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Timber structures — Dowel-type fasteners — Requirements

bsi.

National foreword

This British Standard is the UK implementation of EN 14592:2022. It supersedes BS EN 14592:2008+A1:2012, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/518, Structural timber.

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

National Annex NA, Corrosion Resistance, provides additional informative guidance to assist users in determining the appropriate level of fastener corrosion protection necessary for their particular application, and can be found at the end of this document.

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Timber structures - Dowel-type fasteners - Requirements

Structures en bois - Éléments de fixation de type tige - Exigences

Holzbauwerke - Stiftförmige Verbindungsmittel - Anforderungen

This European Standard was approved by CEN on 13 February 2020.

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Contents

European foreword

This document (EN 14592:2022) has been prepared by Technical Committee CEN/TC 124 “Timber structures”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by October 2022 and conflicting national standards shall be withdrawn at the latest by January 2024.

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

This document supersedes EN 14592:2008+A1:2012.

The main changes with respect to the previous edition are listed below:

— new concepts concerning dimensions and tolerances, e.g. target diameter;

— improved categories for corrosion protection;

— new specifications on wood density for testing of connections with dowel-type fasteners;

— low cycle ductility classes (seismic performance) and related test method;

— axial stiffness, static ductility and torsional ratio for screws.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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1 Scope

This document specifies the characteristics of the following types of dowel-type fasteners:

— nails;

— staples;

— screws;

— dowels;

— bolts with nuts.

This document covers dowel-type fasteners for structural use in load bearing timber structures only. This document covers also the following additional intended uses of the screws:

— to fix roof or cladding elements to the timber structure, with or without insulation layers; and

— as reinforcement inserted in timber or in a glue laminated timber element to improve its resistance to compression perpendicular to the grain.

This document covers types of dowel-type fasteners, which are manufactured of either carbon steel or stainless steel and which may be coated for the following purposes:

— corrosion protection (as Type 1 coating);

— lubrication, to facilitate insertion (as Type 2 coating);

— withdrawal enhancement and/or collation for nails and staples (adhesive and/or resin coatings) (as Type 3 coating).

This document covers types of dowel-type fasteners, which are manufactured from materials and within the specifications for their geometry related properties, only as they are specified for:

— nails (see G.1);

— staples (see G.2);

— screws (see G.3);

— dowels (see G.4); and

— bolts with nuts (see G.5).

This document specifies also the assessment and verification of constancy of performance (AVCP) procedures of these characteristics and includes provisions for marking of dowel-type fasteners.

This document does not cover dowel-type fasteners treated with fire retardants to improve their fire performance, nor does it cover glued-in rods.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 409:2009, *Timber structures - Test methods - Determination of the yield moment of dowel type fasteners*

EN 634-2:2007, *Cement-bonded particleboards - Specifications - Part 2: Requirements for OPC bonded particleboards for use in dry, humid and external conditions*

EN 636:2012+A1:2015, *Plywood - Specifications*

EN 1382:2016, *Timber Structures - Test methods - Withdrawal capacity of timber fasteners*

EN 1383:2016, *Timber structures - Test methods - Pull through resistance of timber fasteners*

EN 1990:2002, *Eurocode - Basis of structural design*

EN 1993-1-4:2006/A1:2015, *Eurocode 3 - Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels*

EN 1995-1-1:2004[1], *Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings*

EN 10025-2:2019, *Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3:2019, *Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10088-1:2014, *Stainless steels - Part 1: List of stainless steels*

EN 10088-2:2014, *Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes*

EN 10088-3:2014, *Stainless steels - Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

EN 10088-4:2009, *Stainless steels - Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes*

EN 10088-5:2009, *Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes*

EN 10149-1:2013, *Hot rolled flat products made of high yield strength steels for cold forming - Part 1: General technical delivery conditions*

EN 10204:2004, *Metallic products - Types of inspection documents*

[1] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

EN 10218-1:2012, *Steel wire and wire products - General - Part 1: Test methods*

EN 10277:2018, *Bright steel products - Technical delivery conditions*

EN 13501-1:2018, *Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests*

EN 13986:2004+A1:2015, *Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking*

EN 14081-1:2016+A1:2019, *Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements*

EN 14358:2016, *Timber structures - Calculation and verification of characteristic values*

EN 15737:2009, *Timber Structures - Test methods - Torsional resistance of driving in screws*

EN ISO 898-1:2013[2], *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 1460:1994, *Metallic coatings - Hot dip galvanized coatings on ferrous materials - Gravimetric determination of the mass per unit area (ISO 1460:1992)*

EN ISO 1463:2004, *Metallic and oxide coatings - Measurement of coating thickness - Microscopical method (ISO 1463:2003)*

EN ISO 2081:2018, *Metallic and other inorganic coatings - Electroplated coatings of zinc with supplementary treatments on iron or steel (ISO 2081:2018)*

EN ISO 2178:2016, *Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method (ISO 2178:2016)*

EN ISO 3497:2000, *Metallic coatings - Measurement of coating thickness - X-ray spectrometric methods (ISO 3497:2000)*

EN ISO 3506-1:2009, *Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs (ISO 3506-1:2009)*

EN ISO 4042:2018, *Fasteners - Electroplated coating systems (ISO 4042:2018)*

EN ISO 6270-1:2018, *Paints and varnishes - Determination of resistance to humidity - Part 1: Condensation (single-sided exposure) (ISO 6270-1:2017)*

EN ISO 6892-1:2019, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2019)*

[2] As impacted by EN ISO 898-1:2013/AC:2013.

EN ISO 8407:2014, *Corrosion of metals and alloys - Removal of corrosion products from corrosion test specimens (ISO 8407:2009)*

EN ISO 8565:2011, *Metals and alloys - Atmospheric corrosion testing - General requirements (ISO 8565:2011)*

EN ISO 9226:2012, *Corrosion of metals and alloys - Corrosivity of atmospheres - Determination of corrosion rate of standard specimens for the evaluation of corrosivity (ISO 9226:2012)*

EN ISO 9227:2017, *Corrosion tests in artificial atmospheres - Salt spray tests (ISO 9227:2017)*

EN ISO 10289:2001, *Methods for corrosion testing of metallic and other inorganic coatings on metallic substrates - Rating of test specimens and manufactured articles subjected to corrosion tests (ISO 10289:1999)*

EN ISO 10666:1999, *Drilling screws with tapping screw thread - Mechanical and functional properties (ISO 10666:1999)*

EN ISO 10684:2004,[3] *Fasteners - Hot dip galvanized coatings (ISO 10684:2004)*

EN ISO 11997-1:2017, *Paints and varnishes - Determination of resistance to cyclic corrosion conditions - Part 1: Wet (salt fog)/dry/humid (ISO 11997-1:2017)*

EN ISO 16120-1:2017, *Non-alloy steel wire rod for conversion to wire - Part 1: General requirements (ISO 16120-1:2017)*

EN ISO 16120-2:2017, *Non-alloy steel wire rod for conversion to wire - Part 2: Specific requirements for general purpose wire rod (ISO 16120-2:2017)*

EN ISO 16120-3:2011, *Non-alloy steel wire rod for conversion to wire - Part 3: Specific requirements for rimmed and rimmed substitute, low-carbon steel wire rod (ISO 16120-3:2011)*

EN ISO 16120-4:2017, *Non-alloy steel wire rod for conversion to wire - Part 4: Specific requirements for wire rod for special applications (ISO 16120-4:2017)*

EN ISO 21968:2019, *Non-magnetic metallic coatings on metallic and non-metallic basis materials - Measurement of coating thickness - Phase-sensitive eddy-current method (ISO 21968:2019)*

ISO 965-1:2013, *ISO general purpose metric screw threads - Tolerances - Part 1: Principles and basic data*

ISO 965-2:1998, *ISO general purpose metric screw threads - Tolerances - Part 2: Limits of sizes for general purpose external and internal screw threads - Medium quality*

ISO 965-3:1998, *ISO general purpose metric screw threads - Tolerances - Part 3: Deviations for constructional screw threads*

ISO 965-4:1998, *ISO general purpose metric screw threads - Tolerances - Part 4: Limits of sizes for hot-dip galvanized external screw threads to mate with internal screw threads tapped with tolerance position H or G after galvanizing*

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[3] As impacted by EN ISO 10684:2004/AC:2009.

ISO 965-5:1998, *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, definitions, symbols, units and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1995-1-1:2004 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
smooth shank nail
nail that has a constant cross-section along its entire length

EXAMPLE Round, square or grooved.

3.1.2
ring shank nail
nail that has a profiled shank along a part of its length

EXAMPLE Ringed or twisted.

Note 1 to entry: The profiled length l_g is defined in Figure G.1 b).

3.1.3
staple crown width
distance between the outer edges of the staple legs

3.1.4
dowel
cylindrical metal fastener that does not contain an integral head

3.1.5
bolt
cylindrical metal fastener consisting of a screw part and a nut part

3.1.6
nominal diameter
cross-sectional dimension of a dowel-type fastener for the determination of a load bearing capacity

Note 1 to entry: Nails: for smooth shank nails, spiral rolled nails or annular ring shank nails, *d* is the outer cross-sectional diameter of the round nail wire, or the side length dimension of the cross-section for a square nail, for all other profiled nails, *d* is the cross-sectional diameter of the original wire rod, from which the profiled nail has been produced.

Note 2 to entry: Staples: *d* is the diameter of a round rod with the same area as that of the cross-sectional area of one leg of the staple. See G.2 for exceptions.

Note 3 to entry: Screws: *d* is the outer thread diameter.

Note 4 to entry: Dowels: *d* is the diameter.

Note 5 to entry: Bolts: *d* is the nominal diameter of the threaded part of the screw.

3.1.7
target diameter
diameter used to declare the nominal diameter of screws intended for use in load bearing timber structures as specified in G.3

Note 1 to entry: For the purpose of both production specifications and applicability, screws may only be produced allowing some tolerances. Thus for production purposes these tolerances are measured on the target diameter, d_t.

3.1.8
inner thread diameter
inner diameter of the thread of a screw

Note 1 to entry: The inner diameter is used in EN 1995-1-1:2004 to determine the effective diameter for laterally loaded screws.

3.1.9
stiffness
force for a unit deformation

3.1.10
coating type
the purpose of a coating is defined as follows:

— Type 1 coating: corrosion protection, with either pure zinc coating or hot-dipped galvanized coating or alternative coatings;

— Type 2 coating: lubrication, to facilitate insertion;

— Type 3 coating: withdrawal enhancement and/or collation for nails and staples (adhesive and/or resin coatings)

Note 1 to entry: A coating can serve more than one purpose, i.e. for staples the coating is both adhesive and serves collation purposes.

3.2 Symbols, units and abbreviated terms

For the purposes of this document, the symbols and abbreviations given in EN 1995-1-1:2004[4] and the following apply:

A_{80}	percentage elongation (%)
A_h	nail head area (mm²)
A_s	staple leg cross-sectional area (mm²)
b_R	staple crown width (mm)
d	nominal diameter (mm)
d_h	head diameter (mm)
d_s	diameter of the smooth shank of a screw (mm)
d^t	target diameter (mm)
d_i	inner thread diameter; inner diameter of fluting (mm)
d_1	secondary thread diameter (mm)
$f_{ax,k}$	characteristic withdrawal parameter (N/mm²)
$f_{head,k}$	characteristic head pull-through parameter (N/mm²)
$F_{tens,k}$	characteristic tensile capacity (N)
$f_{y,tens,k}$	characteristic tensile yield stress (N/mm²)
f_u	tensile strength of the wire (N/mm²)
h_t	nail head thickness (mm)
L	nominal dowel-type fastener length (mm)
l_g	length of profiling/threading (mm)
$l_{g,1}$	length of the secondary profiling/threading (mm)
l_p	length of the nail point (mm)
$M_{y,Rk}$	characteristic yield moment (N.mm)
$M_{tor,Rk}$	characteristic torsional moment capacity (N.mm)
α	bend angle (°)
α_c	bend angle under cyclic loading (°)
ρ_k	characteristic timber density when conditioned to constant mass at 20 °C and 65 % relative humidity (kg/m³)
ω	moisture content

[4] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

4 General product characteristics – Testing, assessment and sampling method

4.1 Corrosion resistance

4.1.1 General

Dowel-type fasteners shall withstand corrosion exposure of both the timber and the atmosphere for the design service life. Pure zinc coated and hot-dipped galvanized coated dowel-type fasteners shall be assigned to a T-category and C-category in accordance with Table 1 and Table 2. Stainless steel dowel-type fasteners shall be assigned to a category for corrosion resistance in atmosphere expressed by a Corrosion Resistance Class (CRC) and a T-category in accordance with Table 3 and Table 4. Alternative coated dowel-type fasteners shall be assigned to a T-category and C-category in accordance with Table 5 and Table 6.

The T-category refers to the fastener resistance with respect corrosion caused by the timber. The C-category and CRC refers to the fastener resistance with respect corrosion caused by the atmosphere.

The design service life is generally assumed to be 50 years for T-categories, C-categories and CRC. In addition, for alternative coated dowel-type fasteners to be used in structures with shorter service life or in replaceable structural parts, additional T-categories and C-categories with a design service life of 15 years are provided in Clause 4.1.4.

NOTE Advices on appropriate categories specification are given in Annex B.

4.1.2 Pure zinc coating and hot-dipped galvanized coating

4.1.2.1 Determination

The specifications to achieve a category of corrosion resistance with respect to timber and atmospheres shall be determined in accordance with Table 1 and Table 2, respectively. The corrosion protection stated in these tables is assumed to secure a design service life of 50 years.

4.1.2.2 Evaluation

The zinc thicknesses shall be measured in accordance with Annex C. The mean value of the coating thickness, measured in accordance with Annex C, shall be greater than or equal to the thickness specified by the manufacturer.

The zinc layer thickness of Table 1 and Table 2 may be reduced when a protective layer is applied. For applications in C2 atmospheres, CrIII passivation may reduce the required coating thickness by 25 %, and with CrVI passivation the required coating thickness may be reduced by 50 %.

4.1.2.3 Expression

The corrosion resistance of dowel-type fasteners made of pure zinc coated carbon steel or hot-dipped galvanized coated carbon steel shall be expressed according to Table 1 and Table 2, giving the dowel-type fastener a corrosion resistance category for both timber and atmosphere. The indication of the categories implies fulfilment with the provisions for corrosion resistance.

EXAMPLE 1 T3/C3.

Table 1 — Categories for corrosion resistance of dowel-type fasteners in timber — Minimum thicknesses for pure zinc coating and hot-dipped galvanized coating

Timber category	T1	T2	T3	T4	T5
Zinc thickness on carbon steel	–	10 µm	20 µm	55 µm	n.a.

Table 2 — Categories for corrosion resistance of dowel-type fasteners in atmospheres — Minimum thicknesses for pure zinc coating and hot-dipped galvanized coating

Atmosphere category	C1	C2nw	C2w	C3	C4	C5
Zinc thickness on carbon steel	–	10 µm	20 µm	55 µm	110 µm	n.a.

