 1907/2006, (REACH) shall be provided together with the DoP.

ZA.2.2.3 Example of DoP

The following gives an example of a filled-in DoP for high-strength structural bolting assemblies for preloading.

DECLARATION OF PERFORMANCE

(To be given by the manufacturer.)

1. Unique identification code of the product-type:

(To be given by the manufacturer.)

2. Type, batch or serial number or any other element allowing identification of the construction product as required under Article 11(4):

(To be given by the manufacturer.)

3. Intended use of the construction product, in accordance with the applicable harmonized technical specification, as foreseen by the manufacturer:

Structural metallic works

4. Name, registered trade name or registered trade mark and contact address of the manufacturer as required under Article 11(5):

AnyCo SA,

PO Box 21

B-1050 Brussels, Belgium

Tel. +32987654321

Fax: +32123456789

Email: anyco.sa@provider.be

5. Where applicable, name and contact address of the authorized representative whose mandate covers the tasks specified in Article 12(2):

Anyone Ltd

Flower Str. 24

West Hamfordshire

UK-589645 United Kingdom

Tel. +44987654321

Fax: +44123456789

e-mail: anyone.ltd@provider.uk

6. System of assessment and verification of constancy of performance of the construction product as set out in CPR, Annex V:

System 2+

7. In case of the declaration of performance concerning a construction product covered by a harmonized standard:

Notified factory production control certification body No. 5678 performed the initial inspection of the manufacturing plant and of factory production control and the continuous surveillance, assessment and evaluation of factory production control and issued the certificate of conformity of the factory production control.

8. Declared performance

Essential characteristics	Performance	Harmonized technical specification
Type	HR	EN 14399-1:2015
Property class	10.9/10	
Product grade	C/B/A	
k-class and k-Factor	K2: $0{,}10 \leq k_m \leq 0{,}23$ $V_k \leq 0{,}06$	

9. The performance of the product identified in points 1 and 2 is in conformity with the declared performance in point 8.

This declaration of performance is issued under the sole responsibility of the manufacturer identified in point 4.

Signed for and on behalf of the manufacturer by:

……

(name and function)

…… ……

(place and date of issue) (signature)

ZA.3 CE marking and labelling

The CE marking symbol shall be in accordance with the general principles set out in Article 30 of Regulation (EC) No 765/2008 and shall be affixed visibly, legibly and indelibly on the label. For single bolting assembly lots the label shall be attached to the packaging of the bolting assemblies. For extended bolting assembly lots that are supplied as components packed in separate packages the label shall appear on the accompanying document.

The CE marking shall be followed by:

— the last two digits of the year in which it was first affixed;

— the name and the registered address of the manufacturer, or the identifying mark allowing identification of the name and address of the manufacturer easily and without any ambiguity;

— the unique identification code of the product-type;

— the reference number of the declaration of performance;

— the level or class of the performance declared;

— the dated reference to the harmonized technical specification applied;

— the identification number of the notified body;

— the intended use as laid down in the harmonized technical specification applied.

The CE marking shall be affixed before the construction product is placed on the market. It may be followed by a pictogram or any other mark notably indicating a special risk or use.

CE **5678**	*CE marking, consisting of the "CE"-symbol* *Identification number of the notified production control certification body*
AnyCo Ltd, PO Box 21, B-1050, Brussels, Belgium **15** (To be given by the manufacturer.)	*Name and the registered address of the manufacturer, or identifying mark* *Last two digits of the year in which the CE marking was first affixed*
EN 14399-1:2015 (To be given by the manufacturer.) Intended to be used in structural metallic works	*Reference number of the DoP* *No. of European Standard applied, as referenced in OJEU* *Unique identification code of the product-type* *Intended use of the product as laid down in the European Standard applied*
Type: HR **Property class:** 10.9/10 **Product grade:** C/B/A k**-class and** k**-factor:** K2: $0{,}10 \leq k_m \leq 0{,}23$ $V_k \leq 0{,}06$	*Level or class of the performance declared*

Figure ZA.1 — Example CE marking information of products under AVCP system 2+

Bibliography

[1] EN 10204, *Metallic products - Types of inspection documents*

[2] EN ISO 9001, *Quality management systems - Requirements (ISO 9001)*

[3] EN ISO 12944 (all parts), *Paints and varnishes - Corrosion protection of steel structures by protective paint systems*

[4] Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing council directive 89/106/EEC

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