NOTE The minimum zinc thicknesses are based on the upper limit of the average steady corrosion rate for zinc in the first 20 years of EN ISO 9224:2012 and linearly extended to 50 years.

4.1.3 Stainless steel

4.1.3.1 Determination

The specifications to achieve a category of corrosion resistance with respect to atmospheres shall be determined in accordance with Table 3. The specifications to achieve a category of corrosion resistance with respect to timber shall be determined in accordance with Table 4. The corrosion protection stated in these tables is assumed to secure a design service life of 50 years.

4.1.3.2 Evaluation

The assignment of stainless steel grades to CRC is given in Table 3.

4.1.3.3 Expression

The corrosion resistance of dowel-type fasteners made of stainless steel shall be expressed giving the dowel-type fastener a corrosion resistance category for timber according to Table 4 and a CRC for atmospheric corrosivity according to Table 3.

In addition, either the steel number according to EN 10088-1:2014 or steel grade according to EN ISO 3506-1:2009, Table 1 may be added. The indication of the T-category and the CRC class implies fulfilment with the provisions for corrosion resistance.

EXAMPLE 1 T3/CRC II.

EXAMPLE 2 T3/C3 (1.4567); T3/CII (A2).

Table 3 — Stainless steel grades assigned to Corrosion Resistance Classes

Corrosion Resistance Class (CRC)	Steel number according to EN 10088-1:2014	EN ISO 3506-1:2009, Table 1
CRC II	1.4301	A2
	1.4307	A2
	1.4567	A2
	1.4541	A3
	1.4318	-
	1.4306	-
	1.4311	-
	1.4482	-

Corrosion Resistance Class (CRC)	Steel number according to EN 10088-1:2014	EN ISO 3506-1:2009, Table 1
CRC III	1.4401	A4
	1.4404	A4
	1.4578	A4
	1.4571	A5
	1.4362	–
	1.4062	–
	1.4162	–
	1.4662	–
	1.4429	-
	1.4432	-
	1.4435	-
CRC IV	1.4439	–
	1.4462	–
	1.4539	–
CRC V	1.4565	–
	1.4529	–
	1.4547	–
	1.4410	-
	1.4501	-
	1.4507	-

NOTE Classes are in accordance with EN 1993-1-4:2006/A1:2015, Annex A.

Table 4 — Categories for corrosion resistance of dowel-type fasteners in timber — Minimum specifications for stainless steel

Timber category	T1	T2	T3	T4	T5
Corrosion Resistance Class for stainless steel	–	–	CRC II	CRC III	CRC III

4.1.4 Alternative coatings

4.1.4.1 Determination

The specifications to achieve a category of corrosion resistance with respect to timber and atmospheres shall be determined in accordance with Table 5 and Table 6, respectively. The corrosion protection stated in these tables is assumed to secure a design service life of 50 years unless otherwise specified.

Alternative coated dowel-type fasteners satisfying test procedure according to A.2.1 shall be assigned to classes T3 and C2w.

Alternative coated dowel-type fasteners satisfying test procedure according to A.3.1 shall be assigned to classes T4 and C3.

Alternative coated dowel-type fasteners with coating made of inorganic materials with or without an organic top coat satisfying test procedure according to A4.1.4 shall be assigned to classes T3(15) and C4(15) or T2 and C2nw. Note that T3(15) and C4(15) assume to secure a design service life of 15 years.

Alternative coated dowel-type fasteners with coating made of organic materials with or without an organic top coat satisfying test procedure according to A4.2.3 shall be assigned to classes T3(15) and C4(15) or T2 and C2nw. Note that T3(15) and C4(15) assume to secure a design service life of 15 years.

4.1.4.2 Evaluation

For alternative coated dowel-type fasteners assigned to categories T3 and C2w the evaluation is defined in A.2.2.

For alternative coated dowel-type fasteners assigned to categories T4 and C3 the evaluation is defined in A.3.2.

For alternative coated dowel-type fasteners with coating made of inorganic materials with or without an organic top coat assigned to classes T3(15) and C4(15) or T2 and C2nw the evaluation is defined in A.4.1.5.

For alternative coated dowel-type fasteners with coating made of organic coatings with or without an organic top coat assigned to classes T3(15) and C4(15) or T2 and C2nw the evaluation is defined in A.4.2.3.

4.1.4.3 Expression

The corrosion resistance category of dowel-type fasteners made of alternative coated steel shall be expressed according to Table 5 and Table 6, giving the dowel-type fastener a corrosion resistance category for both timber and atmosphere. The indication of the categories implies fulfilment with the provisions for corrosion resistance.

EXAMPLE 4 T3(15)/C4(15).

Table 5 — Categories for corrosion resistance of dowel-type fasteners in timber — Minimum specifications for alternative coatings

Timber category	T1	T2	T3(15)	T3	T4	T5
Alternative coatings	–	Annex A A.4	Annex A A.4	Annex A A.2	Annex A A.3	n.a.

Table 6 — Categories for corrosion resistance of dowel-type fasteners in atmospheres — Minimum specifications for alternative coatings

Atmosphere category	C1	C2nw	C2w	C3	C4(15)	C4	C5
Alternative coatings	–	Annex A A.4	Annex A A.2	Annex A A.3	Annex A A.4	n.a.	n.a.

4.2 Low cycle ductility (seismic performance)

Dowel-type fasteners for use in seismic regions shall be assigned to one of the low cycle ductility classes given in Table 7 where α_c is the minimum required bending angle under cyclic loading and α is $45/d^{0,7}$ degrees (where d is in mm). Products shall be tested according to Annex E to ensure that the required value of α_c is achieved.

NOTE The level of seismic performance increases from S1 to S3.

Table 7 — Minimum values of bending angle αc for the classification of dowel-type fasteners into low cycle ductility classes

Low cycle ductility classes	Minimum value of bending angle under cyclic loading, α_c (°)
S1	$1,0\ \alpha \le \alpha_c < 1,5\ \alpha$
S2	$1,5\ \alpha \le \alpha_c < 2,0\ \alpha$
S3	$\alpha_c \ge 2,0\ \alpha$

4.3 Reaction to fire

4.3.1 General

The reaction to fire indicates the degree of contribution of the material to the behaviour of the construction product in the event of fire. Reaction to fire performance of a dowel-type fastener shall be based on the reaction to fire performance of its constituent materials and shall be expressed as one of the following reaction to fire classes, according to EN 13501-1:2018:

a) class A1, without testing (WT), for inorganic materials, when meeting the criteria specified in 4.3.2 ; or otherwise,

b) class, defined according to the result of testing of the organic material(s), for which the dowel-type fastener is made of or its surface coated with, according to the standard(s) referred to in EN 13501-1:2018, as specified in 4.3.3.

4.3.2 Classification without testing (WT)

The reaction to fire performance of a dowel-type fastener shall be expressed according to EN 13501-1:2018 as Class A1[5], without testing, provided that:

a) each of the constituent material(s) that the dowel-type fastener is made of, contains not more than 1 % of homogeneously distributed organic material, by mass or volume (whichever is the most onerous) (e.g. for uncoated steel and stainless steel); and

b) any external coating, if applied over the surface area of the dowel-type fastener, is made on inorganic material(s), which is/are also classified as Class A1 (e.g. for zinc coated steel, …).

5 See Decision of the Commission 96/603/EC of 1996-10-04 (see OJEU L 267 of 1996-10-19), as twice amended by 2000/605/EC of 2000-09-26 (see OJEU L 258 of 2000-10-12) and by 2003/424/EC of 2003-06-06 (see OJEU L 144 of 2003-06-12).

4.3.3 Classification according to the test results

For the reaction to fire performance of a dowel-type fastener each of its constituent organic material(s), including those in surface coating of the fastener, if any, shall be assessed regarding its reaction to fire classification according to EN 13501-1:2018 and only the lowest class of such materials shall be expressed.

The reaction to fire class of an individual constituent organic material shall be obtained as the result of the test method(s), relevant to the class claimed and as specified in the standards, referred to in EN 13501-1:2018. Test specimens used for the test methods, applicable for this classification, shall be prepared according to the relevant standards.

A constituent organic material of the dowel-type fastener, including those used in its surface coating, if any, is considered as the "external non-substantial component"[6] material.

5 Product specific characteristics - Testing, assessment and sampling method

5.1 Nails

5.1.1 Mechanical strength and stiffness

5.1.1.1 General

5.1.1.1.1 The following characteristics are applicable for assessing the mechanical strength and stiffness of nails:

a) characteristic yield moment;

b) characteristic withdrawal parameter;

c) characteristic head pull-through parameter;

d) characteristic tensile capacity;

e) low cycle ductility (seismic performance).

5.1.1.1.2 For the purposes of strength, the characteristic values shall be determined either by:

i) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D for 5.1.1.1.1, a), d), e) or EN 14358:2016 for 5.1.1.1.1, b), c);

ii) by calculation using relevant formulae, given in EN 1995-1-1:2004[7].

NOTE For the purposes of strength calculations for nailed joints, the nail diameter is taken as the nominal diameter, *d*, measured in accordance with G.1.

6 See Item 2 in Annex to Commission Delegated Regulation (EU) 2016/364 of 2015-07-01 (see OJEU L 68 of 2016-03-15).

7 As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

5.1.1.1.3 For the purposes of stiffness (bending angle α) the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

i) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D;

ii) by calculation using relevant formulae, given in EN 1995-1-1:2004[8].

5.1.1.2 Characteristic yield moment

NOTE See 5.1.1.1.1, a).

5.1.1.2.1 For smooth shank nails, with round or square cross-section, uncoated or coated, the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

a) 5.1.1.1.3, i) where test is based on EN 409:2009 (testing and calculation); or

b) 5.1.1.1.3, ii), (calculation).

5.1.1.2.2 For all other types of nail, including ring shank nails, coated or uncoated, the characteristic yield moment $M_{y,Rk}$ shall be determined in accordance with 5.1.1.1.3, i), where test is based on EN 409:2009 (testing and calculation). For ring shank nails the characteristic yield moment $M_{y,Rk}$ shall be determined for the weakest part.

5.1.1.2.3 Performance of the characteristic yield moment $M_{y,Rk}$ shall be expressed as value in Nmm. The expression of the value of $M_{y,Rk}$ implies compliance with the requirement $M_{y,Rk} \leq$ characteristic value from testing or calculated value.

5.1.1.3 Characteristic withdrawal parameter

NOTE See 5.1.1.1.1, b)

5.1.1.3.1 For smooth shank nails, uncoated or coated with Type 1 or Type 2 coatings, the characteristic withdrawal parameter $f_{ax,k}$ shall be determined either by:

a) 5.1.1.1.2, i), where test is based on EN 1382:2016, (testing and calculation); or

b) 5.1.1.1.2, ii) (calculation).

Test specimens shall be selected according to the provisions of Annex D, replacing those of EN 1382:2016. If necessary, when testing according to EN 1382:2016 the measured value of the characteristic withdrawal parameter shall be corrected for the wood densities in accordance with Annex D.

5.1.1.3.2 For all other types of nail, including ring shank nails, uncoated or coated with Type 1 or Type 2 coatings, the characteristic withdrawal parameter $f_{ax,k}$ shall be determined in accordance with 5.1.1.1.2, i), where test is based on EN 1382:2016, (testing and calculation).

Test specimens shall be selected according to the provisions of Annex D, replacing those of EN 1382:2016. If necessary, when testing according to EN 1382:2016 the measured value of the characteristic withdrawal parameter shall be corrected for the wood densities in accordance with Annex D.

5.1.1.3.3 For nails with the Type 3 coating, the characteristic withdrawal parameter $f_{ax,k}$ shall be determined in accordance with Annex F, (testing and calculation).

5.1.1.3.4 Performance of the characteristic withdrawal parameter $f_{ax,k}$ shall be expressed as value in N/mm² together with the value of the associated characteristic timber or wood-based product density ρ_k in kg/m³. The expression of the value of $f_{ax,k}$ implies compliance with the requirement $f_{ax,k}$ ≤ characteristic value from testing or calculated value.

5.1.1.4 Characteristic head pull-through parameter

NOTE See 5.1.1.1.1, c).

5.1.1.4.1 For smooth shank nails, uncoated or coated, the characteristic head pull-through parameter $f_{head,k}$ shall be determined either by:

a) 5.1.1.1.2, i), where test is based on EN 1383:2016, (testing and calculation); or

b) 5.1.1.1.2, ii) (calculation).

Test specimens shall be selected according to the provisions of Annex D, replacing those of EN 1382:2016. If necessary, when testing according to EN 1383:2016 the measured value of the characteristic head pull-through parameter shall be corrected for the wood densities in accordance with Annex D.

5.1.1.4.2 For all other types of nail, including ring shank nails, uncoated or coated, the characteristic head pull-through parameter $f_{head,k}$ shall be determined in accordance with 5.1.1.1.2, i), where test is based on EN 1383:2016, (testing and calculation).

Test specimens shall be selected according to the provisions of Annex D, replacing those of EN 1382:2016. If necessary, when testing according to EN 1383:2016 the measured value of the characteristic head pull-through parameter shall be corrected for the wood densities in accordance with Annex D.

5.1.1.4.3 Performance of the characteristic head pull-through parameter $f_{head,k}$ shall be expressed as value in N/mm² together with the value of the associated characteristic timber or wood-based product density ρ_k in kg/m³. The expression of the value of $f_{head,k}$ implies compliance with the requirement $f_{head,k}$ ≤ characteristic value from testing or calculated value.

5.1.1.5 Characteristic tensile capacity

NOTE See 5.1.1.1.1, d).

5.1.1.5.1 For any types of nail, uncoated or coated, the characteristic tensile capacity $F_{tens,k}$ (head pull-off or shank tensile capacity) shall be determined in accordance with 5.1.1.1.2, i), where test is based on EN 1383:2016, accounting for the following modifications (testing with calculation):

— use a steel plate to replace the head side timber member shown in Figure 4 of EN 1383:2016. The steel plate shall be of sufficient thickness to induce either a pull-off failure of the head, or a tensile failure of the shank and shall contain a pre-drilled hole for the nail which shall not exceed the maximum outer diameter of the nail + 1 mm in diameter;

— for partially profiled nails, the area of transition from the profiled to the smooth part of the shank shall be located within the free length of testing and shall have a clear distance from the jaws of the testing equipment of at least 3 *d*;

— the rate of loading shall be chosen so that the failure load (ultimate load) is reached within 10 s ± 5 s. Description of the mode and location of failure should be reported.

5.1.1.5.2 Performance of the characteristic tensile capacity $F_{tens,k}$ shall be expressed as value in N. The expression of the value of $F_{tens,k}$ implies compliance with the requirement $F_{tens,k}$ ≤ characteristic value from testing.

5.1.1.6 Low cycle ductility (seismic performance)

NOTE See 5.1.1.1.1, e).

5.1.1.6.1 For the purpose of assessing the seismic performance of any types of nail, uncoated or coated, the following two moment capacities shall be determined in accordance with the method given in Annex E, (testing with calculation)

a) reference mean yield moment capacity, determined on samples of the same batch by monotonic tests;

b) residual moment capacity, determined after three fully reversed cycles carried out at the value of the selected angle α_c considering that:

   — for smooth shank nails, the cross section subjected to bending shall be in the middle part;

   — for ring shank nails, the cross section subjected to bending shall be in the profiled part.

5.1.1.6.2 At the value of the selected α_c, the residual moment capacity of the nail shall be at least 80 % of the mean yield moment capacity.

5.1.1.6.3 The seismic performance shall be expressed as one of the low cycle ductility classes (S1 to S3), according to Table 8 in 4.2. Smooth shank non-hardened nails may be assumed to fulfil low cycle ductility Class S1 without testing. The expression of the low cycle ductility class implies compliance with the specifications for that class.

5.2 Staples

5.2.1 Mechanical strength and stiffness

5.2.1.1 General

5.2.1.1.1 The following characteristic are applicable for assessing the mechanical strength and stiffness of staples:

a) characteristic yield moment;

b) characteristic withdrawal parameter;

c) characteristic head pull-through parameter;

d) low cycle ductility (seismic performance).

5.2.1.1.2 For the purposes of strength, the characteristic values shall be determined either by:

i) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D for 5.2.1.1.1, a), d), or EN 14358:2016 for 5.2.1.1.1, b), c);

ii) by calculation using relevant formulae, given in EN 1995-1-1:2004[8].

NOTE For the purposes of strength calculations for stapled joints, the staple diameter is taken as the nominal leg diameter, d, measured in accordance with G.2.

5.2.1.1.3 For the purposes of stiffness (bending angle α) the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

i) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D;

ii) by calculation using relevant formulae, given in EN 1995-1-1:2004[9].

5.2.1.2 Characteristic yield moment

NOTE See 5.2.1.1.1, a).

5.2.1.2.1 For any types of staple, uncoated or coated, the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

a) 5.2.1.1.3, i) where test is based on EN 409:2009 (testing and calculation); or

b) 5.2.1.1.3, ii), (calculation).

5.2.1.2.2 Performance of the characteristic yield moment $M_{y,Rk}$ shall be expressed as value in Nmm.

5.2.1.3 Characteristic withdrawal parameter

NOTE See 5.2.1.1.1, b).

5.2.1.3.1 For any types of staples, uncoated or coated with Type 1 or Type 2 coatings, the characteristic withdrawal parameter $f_{ax,k}$ shall be determined either by:

a) 5.2.1.1.2, i), where test is based on EN 1382:2016, (testing and calculation); or

b) 5.2.1.1.2, ii) (calculation).

Test specimens shall be selected according to the provisions of Annex D, replacing those of EN 1382:2016. If necessary, when testing according to EN 1382:2016 the measured value of the characteristic withdrawal parameter shall be corrected for the wood densities in accordance with Annex D.

5.2.1.3.2 For staples with the Type 3 coating, the characteristic withdrawal parameter $f_{ax,k}$ shall be determined in accordance with Annex F, (testing and calculation).

5.2.1.3.3 Performance of the characteristic withdrawal parameter $f_{ax,k}$ shall be expressed as value in N/mm^2 together with the value of the associated characteristic timber or wood-based product density ρ_k in kg/m^3.

[8] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

[9] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

5.2.1.4 Characteristic head pull-through parameter

NOTE See 5.2.1.1.1, c).

5.2.1.4.1 For any types of staple, uncoated or coated, the characteristic head pull-through parameter $f_{head,k}$ shall be determined in accordance with 5.2.1.1.2, i), where test is based on EN 1383:2016, (testing and calculation).

Test specimens shall be selected according to the provisions of Annex D replacing those of EN 1382:2016. If necessary, when testing according to EN 1383:2016 the measured value of the characteristic head pull-through parameter shall be corrected for the wood densities in accordance with Annex D.

5.2.1.4.2 Performance of the characteristic head pull-through parameter $f_{head,k}$ shall be expressed as value in N/mm^2 together with the value of the associated characteristic timber or wood-based product density ρ_k in kg/m^3.

5.2.1.5 Low cycle ductility (seismic performance)

NOTE See 5.2.1.1.1, d).

5.2.1.5.1 For the purpose of assessing the seismic performance of any types of staples, uncoated or coated, the following two moment capacities shall be determined in accordance with the method given in Annex E, (testing with calculation):

a) reference mean yield moment capacity, determined on samples of the same batch by monotonic tests;

b) residual moment capacity, determined after three fully reversed cycles carried out in the middle part of one leg at the value of the selected angle α_c.

5.2.1.5.2 At the value of the selected α_c, the residual moment capacity of the staple shall be at least 80 % of the mean yield moment capacity.

5.2.1.5.3 The seismic performance shall be expressed as one of the low cycle ductility classes (S1 to S3), according to Table 8 in 4.2. Smooth shank non-hardened staples may be assumed to fulfil low cycle ductility Class S1 without testing.

5.3 Screws

5.3.1 Mechanical strength and stiffness

5.3.1.1 General

5.3.1.1.1 The following characteristic are applicable for assessing the mechanical strength and stiffness of screws:

a) characteristic yield moment;

b) static ductility;

c) characteristic withdrawal parameter;

d) characteristic head pull-through parameter;

e) characteristic tensile capacity;

f) characteristic tensile yield stress;

g) torsional ratio;

h) low cycle ductility (seismic performance);

i) axial stiffness.

5.3.1.1.2 For the purposes of strength, the characteristic values shall be determined either by:

i) testing in accordance with the standard or annex identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D for 5.3.1.1.1, a), b), e), f), g) (torsional resistance), h) or EN 14358:2016 for 5.3.1.1.1, c), d), g) (insertion moment), i);

ii) by calculation using relevant formulae, given in EN 1995-1-1:2004[10].

NOTE For the purposes of strength calculations for screwed joints, the screw diameter is taken as the nominal diameter, *d*, in accordance with G.3.

5.3.1.1.3 For the purposes of stiffness (bending angle α) the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

i) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D;

ii) by calculation using relevant formulae, given in EN 1995-1-1.

For screws where the target diameter d_t deviates from the nominal diameter *d*, the screw specimens for testing shall have a diameter within the range of d_t ± the tolerance.

5.3.1.2 Characteristic yield moment

NOTE See 5.3.1.1.1, a).

5.3.1.2.1 For any types of screw, uncoated or coated, the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

a) 5.3.1.1.3, i) where test is based on EN 409:2009 (testing and calculation), accounting for the following modifications (testing and calculation):

   — the bend angle, α, is limited to a maximum value of $45/d^{0,7}$ degrees (where *d* is in mm) without any cracks or loss of resistance,

   — $M_{y,Rk}$ is the minimum characteristic value determined on both the threaded section and the smooth section of the screw, if present.

b) 5.3.1.1.3, ii), (calculation).

[10] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

5.3.1.2.2 Performance of the characteristic yield moment $M_{y,Rk}$ shall be expressed as value in N.mm. Yield moments in both the threaded and in the smooth part may also be specified.

5.3.1.3 Static ductility

NOTE See 5.3.1.1.1, b).

5.3.1.3.1 Screws shall have sufficient ductility. Screws prove to have sufficient ductility by testing to a minimum bend angle, α, of $(45/d^{0,7} + 20)$ degrees without breaking into pieces. The test shall be performed on the threaded part of the screw according to EN 409:2009 (testing with calculation). Tests may be performed on the same specimens as used for yield moment test.

5.3.1.3.2 Static ductility performance shall be expressed as value of the bend angle in degrees at which screws pass the test.

5.3.1.4 Characteristic withdrawal parameter

NOTE See 5.3.1.1.1, c).

5.3.1.4.1 For all types of screw, uncoated or coated, the characteristic withdrawal parameter $f_{ax,k}$ shall be determined in accordance with 5.3.1.1.2, i), where test is based on EN 1382:2016 using a penetration depth of maximum 10 d and calculating the parameter using the nominal diameter, d, (testing and calculation).

Test specimens shall be selected according to the provisions of Annex D, replacing those of EN 1382:2016. If necessary, when testing according to EN 1382:2016 the measured value of the characteristic withdrawal parameter shall be corrected for the wood densities in accordance with Annex D.

5.3.1.4.2 Performance of the characteristic withdrawal parameter $f_{ax,k}$ shall be expressed as value in N/mm^2 together with the value of the associated characteristic timber or wood-based product density ρ_k in kg/m^3.

5.3.1.5 Characteristic head pull-through parameter

NOTE See 5.3.1.1.1, d).

5.3.1.5.1 For any types of screws, including fully threaded screws, uncoated or coated, the characteristic head pull-through parameter $f_{head,k}$ shall be determined in accordance with 5.3.1.1.2, i), where test is based on EN 1383:2016 and $f_{head,k}$ shall be calculated using the maximum tolerance value for head diameter, d_h, (testing and calculation).

Test specimens shall be selected according to the provisions of Annex D, replacing those of EN 1383:2016. If necessary, when testing according to EN 1383:2016 the measured value of the characteristic head pull-through parameter shall be corrected for the wood densities in accordance with Annex D.

5.3.1.5.2 For screws with a head diameter of at least 1,8 times the shank diameter, the characteristic head pull-through parameter for structural timber according to EN 14081-1:2016+A1:2019 with a characteristic density of 350 kg/m^3 can be assumed to be 10 N/mm^2 (without testing).

The same value applies to wood-based panels, according to EN 13986:2004+A1:2015, with thicknesses of more than 20 mm and of the following types:

— plywood: EN 636:2012+A1:2015-1S, EN 636:2012+A1:2015-2S, EN 636:2012+A1:2015-3S;

— solid wood panel: SWP/1, SWP/2, SWP/3;

— OSB: OSB/2, OSB/3, OSB/4;

— particle boards: P4, P5, P6, P7;

— cement-bonded particleboards: EN 634-2:2007, type 1 and type 2;

— fibreboards: HB.LA, HB.HLA1, HB.HLA2, MBH.LA1, MBH.LA2, MBH.HLS1, MBH.HLS2.

For thicknesses between 12 mm and 20 mm the head pull-through parameter may be assumed to be 8 N/mm² (without testing).

5.3.1.5.3 Performance of the characteristic head pull-through parameter $f_{head,k}$ shall be expressed as value in N/mm² together with the value of the associated characteristic timber or wood-based product density ρ_k in kg/m³.

5.3.1.6 Characteristic tensile capacity

NOTE See 5.3.1.1.1, e).

5.3.1.6.1 For any types of screws, uncoated or coated, the characteristic tensile capacity $F_{tens,k}$ (head pull-off or shank tensile capacity) shall be determined in accordance with 5.3.1.1.2, i), where test is based on EN 1383:2016, accounting for the following modifications (testing with calculation):

— use a steel plate to replace the head side timber member shown in Figure 4 of EN 1383:2016. The steel plate shall be of sufficient thickness to induce either a pull-off failure of the head, or a tensile failure of the shank and shall contain a pre-drilled hole for the screw which shall not exceed the maximum outer diameter of the screw + 1 mm in diameter;

— for partially threaded screws, the area of transition from the threaded part to the smooth part of the shank shall be located within the free length of testing and shall have a clear distance from the jaws of the testing equipment of at least 3 d;

— the rate of loading shall be chosen so that the failure load (ultimate load) is reached within 10 s ± 5 s. Description of the mode and location of failure should be reported.

5.3.1.6.2 Performance of the characteristic tensile capacity $F_{tens,k}$ shall be expressed as value in N.

5.3.1.7 Characteristic tensile yield stress

NOTE See 5.3.1.1.1, f).

5.3.1.7.1 For fully threaded screws only, uncoated or coated, the characteristic tensile yield stress $f_{y,tens,k}$ shall be determined in accordance with 5.3.1.1.2, i), where test is based on 5.3.1.6.1 accounting for the following modifications (testing with calculation):

— the elongation shall be measured in the middle of each screw using a strain gauge;

— the measuring length shall be in the range 50 mm and 80 mm;

— the yield strength is the stress at the crossing point between the stress-strain curve and a straight line parallel to the initial part of the stress-strain line but off-set by 0,2 %. After exceeding the yield strength, the applied load shall be reduced to 10 % of the yield force. Afterwards the load shall be increased so it exceeds the original force at yield;

— the characteristic tensile yield stress is obtained by the following formulae:

$f_{tens,y,k} = F_{tens,y,k} / A_{core}$ where $A_{core} = \pi / 4 d_1^2$

5.3.1.7.2 Performance of the characteristic tensile yield stress $f_{y,tens,k}$ shall be expressed as value in N/mm².

5.3.1.8 Torsional ratio

NOTE See 5.3.1.1.1, g).

5.3.1.8.1 For the purpose of assessing the torsional ratio of any types of screw, uncoated or coated, the following two quantities shall be considered (testing with calculation):

a) characteristic torsional moment capacity $M_{tor,Rk}$ determined by testing in accordance with the method given in EN ISO 10666:1999, 4.2.3;

b) mean torsional resistance to insertion into timber, $M_{tor,Em}$, shall be determined in accordance with EN 15737:2009.

5.3.1.8.2 The value of the torsional ratio is obtained by the following: $M_{tor,Rk} / M_{tor,Em}$.

5.3.1.8.3 Performance of the torsional ratio shall be expressed as value $M_{tor,Rk} / M_{tor,Em}$ together with the value of $M_{tor,Em}$.

5.3.1.9 Low cycle ductility (seismic performance)

NOTE See 5.3.1.1.1, h).

5.3.1.9.1 For the purpose of assessing the seismic performance of any types of screws, uncoated or coated, the following two moment capacities shall be determined in accordance with the method given in Annex E, (testing with calculation):

a) reference mean yield moment capacity, determined on samples of the same batch by monotonic tests;

b) residual moment capacity, determined after three fully reversed cycles carried out at the value of the selected angle α_c considering that the cross section subjected to bending shall be in the threaded part.

5.3.1.9.2 At the value of the selected α_c, the residual moment capacity of the screw shall be at least 80 % of the mean yield moment capacity.

5.3.1.9.3 The seismic performance shall be expressed as one of the low cycle ductility classes (S1 to S3), according to Table 8 in 4.2.

5.3.1.10 Axial stiffness

NOTE See 5.3.1.1.1, i).

5.3.1.10.1 For self-tapping screws in softwood inserted perpendicular to the grain, the axial stiffness in the serviceability limit state can be determined as follows (calculation):

$K_{ser,ax} = d.l_{ef}\, 25$ N/mm³

where d is the outer thread diameter and l_{ef} is the penetration depth of the threaded part. The equation presupposes a moisture content of 12 % and a mean density of 450 kg/m³.

5.3.1.10.2 Performance of the axial stiffness in the serviceability limit state $K_{ser,ax}$ shall be expressed as value in N/mm.

5.4 Dowels

5.4.1 Mechanical strength and stiffness

5.4.1.1 General

5.4.1.1.1 The following characteristic are applicable for assessing the mechanical strength and stiffness of dowels:

a) characteristic yield moment;

b) seismic performance.

5.4.1.1.2 For the purposes of strength, the characteristic values shall be determined either by:

i) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D;

ii) by calculation using relevant formulae, given in EN 1995-1-1:2004[11].

NOTE For the purposes of strength calculations for dowelled joints, the dowel diameter is taken as the nominal diameter, *d*, measured in accordance with G.4.

5.4.1.1.3 For the purposes of stiffness (bending angle α) the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

a) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D;

b) by calculation using relevant formulae, given in EN 1995-1-1:2004[12].

5.4.1.2 Characteristic yield moment

NOTE See 5.4.1.1.1, a).

5.4.1.2.1 For any types of dowel, uncoated or coated, the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

a) 5.4.1.1.3, i) where test is based on EN 409:2009 (testing and calculation), accounting for the following modifications (testing and calculation):

   — the bend angle, α, is limited to a maximum value of $45/d^{0,7}$ degrees (where d is in mm);

b) 5.4.1.1.3, ii), (calculation).

5.4.1.2.2 Performance of the characteristic yield moment $M_{y,Rk}$ shall be expressed as value in N.mm.

[11] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

5.4.1.3 Low cycle ductility (seismic performance)

NOTE See 5.4.1.1.1, b).

5.4.1.3.1 For the purpose of assessing the seismic performance of any types of dowels, uncoated or coated, the following two moment capacities shall be determined in accordance with the method given in Annex E, (testing with calculation):

a) reference mean yield moment capacity, determined on samples of the same batch by monotonic tests;

b) residual moment capacity, determined after three fully reversed cycles carried out at the value of the selected angle α_c.

Additionally, for use in a seismic area, dowels shall be secured against withdrawal during the earthquake. The characteristic withdrawal resistance shall be determined according to EN 1382:2016 using wood with a mean density of 420 kg/m^3. Test specimens used for the determination of withdrawal parameter of dowels shall be selected according to the provisions of Annex D, replacing those of EN 1382:2016. Characteristic values shall be calculated in accordance with EN 14358:2016.

5.4.1.3.2 At the value of the selected α_c, the residual moment capacity of the dowel shall be at least 80 % of the mean yield moment capacity. Additionally, the characteristic withdrawal capacity shall be not less than 1 kN.

5.4.1.3.3 The seismic performance shall be expressed as one of the low cycle ductility classes (S1 to S3), according to Table 8 in 4.2. Fluted dowels manufactured to the specifications of G.4 may be assumed to fulfil low cycle ductility Class S1 without testing.

5.5 Bolts and nuts

5.5.1 Mechanical strength and stiffness

5.5.1.1 General

5.5.1.1.1 The following characteristic are applicable for assessing the mechanical strength and stiffness of bolts:

a) characteristic yield moment;

b) seismic performance.

5.5.1.1.2 For the purposes of strength, the characteristic values shall be determined either by:

i) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D;

ii) by calculation using relevant formulae, given in EN 1995-1-1:2004[12].

NOTE For the purposes of strength calculations for bolted joints, the bolt diameter is taken as the nominal diameter, *d*, measured in accordance with G.5.

[12] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

5.5.1.1.3 For the purposes of stiffness (bending angle α) the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

a) testing in accordance with the standard or annex, identified in the subsequent subclauses, followed by calculation in accordance with EN 1990:2002, Annex D;

b) by calculation using relevant formulae, given in EN 1995-1-1:2004[13].

5.5.1.2 Characteristic yield moment

NOTE See 5.5.1.1.1, a).

5.5.1.2.1 For any types of bolts, uncoated or coated, the characteristic yield moment $M_{y,Rk}$ shall be determined either by:

a) 5.5.1.1.3, i) where test is based on EN 409:2009 (testing and calculation), accounting for the following modifications (testing and calculation):

   — the bend angle, α, is limited to a maximum value of $45/d^{0,7}$ degrees (where d is in mm);

b) 5.5.1.1.3, ii), (calculation).

5.5.1.2.2 Performance of the characteristic yield moment $M_{y,Rk}$ shall be expressed as value in N.mm.

5.5.1.3 Low cycle ductility (seismic performance)

NOTE See 5.5.1.1.1, b).

5.5.1.3.1 For the purpose of assessing the seismic performance of any types of bolts, uncoated or coated, the following two moment capacities shall be determined in accordance with the method given in Annex E, (testing with calculation):

a) reference mean yield moment capacity, determined on samples of the same batch by monotonic tests;

b) residual moment capacity, determined after three fully reversed cycles carried out at the value of the selected angle α_c considering that the cross section subjected to bending shall be in the threaded part.

5.5.1.3.2 At the value of the selected α_c, the residual moment capacity of the bolt shall be at least 80 % of the mean yield moment capacity.

5.5.1.3.3 The seismic performance shall be expressed as one of the low cycle ductility classes (S1 to S3), according to Table 8 in 4.2. Bolts of strength classes 4.6 or 4.8, where the screw part has a rolled thread, may be assumed to fulfil low cycle ductility Class S1 without testing.

[13] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

6 Assessment and verification of constancy of performance - AVCP

6.1 General

The technical details necessary for the implementation of the system of assessment and verification of constancy of performance comprise provisions with regards to:

— the applicable factory production control; and

— the assessment of the performance of the construction product, which may be carried out on the basis of testing/measuring (including sampling), calculation, tabulated values or descriptive documentation of the product.

6.2 Assessment of performance

6.2.1 General

When the intention is to declare any performance related to characteristics included in this document, this shall be carried out on the basis of testing (including sampling) in accordance with Clauses 4 and 5, unless this document gives provisions for declaring them without performing tests, i.e. on the basis of calculation, tabulated values or descriptive documentation of the product (e.g. use of previously existing data, conditions for classification without (further) testing[14] and conventionally accepted performance).

Assessment previously performed in accordance with the provisions of this document may be considered provided that this assessment was performed to the same, an equivalent or a more rigorous assessment 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.

A product performance is not necessarily the same as (a) sample(s) performance, i.e. in general, it is not intended that test report results are copied into Declarations of performance (DoPs). Once the assessment specified in the harmonized technical specification has been performed, based on all the available information, verification is necessary whether those test report results correspond with the product's performance.

For the purposes of assessment, the 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.

NOTE 1 Products can be grouped into different families for different characteristics.

The necessary information should be provided to permit the selection of suitable representative samples.

In addition, the determination of the product type shall be:

— carried out for all characteristics included in the standard for which the performance declarations are intended:

  — on first application of this document, or

  — at the beginning of the production of a new or modified dowel-type fastener, unless a member of the same product family; or

14 In the framework of Regulation (EU) N° 305/2011, these are published in the Official Journal of the European Union as Commission Delegated Decisions (and may also be known as "deemed-to-satisfy", CWFT, WFT or WT provisions)

- at the beginning of a new or modified method of production where the modification may affect the stated properties; or
- when one or more assessment methods of this document changes in such a way that the result(s) of the assessment done according to the previous method(s) is significantly overestimated compared to the result(s) obtained with the new method(s), for the characteristic(s) covered by these methods;
- repeated for the appropriate characteristic(s), whenever a change occurs in the dowel-type fastener design, in the raw material(s) or in the supplier of the components, and/or in the method of production (subject to the definition of a family), which may affect significantly one or more of the characteristics;

— take into consideration substitution or extension rules where and when relevant.

Where components are used whose characteristics have already been determined on the basis of assessment methods of other harmonized technical specifications, these characteristics do not need to be re-assessed, if the intended use and the assessment methods correspond and if the same or higher AVCP system applies for these components. The specifications of these components shall be documented.

6.2.2 Test samples, testing and conformity criteria

The samples of dowel-type fasteners to be tested/assessed shall be in accordance with Tables 8 to 12, as appropriate:

— Table 8, for nails;

— Table 9, for staples;

— Table 10, for screws;

— Table 11, for dowels;

— Table 12, for bolts and nuts.

Table 8 — Nails: number of samples to be tested and compliance criteria

Characteristic	Clause	Assessment method	No. of samples	Compliance criteria
Mechanical strength and stiffness, dealt with by:				
a) Characteristic yield moment, $M_{y,Rk}$				
- for smooth shank nails, with round or square cross-section, uncoated or coated	5.1.1.2.1, a)	5.1.1.2.1, a)	10	5.1.1.2.3
- for all other types of nails, uncoated or coated	5.1.1.2.2	5.1.1.2.2	10	5.1.1.2.3
b) Characteristic withdrawal parameter, $f_{ax,k}$				
- for smooth shank nails, uncoated or coated with Type 1 or Type 2 coatings	5.1.1.3.1, a)	5.1.1.3.1	20	5.1.1.3.4
- for all other types of nails, uncoated or coated with Type 1 or Type 2 coatings	5.1.1.3.2	5.1.1.3.2	20	5.1.1.3.4

Characteristic	Clause	Assessment method	No. of samples	Compliance criteria
- for nails with Type 3 coating	5.1.1.3.3	5.1.1.3.3	20	5.1.1.3.4
c**) Characteristic head pull-through parameter, $f_{head,k}$**				
- for smooth shank nails, uncoated or coated	5.1.1.4.1, a)	5.1.1.4.1	20	5.1.1.4.3
- for all other type of nails, uncoated or coated	5.1.1.4.2	5.1.1.4.2	20	5.1.1.4.3
d) Characteristic tensile capacity, $F_{tens,k}$				
- for any type of nails, uncoated or coated	5.1.1.5.1	5.1.1.5.1	10	5.1.1.5.2
e) Low cycle ductility (seismic performance): low cycle ductility class				
- for smooth shank non-hardened nails, uncoated or coated [a]	5.1.1.6.1	5.1.1.6.2	3 + 3 [b]	5.1.1.6.3
- for all other type of nails, uncoated or coated	5.1.1.6.1	5.1.1.6.2	3 + 3 [b]	5.1.1.6.3
Reaction to fire, for:				
Reaction to fire class for any type of nails, uncoated or coated, not meeting the specifications of 4.3.2	4.3.3	4.3.3	5	4.3.3
Durability, dealt with by:				
a) Corrosion resistance in timber: category for corrosion resistance in timber				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3

[a] Not required in case of determination without testing

[b] 3 specimens for cyclic tests and 3 specimens for monotonic tests

[c] For T3 and C2w, T4 and C3 corrosion categories

Table 9 — Staples: number of samples to be tested and compliance criteria

Characteristic	Clause	Assessment method	No. of samples	Compliance criteria
Mechanical strength and stiffness, dealt with by:				
a) Characteristic yield moment, $M_{y,Rk}$				
- for any types of staples, uncoated or coated	5.2.1.2.1, a)	5.2.1.2.1, a)	10	5.2.1.2.2
b) Characteristic withdrawal parameter, $f_{ax,k}$				
- for staples with Type 3 coating	5.2.1.3.1	5.2.1.3.2	20	5.2.1.3.3
- for all other types of staples, uncoated or coated	5.2.1.3.1, a)	5.2.1.3.1	20	5.2.1.3.3
c) Characteristic head pull-through parameter, $f_{head,k}$				
- for any types of staples, uncoated or coated	5.2.1.4.1	5.2.1.4.1	20	5.2.1.4.2
d) Low cycle ductility (seismic performance): low cycle ductility class				
- for smooth shank non-hardened staples, uncoated or coated [a]	5.2.1.5.1	5.2.1.5.2	3 + 3 [b]	5.2.1.5.3
- for all other type of staples, uncoated or coated	5.2.1.5.1	5.2.1.5.2	3 + 3 [b]	5.2.1.5.3
Reaction to fire, for:				
Reaction to fire class for any type of staples, uncoated or coated, not meeting the specifications of 4.3.2	4.3.3	4.3.3	5	4.3.3
Durability, dealt with by:				
a) Corrosion resistance in timber: category for corrosion resistance in timber				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3

[a] Not required in case of determination without testing.

[b] 3 specimens for cyclic tests and 3 specimens for monotonic tests.

[c] For T3 and C2w, T4 and C3 corrosion categories.

Table 10 — Screws: number of samples to be tested and compliance criteria

Characteristic	Clause	Assessment method	No. of samples	Compliance criteria
Mechanical strength and stiffness, dealt with by:				
a) Characteristic yield moment, $M_{y,Rk}$				
- for any type of screws, uncoated or coated	5.3.1.2.1, a)	5.3.1.2.1, a)	10	5.3.1.2.2
b) Static ductility, α (bend angle at which screws pass the test)				
- for any type of screws, uncoated or coated	5.3.1.3.1	5.3.1.3.1	10	5.3.1.3.2
c) Characteristic withdrawal parameter, $f_{ax,k}$				
- for any type of screws, uncoated or coated	5.3.1.4.1	5.3.1.4.1	20	5.3.1.4.2
d) Characteristic head pull-through parameter, $f_{head,k}$				
- for screws with dh ≥ 1,8 ds, uncoated or coated [a]	5.3.1.5.1	5.3.1.5.1	20	5.3.1.5.3
- for all other type of screws, uncoated or coated	5.3.1.5.1	5.3.1.5.1	20	5.3.1.5.3
e) Characteristic tensile capacity, $F_{tens,k}$				
- for any type of screws, uncoated or coated	5.3.1.6.1	5.3.1.6.1	10	5.3.1.6.2
f) Characteristic tensile yield stress, $f_{y,tens,k}$				
- for fully threaded screws only, uncoated or coated	5.3.1.7.1	5.3.1.7.1	10	5.3.1.7.2
g) Torsional ratio, $M_{tor,Rk}$ / $M_{tor,Em}$				
- for any type of screws, uncoated or coated	5.3.1.8.1	5.3.1.8.2	10	5.3.1.8.3
h) Low cycle ductility (seismic performance): low cycle ductility class				
- for any type of screws, uncoated or coated [a]	5.3.1.9.1	5.3.1.9.2	3 + 3 [b]	5.3.1.9.3
Reaction to fire, for:				
Reaction to fire class for any type of screws, uncoated or coated, not meeting the specifications of 4.3.2	4.3.3	4.3.3	5	4.3.3

Characteristic	Clause	Assessment method	No. of samples	Compliance criteria
Durability, dealt with by:				
a) Corrosion resistance in timber: category for corrosion resistance in timber				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3

[a] Not required in case of determination without testing

[b] 3 specimens for cyclic tests and 3 specimens for monotonic tests

[c] For T3 and C2w, T4 and C3 corrosion categories

Table 11 — Dowels: number of samples to be tested and compliance criteria

Characteristic	Clause	Assessment method	No. of samples	Compliance criteria
Mechanical strength and stiffness, dealt with by:				
a) Characteristic yield moment, $M_{y,Rk}$				
- for any type of dowels, uncoated or coated	5.4.1.2.1 a)	5.4.1.2.1 a)	10	5.4.1.2.2
b) Low cycle ductility (seismic performance): low cycle ductility class				
- for fluted dowels, uncoated or coated [a]	5.4.1.3.1	5.4.1.3.2	3 + 3 [b]	5.4.1.3.3
- all other type of dowels with characteristic withdrawal capacity ≥ 1 kN, uncoated or coated	5.4.1.3.1	5.4.1.3.2	3 + 3 [b]	5.4.1.3.3
Reaction to fire, for:				
Reaction to fire class for any type of dowels, uncoated or coated, not meeting the specifications of 4.3.2	4.3.3	4.3.3	5	4.3.3
Durability, dealt with by:				
a) Corrosion resistance in timber: category for corrosion resistance in timber				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3

[a] Not required in case of determination without testing

[b] 3 specimens for cyclic tests and 3 specimens for monotonic tests

[c] For T3 and C2w, T4 and C3 corrosion categories

Table 12 — Bolts and nuts: number of samples to be tested and compliance criteria

Characteristic	Clause	Assessment method	No. of samples	Compliance criteria
Mechanical strength and stiffness, dealt with by:				
a) Characteristic yield moment, $M_{y,Rk}$				
- for any type of bolts, uncoated or coated	5.5.1.2.1 a)	5.4.1.2.1 a)	10	5.4.1.2.2
b) Seismic performance: low cycle ductility class				
- for bolts of strength classes 4.6 or 4.8, with rolled thread, uncoated or coated [a]	5.5.1.3.1	5.4.1.3.2	3 + 3 [b]	5.4.1.3.3
- all other type of bolts, uncoated or coated	5.5.1.3.1	5.5.1.3.2	3 + 3 [b]	5.5.1.3.3
Reaction to fire, for:				
Reaction to fire class for any type of bolts and nuts, uncoated or coated, not meeting the specifications of 4.3.2	4.3.3	4.3.3	5	4.3.3
Durability, dealt with by:				
a) Corrosion resistance in timber: category for corrosion resistance in timber				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere				
- for pure zinc coating and hot-dipped galvanized coating	4.1.2	4.1.2.2	5	4.1.2.3
- for alternative coatings	4.1.4	4.1.4.2	20 [c], 40	4.1.4.3

[a] Not required in case of determination without testing

[b] 3 specimens for cyclic tests and 3 specimens for monotonic tests

[c] For T3 and C2w, T4 and C3 corrosion categories

6.2.3 Test reports

The results of the assessment of performance shall be documented in test (or calculation) reports.

Regulation (EU) 305/2011, Article 36 may be used.

6.3 Verification of constancy of performance

6.3.1 Factory production control (FPC)

6.3.1.1 General

An FPC system shall be established, documented, operated and maintained to ensure that the products placed on the market comply with the designated performance of the essential characteristics.

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

All the elements and provisions shall be documented in a systematic manner in the form of written policies and procedures.

An effective implementation of the FPC system shall be established in line with the content of this product 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 performance deviating in a negative way from the declared values, the personnel entitled to define the actions in this case and the personnel in charge to identify and register negative deviations from the declared performance of the product.

The qualification and competence (e.g. on the basis of education, training, skills, or experience) of personnel performing tasks affecting the assessment and verification of constancy of performance of the product shall be recorded and 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 of performance;

— identify and record any instance of non-constancy of performance;

— identify procedures to correct instances of non-constancy of performance.

Documents defining the factory production control system shall be drawn up and kept up-to-date. Documentation and procedures shall be appropriate to the product and production process. The FPC system shall 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.

In case production is (partially or completely) subcontracted, the entity assuming responsibility for the placing on the market shall retain the overall control of the product and ensure that he receives all the information that is necessary.

If parts of the product or components are 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 entity assuming responsibility for the placing on the market that subcontracts all of his activities may in no circumstances pass the above responsibilities on to a subcontractor.

FPC systems that comply with EN ISO 9001 and which address the provisions of this document may be considered as satisfying the FPC provisions of the Regulation (EU) No 305/2011.

6.3.1.2 Equipment

6.3.1.2.1 Testing

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

6.3.1.2.2 Production

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

6.3.1.3 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.

In case supplied product components are used, the AVCP system of the component shall be that given in the appropriate harmonized technical specification for that component.

6.3.1.4 Controls during the production process

Production shall be planned and carried out under controlled conditions. Monitoring of the constancy of the product throughout the process of production, including intermediate steps, shall be carried out as defined in 6.3.1.5.

6.3.1.5 Procedures

Procedures to ensure that the stated values of the declared characteristics are maintained shall be established. The characteristics, and the means of control, are:

For all type of dowel-type fasteners, the following shall be controlled daily, in each 8-h shift:

— materials and geometry (i.e. dimensions and tolerances);

— mechanical strength and stiffness;

— protection against corrosion (if relevant).

The daily control shall be carried out in accordance with:

— Table 13, for nails;

— Table 14, for staples;

— Table 15, for screws;

— Table 16, for dowels;

— Table 17, for bolts and nuts.

For all type of ring shank nails, the following shall be controlled on a 6-monthly basis:

— characteristic withdrawal parameter.

For all type of screws, the following shall be controlled on a 6-monthly basis:

— torsional ratio.

The 6-monthly control shall be carried out in accordance with Table 18.

Table 13 — Nails: inspection scheme for daily factory production control

Characteristic	Assessment method	Minimum number of assessments per day	Compliance criteria
Materials and Geometry properties [a]			
- for any type of nails, uncoated or coated:			
tensile strength of the wire, f_u	G.1 [b]	Each steel consignment	G.1
length, l	G.1	5	G.1
nominal diameter, d	G.1	5	G.1
head diameter, d_h	G.1	5	G.1
- additionally, for nails without round shape head, uncoated or coated:			
equivalent head diameter, d_h	G.1	5	G.1
- additionally, for nails with a profiled part, uncoated or coated:			
profiled length, lg	G.1	5	G.1
diameter of the profiled part, dprofile [c]	G.1	5	G.1
inner diameter, d_i [c]	G.1	5	G.1
- additionally, for nails with a secondary profiled part, uncoated or coated:			
length of the secondary profiled part, $l_{g,1}$	G.1	5	G.1
- additionally, for nails with Type 3 coating:			
coated length, l_H	G.1	5	G.1

Characteristic	Assessment method	Minimum number of assessments per day	Compliance criteria
Mechanical strength and stiffness, dealt with by:			
e) Low cycle ductility (seismic performance): low cycle ductility class			
- for smooth shank non-hardened nails, uncoated or coated [d]	5.1.1.6.2 [e]	3 + 3 [f]	5.1.1.6.3 [e]
- for all other type of nails, uncoated or coated	5.1.1.6.2 [e]	3 + 3 [f]	5.1.1.6.3 [e]
Durability, dealt with by:			
a) Corrosion resistance in timber: category for corrosion resistance in timber			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3

[a] Mechanical strength and stiffness characteristics shall be indirectly checked by the material and geometry control.

[b] Supplier's certificate of compliance (EN 10204:2004 Designation 2.1 or higher) and/or reference to coating supplier's declaration may be used (as an alternative to the test of Annex A or Annex C).

[c] If the 6 monthly control on characteristic withdrawal parameter as described in 6.3.1 is carried out, it is not required to undertake daily checks on profiles of ring shank nails. Similarly, if daily geometry checks are undertaken it is not required to carry out 6 monthly withdrawal tests.

[d] Not required in case of determination without testing.

[e] As an alternative to the tests of Annex E, tests may be performed by clamping the dowel-type fastener in a vice and bending it cyclically over a mandrel with a diameter of 2d to the required angle α_c. The fastener shall plastically deform to the angle αc. The test is passed if after three fully reversed cycles the dowel-type fastener does not break into two pieces.

[f] 3 specimens for cyclic tests and 3 specimens for monotonic tests.

Table 14 — Staples: inspection schemes for daily factory production control

Characteristic	Assessment method	Minimum number of assessments per day	Compliance criteria
Materials and Geometry properties [a]			
- for any type of staples, uncoated or coated:			
tensile strength of the wire, f_u	G.2 [b]	Each steel consignment	G.2
leg length, l	G.2	5	G.2
nominal l_{eg} diameter, d	G.2	5	G.2
crown width, b_R	G.2	5	G.2
- additionally, for staples with Type 3 coating:			
coated length, l_H	G.2	5	G.2
Mechanical strength and stiffness, dealt with by:			
d) Low cycle ductility (seismic performance): low cycle ductility class			
- for smooth shank non-hardened staples, uncoated or coated [c]	5.2.1.5.2 [d]	3 + 3 [e]	5.2.1.5.3 [d]
- for all other type of staples, uncoated or coated	5.2.1.5.2 [d]	3 + 3 [e]	5.2.1.5.3 [d]
Durability, dealt with by:			
a) Corrosion resistance in timber: category for corrosion resistance in timber			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3

[a] Mechanical strength and stiffness characteristics shall be indirectly checked by the material and geometry control.

[b] Supplier's certificate of compliance (EN 10204:2004 Designation 2.1 or higher) and/or reference to coating supplier's declaration may be used (as an alternative to the test of Annex A or Annex C).

[c] Not required in case of determination without testing.

[d] As an alternative to the tests of Annex E, tests may be performed by clamping the dowel-type fastener in a vice and bending it cyclically over a mandrel with a diameter of 2d to the required angle α_c. The fastener shall plastically deform to the angle αc. The test is passed if after three fully reversed cycles the dowel-type fastener does not break into two pieces.

[e] 3 specimens for cyclic tests and 3 specimens for monotonic tests.

Table 15 — Screws: inspection schemes for daily factory production control

Characteristic	Assessment method	Minimum number of assessments per day	Compliance criteria
Materials and Geometry properties [a]			
- for fully threaded screws, uncoated or coated:			
steel specifications	G.3 [b]	Each steel consignment	G.3
length, l	G.3	5	G.3
thread length, l_g	G.3	5	G.3
nominal diameter, d	G.3	5	G.3
target diameter, d_t	G.3	5	G.3
inner thread diameter, d_i	G.3	5	G.3
head diameter, d_h	G.3	5	G.3
- additionally, for partially threaded screws, uncoated or coated:			
diameter of the shank, d_s	G.3	5	G.3
- additionally, for double threaded screws, uncoated or coated:			
diameter of the shank, d_s	G.3	5	G.3
diameter of the secondary thread, d_1	G.3	5	G.3
secondary thread length, $l_{g,1}$	G.3	5	G.3
Mechanical strength and stiffness, dealt with by:			
b) Static ductility, α (bend angle at which screws pass the test)			
- for any type of screws, uncoated or coated	5.3.1.3.1 [c]	5	5.3.1.3.2 [c]
g) Torsional ratio, $M_{tor,Rk}$ / $M_{tor,Em}$			
- for any type of screws, uncoated or coated	5.3.1.8.2 [d]	5	5.3.1.8.3
h) Low cycle ductility (seismic performance): low cycle ductility class			
- for any type of screws, uncoated or coated	5.3.1.9.2 [e]	3 + 3 [f]	5.3.1.9.3 [e]

Characteristic	Assessment method	Minimum number of assessments per day	Compliance criteria
Durability, dealt with by:			
a) Corrosion resistance in timber: category for corrosion resistance in timber			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3

[a] Mechanical strength and stiffness characteristics shall be indirectly checked by the material and geometry control.

[b] Supplier's certificate of compliance (EN 10204:2004 Designation 2.1 or higher) and/or reference to coating supplier's declaration may be used (as an alternative to the test of Annex A or Annex C).

[c] Tests may be carried out by reaching a bending angle of:
- either (45/d0,7 + 20)° for all screw diameters;
- or 45° for screws with a diameter, d, of 8 mm and less and 30° for screws with a diameter, d, of more than 8 mm.

[d] The value of the torsional ratio may be obtained assuming for $M_{tor,Em}$ the value determined in the Assessment of Performance (Table 10).

[e] As an alternative to the tests of Annex E, tests may be performed by clamping the dowel-type fastener in a vice and bending it cyclically over a mandrel with a diameter of 2d to the required angle α_c. The fastener shall plastically deform to the angle α_c. The test is passed if after three fully reversed cycles the dowel-type fastener does not break into two pieces.

[f] 3 specimens for cyclic tests and 3 specimens for monotonic tests.

Table 16 — Dowels: inspection schemes for daily factory production control

Characteristic	Assessment method	Minimum number of assessments per day	Compliance criteria
Materials and Geometry properties [a]			
- for any type of dowels, uncoated or coated:			
rod yield stress, f_y	G.4 [b]	Each steel consignment	G.4
length, l	G.4	5	G.4
nominal diameter, d	G.4	5	G.4
- additionally, for fluted shank dowels, uncoated or coated:			
inner diameter, d_i (mm)	G.4	5	G.4
Mechanical strength and stiffness, dealt with by:			
b) Low cycle ductility (seismic performance): low cycle ductility class			
- for fluted dowels, uncoated or coated [c]	5.4.1.3.2 [d]	3 + 3 [e]	5.4.1.3.3 [d]
- for all other type of dowels with characteristic withdrawal capacity ≥ 1 kN, uncoated or coated	5.4.1.3.2 [d]	3 + 3 [e]	5.4.1.3.3 [d]
Durability, dealt with by:			
a) Corrosion resistance in timber: category for corrosion resistance in timber			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3

[a] Mechanical strength and stiffness characteristics shall be indirectly checked by the material and geometry control.

[b] Supplier's certificate of compliance (EN 10204:2004 Designation 2.1 or higher) and/or reference to coating supplier's declaration may be used (as an alternative to the test of Annex A or Annex C).

[c] Not required in case of determination without testing.

[d] As an alternative to the tests of Annex E, tests may be performed by clamping the dowel-type fastener in a vice and bending it cyclically over a mandrel with a diameter of 2d to the required angle α_c. The fastener shall plastically deform to the angle α_c. The test is passed if after three fully reversed cycles the dowel-type fastener does not break into two pieces.

[e] 3 specimens for cyclic tests and 3 specimens for monotonic tests.

Table 17 — Bolts and nuts: inspection schemes for daily factory production control

Characteristic	Assessment method	Minimum number of assessments per day	Compliance criteria
Materials and Geometry properties [a]			
- for any type of bolts, uncoated or coated:			
strength class	G.5 [b]	Each steel consignment	G.5
length, *l*	G.5	5	G.5
thread length, *l*	G.5	5	G.5
nominal diameter, *d*	G.5	5	G.5
Mechanical strength and stiffness, dealt with by:			
b) Low cycle ductility (seismic performance): low cycle ductility class			
- for bolts of strength classes 4.6 or 4.8, with rolled thread, uncoated or coated [c]	5.5.1.3.2 [d]	3 + 3 [e]	5.5.1.3.3 [d]
- for all other type of bolts, uncoated or coated	5.5.1.3.2 [d]	3 + 3 [e]	5.5.1.3.3 [d]
Durability, dealt with by:			
a) Corrosion resistance in timber: category for corrosion resistance in timber			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3
b) Corrosion resistance in atmosphere: category for corrosion resistance in atmosphere			
- for pure zinc coating and hot-dipped galvanized coating	4.1.2.2 [b]	Each steel or coating consignment	4.1.2.3
- for stainless steel	4.1.3.2 [b]	Each steel consignment	4.1.3.3
- for alternative coatings	4.1.4.2 [b]	Each steel or coating consignment	4.1.4.3

[a] Mechanical strength and stiffness characteristics shall be indirectly checked by the material and geometry control.

[b] Supplier's certificate of compliance (EN 10204:2004 Designation 2.1 or higher) and/or reference to coating supplier's declaration may be used (as an alternative to the test of Annex A or Annex C).

[c] Not required in case of determination without testing.

[d] As an alternative to the tests of Annex E, tests may be performed by clamping the dowel-type fastener in a vice and bending it cyclically over a mandrel with a diameter of 2d to the required angle α_c. The fastener shall plastically deform to the angle α_c. The test is passed if after three fully reversed cycles the dowel-type fastener does not break into two pieces.

[e] 3 specimens for cyclic tests and 3 specimens for monotonic tests.

Table 18 — Inspection scheme for 6-monthly factory production control

Fastener type	Characteristic	Assessment method	Minimum number of samples	Compliance criteria
Mechanical strength and stiffness				
- for all type of ring shank nails	characteristic withdrawal parameter, $f_{ax,k}$	5.1.1.3	10	5.1.1.3.4
- for screws	Torsional ratio, $M_{tor,Rk}$ / $M_{tor,Em}$	5.3.1.8.2 [a]	10	5.3.1.8.3
[a] The value of the torsional ratio may be obtained assuming for $M_{tor,Rk}$ the value determined in the Assessment of Performance (Table 10).				

6.3.1.6 Non-complying products

The manufacturer shall have written procedures which specify how non-complying products shall be dealt with.

Actions shall be taken so that:

— non-conformity raw materials cannot be used;

— non-conforming products cannot be delivered.

6.3.1.7 Corrective action

Documented procedures shall be maintained that instigate action to eliminate the cause of non-conformities in order to prevent recurrence.

6.3.1.8 Handling, storage and packaging

Written procedures providing methods of product handling shall be maintained and, if applicable, suitable storage areas preventing damage or deterioration shall be foreseen.

6.3.1.9 Product specific provisions

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 production is completely subcontracted, 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 production is partly subcontracted, the operations under b) may be reduced and partly 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 could 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 production 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 production parameters, etc.

Records shall be established and maintained that provide evidence that the production has been sampled and assessed. These records shall show clearly whether the production meets the declared performance.

6.3.1.10 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 document, then all the characteristics for which performance is being declared, which may be affected by the modification, shall be subject to the determination of the product type, as described in 6.2.

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

6.3.1.11 One-off products, pre-production products (e.g. prototypes) and products produced in very low quantity

The dowel-type fasteners produced as a one-off, in very low quantities and prototypes assessed before full production is established shall be assessed as follows.

For determination of the product type, the provisions of 6.2.1, 3rd paragraph apply, together with the following additional provisions:

— in case of prototypes, the test samples shall be representative of the intended future production;

— the results of the assessment of prototype samples may be included in a certificate or in test reports.

FPC provisions on raw materials and/or components for one-off products and products produced in very low quantities shall apply only where appropriate.

For prototypes, before starting series production, the initial inspection of the factory and FPC shall be carried out.

In the initial assessment of the factory and FPC it shall be verified:

a) that all resources necessary for the achievement of the product characteristics to be declared by the manufacturer will be available; and

b) that the FPC-procedures in accordance with the FPC-documentation will be implemented and followed in practice; and

c) that procedures are in place to demonstrate that the factory production processes allow the production of products according to the declared performance determined for the product type.

Once series production is fully established, the provisions of 6.3 shall apply.

Annex A
(normative)

Test methods for alternative coatings

A.1 Introduction

The following test procedures shall be used to examine the lifetime expectancy of alternative coatings.

A.2 Outdoor exposure test with two years of duration

A.2.1 Test method

Dowel-type fasteners shall be tested using test method according to EN ISO 8565:2011. Specimen shall be deposited minimum for two years in C4 approved atmosphere as per EN ISO 9226:2012. At least 10 specimens to be stored in weathered and 10 specimens in not weathered environment. The specimen shall be inserted into softwood by keeping the spacings, end and edge distances in accordance with EN 1995-1-1:2004[15].

A.2.2 Evaluation

The specifications are fulfilled when no specimen is showing red-rust along the whole perimeter after the test period has been expired. For adequate inspection, the softwood shall be opened by using a chisel without disturbing the specimen.

This test regime should be accompanied by metallographic examination to prove that the quality of the protective coating is according to the specification. Furthermore, this examination should also prove that the quality of the protective coating is not deteriorated by the insertion process. Therefore, it is recommended that metallographic examination should be carried out along the perimeter of the dowel-type fastener.

A.3 Outdoor exposure test with four years of duration

A.3.1 Test method

Dowel-type fasteners shall be tested using test method according to EN ISO 8565:2011. Specimen shall be deposited minimum for four years in C4 approved atmosphere as per EN ISO 9226:2012. At least 10 specimens to be stored in weathered and 10 specimens in not weathered environment. The specimen shall be inserted into softwood by keeping the spacings, end and edge distances in accordance with EN 1995-1-1:2004[15].

A.3.2 Evaluation

The specifications are fulfilled when no specimen is showing red-rust along the whole perimeter after the test period has been expired. For adequate inspection, the softwood shall be opened by using a chisel without disturbing the specimen.

[15] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

This test regime should be accompanied by metallographic examination to prove that the quality of the protective coating is according to the specification. Furthermore, this examination should also prove that the quality of the protective coating is not deteriorated by the insertion process. Therefore, it is recommended that metallographic examination should be carried out along the perimeter of the dowel-type fastener.

A.4 Accelerated test methods

A.4.1 Inorganic coatings with or without an organic top coat

A.4.1.1 General

Dowel-type fasteners shall be tested using test method according EN ISO 11997-1:2017, Annex D (Cycle B). Below described criteria for sampling, testing and conformity shall be complied with.

A.4.1.2 Samples

For each coating type 40 samples are required. Twenty samples out of the 40 shall be stored in environment protected from corrosion for reference measuring of coating thickness and subsequently for quality control. Minimum 20 samples shall be used for the accelerated test.

A.4.1.3 Reference test panels

For assessment of the extents of corrosion of carbon steel and zinc at the different exposure time periods in the corrosion test, 6 reference test panels in carbon steel and zinc prepared according to EN ISO 9226:2012 shall be used. The panels shall be masked with an adhesive plastic film on one side.

A.4.1.4 Test method

The dowel-type fastener samples shall be inserted into softwood according to the installation instructions of the manufacture. After installation remove the sample from the wood without disturbing the sample using for instance a chisel to split the wood.

Place dowel-type fastener samples and reference test panels in the test chamber, with the unprotected sides upward and at an angle 20° ± 5° from the vertical.

Reference test panels shall be removed from the test chamber at regular intervals during the test period. Remove the masking and remove the corrosion products by pickling according to EN ISO 8407:2014. After pickling, weigh the sample.

Metal loss shall be expressed as the decrease in thickness by using the mass divided by the density of the metal compared with the initial thickness of the sample obtained from that samples mass and density. Examples of reporting is given in Table A.3 based on the interpolation between Table A.1 and A.2.

Dowel-type fastener samples shall be inspected after each cycle according to EN ISO 10289:2001. The testing time shall be determined by interpolation when more than 10 % of the units of dowel-type fastener samples show base material corrosion on their test areas to a degree corresponding to the rating R_p = 9 according to EN ISO 10289:2001.

Number of test cycles, and from that the derived corrosion class, is determined by the comparison of reference test panels and dowel-type fastener samples at a specific number of cycles. This number of test cycles cannot be lower than 9 test cycles.

A.4.1.5 Determination of corrosion class

Based on the maximum number of test cycles where no more than 10 % of the dowel-type fastener samples show base material corrosion equal to $R_p \leq 9$ a corrosion class can be determined according to Table A.3 using the corrosion protecting class based on the arithmetic mean value of the C(ML15) for zinc and carbon steel at the maximum test cycles were maximum 10 % of dowel-type fastener samples show base corrosion $R_p \leq 9$.

For T3(15)/C4(15) (15 years) the Corrosion protection class C(ML15) shall be greater than or equal to 4,0.

For T2/C2nw the Corrosion protection class C(ML15) shall be greater than or equal to 4,0.

Table A.1 — Metal loss of zinc from corrosion in different atmospheric corrosivity classes according to EN ISO 9224:2012

Corrosivity class	First year metal loss of zinc from corrosion (µm)	Maximal metal loss of zinc after 15 years of corrosion [a] (µm)
C1	0,1	1,0
C2	0,7	10,5
C3	2,1	31,5
C4	4,2	63,0
C5	8,4	126,0
[a] Maximum metal loss is based on first year metal loss multiplied with 15		

Table A.2 — Metal loss of carbon steel from corrosion in different atmospheric corrosivity classes according to EN ISO 9224:2012

Corrosivity class	Maximal metal loss of carbon steel after 15 years of corrosion (µm)
C1	5,4
C2	103
C3	206
C4	330
C5	824

Table A.3 — Reporting format with examples of relationship between exposure time of accelerated test and specifications for different corrosion protection classes

Testing time (cycles)	Zinc		Carbon steel		Corrosion protection class [b]
	Metal loss, ML (µm)	C (ML 15) [a]	Metal loss, ML (µm)	C (ML 15) [a]	
0	0	0,0	0	0,0	0,0
2	33	3,1	37	1,3	2,2
3	50	3,6	55	1,5	2,6
4	66	4,1	73	1,7	2,9
6	95	4,5	120	2,2	3,3
9	130	5,0	240	3,3	4,2

[a] Equal to corrosivity classes with a maximal metal loss (ML15) after 15 years of corrosion in that class. C (ML15) in between two corrosivity class values has been calculated using linear interpolation based on maximum metal loss data from Table A.1 and A.2.

[b] Arithmetic mean value of the C(ML15) values for zinc and carbon steel is used to define a maximum corrosion protection class for that specific number test cycles.

A.4.2 Organic coatings with or without an organic topcoat

A.4.2.1 General

Dowel-type fasteners shall be tested using test method EN ISO 6270-1:2018 and EN ISO 9227:2017. Below described criteria for sampling, testing and conformity shall be complied with.

A.4.2.2 Samples

For each coating type 40 samples is required. Twenty samples shall be stored in protected environment for reference measuring of coating thickness and subsequently for quality control. Minimum 20 samples shall be used for the accelerated test.

A.4.2.3 Test method

The dowel-type fastener samples shall be inserted into softwood according to the installation instructions of the manufacture. After installation remove the sample from the wood without disturbing the sample using for instance a chisel to split the wood.

Place dowel-type fastener samples at an angle 20° ± 5° from the vertical.

Test duration according EN ISO 6270-1 is minimum 720 h.

Test duration according EN ISO 9227 is minimum 1440 h.

A.4.2.4 Evaluation

For T3(15)/C4(15) (15 years) no more than 10 % of the dowel-type fastener samples shall show base material corrosion between R_p10 and R_p9 according to EN ISO 10289:2001, otherwise the dowel-type fastener shall be assigned to corrosion resistance class T2/C2nw.

Annex B
(informative)

Corrosivity of atmospheric environments and timber

B.1 General

Metal dowel-type fasteners shall withstand corrosion exposure of both the timber and the atmosphere for the design service life. The corrosion exposure of the timber depends on wood species, timber treatment and moisture content. The corrosion exposure of the atmosphere depends on relative humidity, air pollution, chloride content and if the connection is weathered (exposed to rain) or non-weathered. T-categories, C-categories (CRC for stainless steel) are specified in 4.1 describing the fasteners ability to withstand corrosion.

The T-category concerns corrosion caused by the timber and the appropriate category should be determined from Table B.3. Treatments applied to the timber influence the corrosion rate. The treatments mentioned are assumed to contain copper or salts as chlorides applied by pressure impregnation or by dipping. Fire retardants are harmful treatments as well. If the treatment specification confirms that there is no corrosive effect for moisture content $\omega \leq 20$ %, category T3 instead of T4 may be selected.

The C-category and CRC concerns corrosion caused by the atmosphere. The appropriate category for pure zinc, hot-dipped galvanized coating and alternative coated dowel-type fasteners should be determined from Table B.1 and Table B.2 depending on its conditions. The definitions are taken partly from EN ISO 9223:2012. The appropriate category for stainless steel fasteners shall be determined according to EN 1993-1-4:2006/A1:2015.

The assumed service life is 50 years, but for structures with shorter design service life or replaceable structural parts additional categories T3(15) and C4(15) for an assumed service life of 15 years is possible using alternative coatings.

The appearance of a dowel-type fastener may change without a protective coating.

Based on experience, zinc has about a two times higher corrosion rate for weathered connectors compared to not weathered in C2 atmosphere.

B.2 Pure zinc, hot-dipped galvanized and alternative coated dowel-type fasteners: corrosivity of atmospheric environments

Table B.1 — Definition of indoor atmospheric categories (indoor = no rain access, i.e. not weathered, *nw*)

Atmosphere category		Climate/humidity	Exposure to pollutions	Examples of environment
C1	Very low	Dry climate/low relative humidity	Insignificant pollution	Heated spaces
C2nw	Low	Varying temperature and relative humidity/low frequency of condensation	Low pollution	Unheated spaces (storage, sport halls, areas of heated and unheated stables where condensation is not taking place and pollution has no access)
		Like outdoor climates C2-C3 but not weathered/rarely condensation		Halls/storage areas/parking decks which are open to the outside
C3	Medium	Elevated relative humidity/ moderate frequency of condensation	Moderate pollution from production process	Food-processing plants, laundries, breweries, dairies, unheated stables
		Like outdoor climates C2-C3 but not weathered/occasional or frequent condensation	Moderate pollution	Parking decks which are open to the outside (frame constructions)
C4 C4(15)	High	Elevated relative humidity/high frequency of condensation	High pollution from production process	Industrial processing plants, heated stables
		Extreme elevated relative humidity/frequent condensation	Elevated pollution	Damp or wet spaces
		No elevated relative humidity/infrequent condensation	High level of hygroscopic salt in the air	Salt storage, pools with salty water in ventilated spaces
		Approximately 30 °C and max. 60 % relative humidity/ condensation	Treatment with disinfection, high level of chlorides	Swimming pools
C5	Very high	High relative humidity/very high frequency of condensation	High pollution from production process	Unventilated spaces in subtropical and tropical zones in extreme contaminated environment or close to coastline

Table B.2 — Definition of outdoor atmospheric categories (outdoor = structures exposed to rain, i.e. weathered, *w*)

Atmosphere category		Climate/humidity	Exposure to chlorides		Exposure to polluting agents	
			Typical environment	Cl– deposition rate ($mg/m^2 \cdot d$)	Typical environment	Level of pollution/ SO2 content ($\mu g/m^3$)
C1	Very low	Dry or cold/infrequent condensation	Regions far from coastline	approximately 0	Certain deserts, central Arctic/ Antarctica	Very low approximately 0
C2w	Low	Temperate/infrequent condensation	> 10 km from coastline	≤ 3	Low polluted rural areas, small towns	Low < 5
C3	Medium	Temperate/occasional condensation	approximately 10 to 3 km from coastline	3 to 60	Medium polluted urban and industrial areas	Medium 5 to 30
			Spray near streets (approximately 10 to 100 m)			
		Subtropical, tropical	Low pollution of chlorides and other contamination (like C2)			
C4 C4(15)	High	Temperate/frequent condensation	approximately 3 to 0,25 km from coastline (without spray of salt water)	60 to 300	High polluted urban and industrial areas	High 30 to 90
			Strong effect of de-icing salts (approximately 0 to 10 m)			
		Subtropical, tropical	Medium pollution of chlorides and other contamination (like C3)			
C5	Very high	Temperate, subtropical/very high – permanent frequency of condensation	< 0,25 km from coastline, occasionally spray of salt water	300 to 1 500	Environment with very high industrial pollution	Very high 90 to 250

B.3 Stainless steel dowel-type fasteners: corrosivity of atmospheric environments

The definitions of the corrosivity of atmospheric environments are taken from EN 1993-1-4:2006/A1:2015. The severity of the corrosivity of the atmospheric environment is calculated using the Corrosion Resistance Factor (CRF).

Suitable steel grades in contact with indoor swimming pool atmospheres to prevent stress corrosion cracking are: 1.4565, 1.4529, 1.4547 (see EN 1993-1-4:2006/A1:2015, Table A.4).

B.4 Corrosivity of timber

Table B.3 — Definition of timber categories for dowel-type fasteners

Timber category [a]	**T1**	**T2**	**T3(15)**	**T3**	**T4**	**T5** [b]
Annual average moisture content	$\omega < 10$ %	10 % ≤ ω ≤ 16 %	16 < ω ≤ 20 %			Permanent $\omega > 20$ %
Treatment/acidity of timber	–	–	Untreated and pH > 4		Treated or pH ≤ 4	–-
Examples of species	All	All	Larch Pine Birch Spruce Fir		Oak Chestnut Red cedar Douglas fir Beech	All
Examples of treatments	–	–	–		Any compositions with chlorides, copper and fire retardants	–

NOTE Table 4.1 in EN 1995-1-1:2004[16] often requires larger zinc thickness than Table 1 in this document for similar moisture exposure

[a] The timber categories T1 to T5 do not correspond directly with the Service Classes in EN 1995-1-1:2004[17]. However, for most climates the annual average moisture content in softwood will not exceed:
10 % for heated spaces, so that T1 almost corresponds to Service Class 1
16 % for unheated spaces, so that T2 almost corresponds to Service Class 2
20 % for structures exposed to rain but without ground contact, so T3 and T4 correspond to many structures belonging to Service Class 3.

[b] T5 corresponds to other structures belonging to Service Class 3.

NOTE Cement-based products have a corrosive effect on galvanized steel dowel-type fasteners when used in environment leading to a moisture larger than 16 %.

[16] As impacted by EN 1995-1-1:2004/A2:2014.

[17] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

Annex C
(normative)

Methods for measuring zinc thicknesses

If no “certificate of compliance” (minimum type 2.1) as defined in EN 10204:2004 is available, the measurement of the zinc thickness shall be carried out by one of the following methods depending on the geometry and coating type of the dowel-type fastener:

1) the stripping method according either to EN ISO 460:1994, or to EN ISO 2081:2018, Annex B. EN ISO 2081:2018, Annex B applies also for samples greater than 100 mm2;

2) the magnetic induction method according to EN ISO 2178:2016 or phase-sensitive eddy-current method according to EN ISO 21968:2019;

3) the X-ray fluorescence analysis method (XRFA) with reference to EN ISO 3497:2000;

4) the microscopical cross section method according to EN ISO 1463:2004.

The minimum number of dowel-type fasteners shall be five per batch extracted randomly.

The zinc thickness of dowel-type fasteners used in timber category T1 or T2 or atmosphere C1 or C2nw shall be measured according to EN ISO 4042:2018, 10.1.

For other timber categories or atmospheres, any of the four described methods may be used. If one of the methods 2, 3 or 4 are used, the dowel-type fasteners shall be proved at 5 different areas. For dowel-type fasteners this is preferably 1 × head, 1 × point and 3 × along the shank.

Annex D
(normative)

Selection of test specimens – Specifications on wood density

D.1 General

This annex specifies a method, based on density, for the selection of pieces of wood used for determining strength and stiffness parameters of mechanical dowel-type fasteners used in sawn timber.

The main principle is that the density distribution of the selected pieces are similar to that of the wood to which the results are intended to be used. If this is not possible, a method to adjust the results is given.

NOTE It is emphasized that the wood density is only one of the properties of the wood that could influence the strength and stiffness parameters. Other relevant properties are, for example, the moisture content, growth-ring size, slope of grain, toughness and hardness.

D.2 Symbols

c	factor that corrects the observed parameter values for density, R proportional to ρ_c
R_i	observed value of the parameter for wood piece i
$R_{i,corr,\rho}$	observed value for wood piece i corrected to refer to ρ_m
$V_{\rho,}$	coefficient of variation of the density of the wood to which the test results are applied
$V_{\rho,sel}$	coefficient of variation of the density of all selected pieces
V_R	coefficient of variation of the observed parameter
$V_{R,corr}$	coefficient of variation of the observed parameter corrected to refer to V_ρ
s_{logR}	standard deviation of log (R_i). It may be assumed that $V_R = s_{logR}$
ρ_m	mean density of the wood to which the test results are applied
ρ_k	characteristic density of the wood to which the test results are applied
$\rho_{m,sel}$	mean wood density of all selected pieces

D.3 Specifications

The wood shall be without localized defects such as knots and cracks that can influence the test results. The test standards used may specify which defects are acceptable.

If no other conditioning is specified, the wood shall be at equilibrium at a relative humidity (*RH*) of (65 ± 5) % and a temperature of (20 ± 2) °C at the time of testing. If the moisture content of the wood at any stage has been below equilibrium at 60 % *RH*, the moisture content shall be increased to equilibrium at 75 % *RH* before conditioning at (65 ± 5) %.

Density of all pieces shall be reported. The density shall be determined in accordance with ISO. This shall be done just after the mechanical testing on pieces selected close to volume tested.

NOTE 1 The results relate only to the wood species or the group of wood species used.

The mean wood density, $\rho_{m,sel}$, of all selected pieces shall satisfy the condition given by Formula (D.1).

$$0,9\rho_m \leq \rho_{m,sel} \leq 1,1\rho_m \quad \text{(D.1)}$$

where

ρ_m mean density of the wood to which the test results are applied,

$\rho_{m,sel}$ mean density of all selected pieces.

Adjustment according to D.4.2 is necessary if

$$V_{\rho,sel} < V\rho$$

where

V_ρ coefficient of variation of the density of the wood to which the test results are applied,

$V_{\rho,sel}$ coefficient of variation of the density of all selected pieces.

V_ρ shall be determined from $\rho_k = \rho_m\,(1–1{,}65\ V_\rho)$

where

ρ_k Characteristic density of the wood to which the test results are applied.

It is recommended that the densities of the selected pieces cover most of the range [$(1–1{,}65\ V_\rho)\ \rho_{m,sel}$; $(1+1{,}65\ V_\rho)\ \rho_{m,sel}$]. For classes according to EN 338:2016 it can be assumed that V_ρ = 0,1.

D.4 Adjustment to target conditions

D.4.1 Mean value

All the measured values, R_i, shall be adjusted as given by Formula (D.2).

$$R_{i,corr,\rho} = R_i(\rho_m / \rho_{m,sel})^c \quad \text{(D.2)}$$

where

R_i observed value for wood piece *I*,

$R_{i,corr,\rho}$ observed value for wood piece *i* corrected to refer to ρ_m,

c factor that corrects observations of ρ_m. When $\rho_m > \rho_{m,sel}$ the lower bound clower is used, otherwise the upper bound cupper.

For softwood, some values for the factor *c* is given in Table D.1. For other cases, the factor shall be estimated by considering the influence of the density for the relevant failure mode(s).

For hardwood, the factor *c* shall be established from testing a wider range of densities.

Table D.1 — Values of the factor c for softwood

Configuration	c_{lower}	c_{upper}	c_{corr}
Withdrawal of smooth nail and staples [a]	1,5	2,0	2,0
Withdrawal of ring shank nail	1,0	1,5	1,5
Withdrawal of coated nail or staple	1,0	2,0	2,0
Withdrawal of screw	0,8	1,2	1,2
Pull-through of head	0,8	1,2	1,2
[a] Including twisted nails and nails with longitudinal grooves.			

D.4.2 Coefficient of variation

If $V_{\rho,} > V_{\rho,sel}$ the characteristic value of the load bearing capacity R shall be calculated using a corrected coefficient of variation $V_{R,corr}$ given by Formula (D.3):

$$V_{\mathrm{R,corr}} = \sqrt{V_{\mathrm{R}}{}^{2} + c_{\mathrm{corr}}{}^{2}\left(V_{\rho}{}^{2} - V_{\rho,\mathrm{sel}}{}^{2}\right)} \tag{D.3}$$

where

V_R coefficient of variation of the observed parameter,

$V_{R,corr}$ coefficient of variation of the observed parameter corrected to $V_{\rho,}$

c_{corr} factor for correction of coefficient of variation given in Table D.1.

If V_R is smaller than a prescribed minimum value, V_R should be replaced by the minimum value. For example, EN 14358:2016 prescribes a minimum value of 0,05.

NOTE When R is LogN-distributed, it can be assumed that V_R = slog(R), the standard deviation of log(R).

For softwood, some values for the factor ccorr are given in Table D.1. For other cases, the factor shall be estimated from relevant pairs of observations of $V_{\rho,sel}$ and V_R.

D.5 Test report

The test report shall contain at least the following information:

a) reference to the Annex D of this document;

b) the wood species or wood species group used;

c) the conditioning used;

d) the densities of the selected wood pieces at the time of testing, the mean density and the coefficient of variation;

e) confirmation that the selected wood pieces satisfy the conditions mentioned in this document or possible deviations;

f) the measured and corrected strength and stiffness parameters;

g) any other information which can influence the use of the test results.

Annex E
(normative)

Test to determine seismic performance

E.1 General

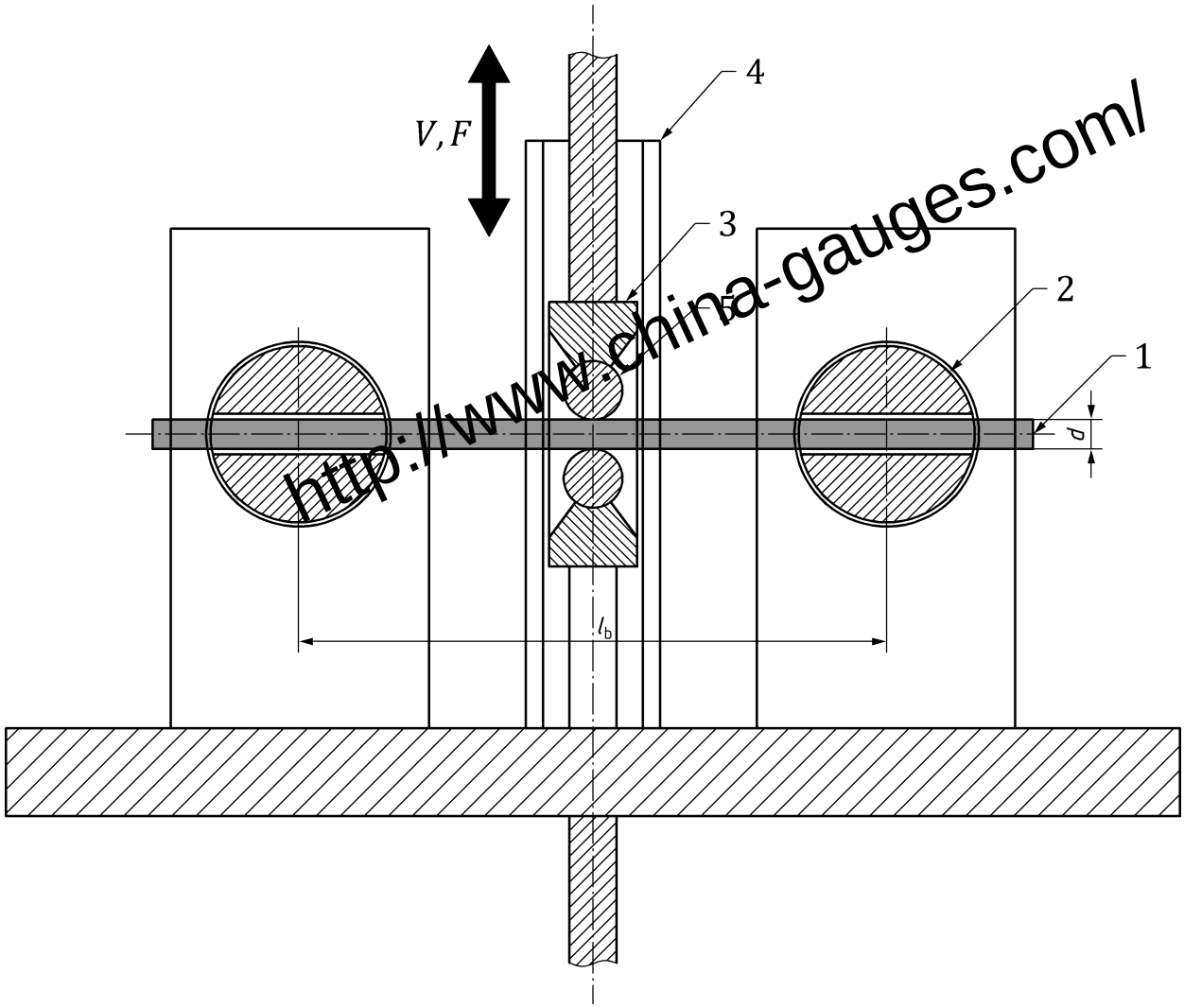
This annex specifies a test method for the assessment of the seismic performance of a dowel-type fastener.

For the purposes of this document the level of seismic performance of a dowel-type fastener shall be determined by investigating its low cycle ductile behaviour.

E.2 Test setup

The sample shall be mounted into a machine that allows a fully reversed bending test.

An example of a suitable test setup is given in Figure E.1.



Key

1	sample
2	end support
3	loading device
4	lateral restrain
5	mandrel
V	displacement
F	load
d	nominal diameter
*l*b	distance between supports

Figure E.1 — Example of test setup

The distance between the supports l_b shall be less than 16*d*. The diameter of the mandrel which the sample is bent over shall be $2d \pm 0{,}5d$. The end supports shall allow for axial displacements and free rotations of the sample. The sample shall be laterally restrained in order to prevent out of plane rotations.

The test apparatus shall allow the applied displacement to be controlled and the corresponding applied load to be measured.

Both the equipment used for measuring the displacement and the applied load shall be capable of achieving an accuracy of 1 % of the measured value.

E.3 Test procedure

The dowel-type fastener shall either be subjected to three fully reversed bending cycles at a minimum value of the bending angle α_c specified for the selected low cycle ductility class.

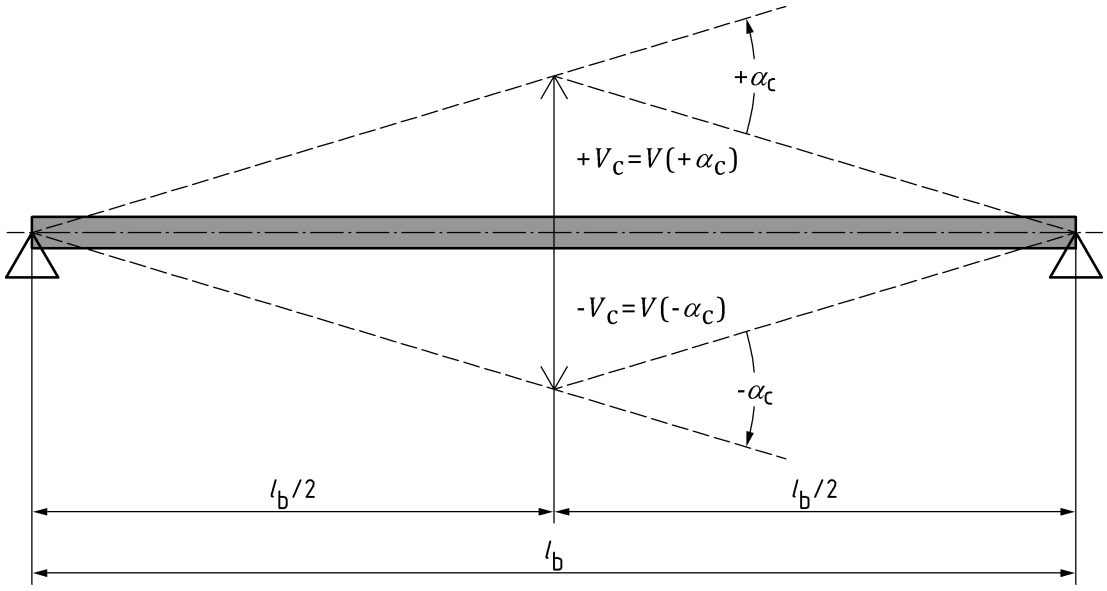
The residual bending moment capacity shall be determined by a monotonic test, increasing the angle up to at least 45° for dowel-type fasteners with d less than or equal to 8 mm and 30° for dowel-type fasteners with d greater than 8 mm.

The test shall be displacement controlled. The displacement corresponding to the required bending angle, V_c (in mm), shall be calculated by Formula (E.4) (see Figure E.2):

$$V_c = \frac{l_b}{2} \cdot tan\left(\frac{\alpha_c}{2}\right) \tag{E.4}$$

The displacement increase rate shall be selected such that the test is completed in 300 s ± 60 s.

Figure E.3 reports the time history of the imposed displacement.



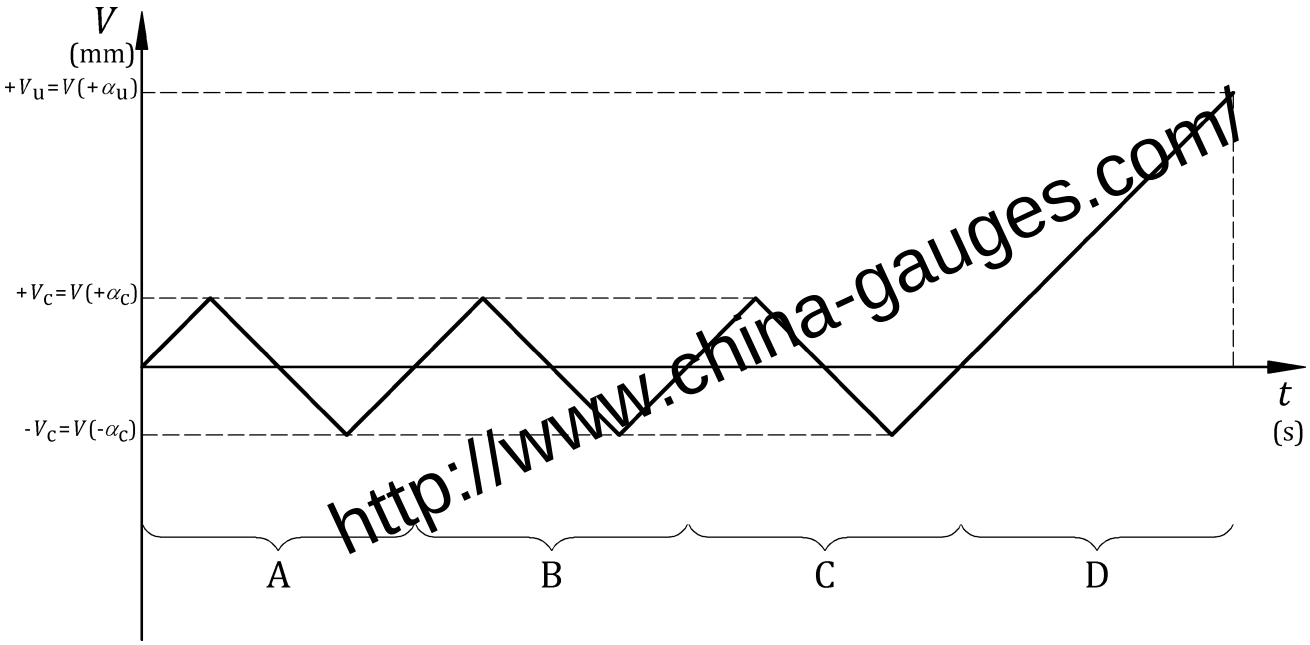
Key

V_c displacement corresponding to the required bending angle

α_c specified value of the bending angle

l_b distance between supports

Figure E.2 — Definition of the bending angle under cyclic loading and corresponding displacement of the dowel-type fastener



Key

A	1st Cycle
B	2nd Cycle
C	3rd Cycle
D	determination of the residual bending moment capacity

Figure E.3 — Time history of the imposed displacement

E.4 Test results

The applied displacement and corresponding load on the sample shall be continuously recorded during the test.

The bending moment versus the bending angle shall be plotted.

The bending moment *M* shall be calculated in accordance with Formula (E.5):

$$M = \frac{l_b}{4} \cdot F \tag{E.5}$$

where

l_b is the distance between the supports,

F is the applied load.

E.5 Test report

The following information shall be included in the test report:

1) reference to the test method of Annex E of this document;
2) the type of dowel-type fastener;
3) the dimensions of the sample;
4) a description of the testing machine and measuring instruments;
5) the length of the supports;
6) the value of the bending angle under cyclic loading;
7) a plot of the recorded bending moment versus angle;
8) the residual bending moment capacity and/or the recorded failure, if any.

Annex F
(normative)

Characteristic withdrawal parameter for dowel-type fasteners with Type 3 coating

NOTE Applicable for the following types of dowel-type fasteners only; i.e. nails (5.1) and staples (5.2).

F.1General

This annex specifies the test method for the determination of the characteristic withdrawal parameter of nails and staples with Type 3 coating made of the following materials:

a) adhesive; and/or

b) resin.

Samples of dowel-type fasteners with Type 3 coating shall be prepared in accordance with F.2 and the characteristic withdrawal parameter determined in accordance with F.3.

Load duration factor specified in F.4. can be used to determine the withdrawal parameter values for medium, long term and permanent load.

F.2Sample preparation

The withdrawal parameter of dowel-type fasteners with Type 3 coating shall be determined always with the coating. The samples of dowel-type fasteners with Type 3 coating shall be prepared as follows:

i) timber specimens shall be selected according to the provisions of Annex D, replacing those of EN 1382:2016;

ii) the test specimens for tests at 60 °C shall be produced and conditioned as described by EN 1382:2016. After this conditioning, the test specimens shall be kept in a chamber at a temperature of 60 °C for a period of approximately 24 h just before the testing.

In addition, when the Type 3 coating is based on resin the following shall be applied:

— organic polymers shall be the basis of resin;

— the surface of the staple or nail shall be without impurities (e.g. grease, oil or dust) to ensure the best possible adhesion of resin;

— the viscosity of the resin shall adjust to the conditions of the application as to allow an acceptable moistening on the surface of the staples or nails as basis for good adhesion;

— the drying of resin coat (temperature and time) shall be done in accordance with the specifications of the resin producer;

— the quality of the chemical composition of the used resin shall provide a good connection between steel and timber (e.g. suitable thermoplastic activity) and guarantee a maximum durability of the coating.

F.3Determination

F.3.1 Test procedure

The withdrawal parameter shall be determined by short-term test in accordance with EN 1382:2016 conducted at two temperature levels:

a) 20 °C; and

b) 60 °C.

F.3.2 Correction of the measured withdrawal parameter

If necessary, when testing according to EN 1382:2016 the measured value of the withdrawal parameter shall be corrected for the wood densities in accordance with Annex D.

NOTE Annex D will later be substituted by a standard covering the same scope as Annex D.

F.3.3 Calculation of the characteristic withdrawal parameter

The characteristic value of the withdrawal parameter shall be calculated in accordance with EN 14358:2016 using the corrected withdrawal parameter values obtained from short-term tests.

The characteristic withdrawal parameter from short-term tests shall be calculated for both temperature levels, 20 °C and 60 °C.

The value of the characteristic withdrawal parameter shall be the smaller of the two values.

F.4Load duration factor

For service class 1 and 2, as defined in EN 1995-1-1:2004[18], dowel-type fasteners with Type 3 coating can be used to sustain medium, long term and permanent load when using the load duration factor k_{mod} = 0,1.

NOTE 1 For instantaneous and short-term load the values for smooth nails and staples given in EN 1995-1-1:2004[18] applies.

Duration factor k_{mod} = 0,1 is a safe value that enables small loads other than instantaneous and short-term loads - like the self-weight of a panel - to be sustained by dowel-type fasteners with Type 3 coating. According to EN 1995-1-1:2004[18] smooth dowel-type fasteners may only be used to sustain instantaneous and short-term loads.

[18] As impacted by EN 1995-1-1:2004/A1:2008 and EN 1995-1-1:2004/A2:2014.

Annex G
(normative)

Specifications for materials and geometry properties

G.1 Nails

Nails shall be produced from a wire in accordance with the specifications given in Table G.1. The tensile strength of all wires, and the category of stainless steel wires, may be given as description of the type of dowel-type fastener.

Steel grades may be indicated referring to other standards with respect to the one listed in Table G.1, provided it has been documented that the steel has at least the same mechanical properties of materials listed in Table G.1. All relevant information of the alternative steel grades shall be obtained from testing (tensile strength of the wire).

Table G.1 — Material and strength specifications for nails

Wire minimum tensile strength in N/mm² **(determined in accordance with EN 10218-1:2012)**	**Standard**	
	Carbon Steel	**Stainless Steel**
600	EN ISO 16120 series	EN 10088 series

Nails shall fulfil the provisions for geometry related properties given in Table G.2. Dimensions listed in Table G.2 may be given as description of the type of dowel-type fastener. Dimensions shall be taken on the dowel-type fastener using a calibrated device capable of achieving an accuracy of ± 1 % of the measurement. Admissible tolerances on nominal values of Table G.2 dimensions are given in Table G.3.

If a dimension or an area has been assigned a tolerance, then the measured values of the dimensions and areas of the dowel-type fasteners shall be within the range of the values ± tolerances. The indication of the value of the results implies fulfilment with the provisions given in the Annex G. If no tolerance has been assigned, then the measured value shall be greater than or equal to the nominal value.

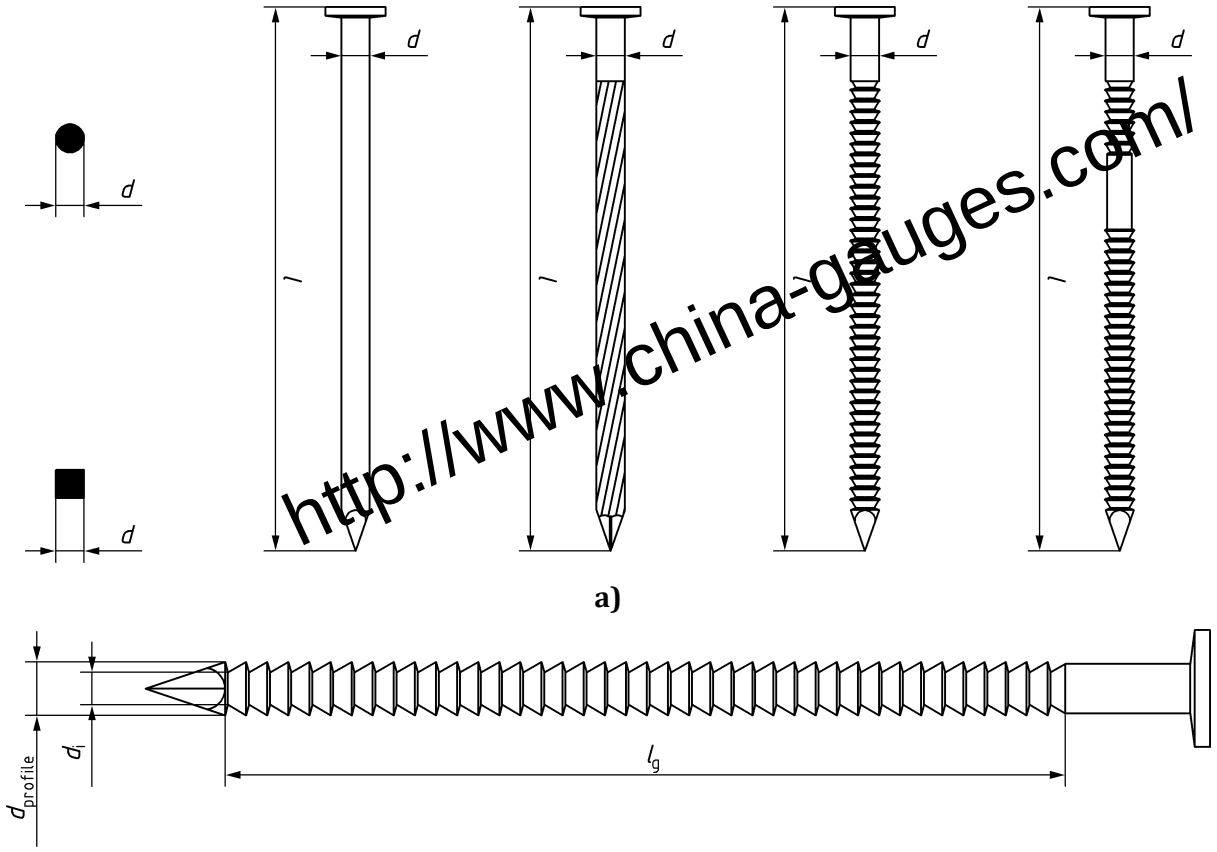
Geometry related properties shall be provided through detailed drawings including tolerances, showing the dimensions of the nails including the length of the profiled parts, drill tip dimensions or secondary rough thread dimensions. The examples given in Figure G.1 and Figure G.2 define the principle that shall be followed.

Table G.2 — Geometry specifications for nails

Dimensions	Specifications	Notes
• **any type of nails, uncoated or coated:**		
- length, l (mm)	–	see Figure G.1
- nominal diameter, d (mm)	1,9 mm ≤ d ≤ 8,0 mm	see Figure G.1
- head diameter, d_h (mm)	≥ 1,8 d	see Figure G.1 and Figure G.2
- head thickness, h_t (mm)	≥ 0,25 d	see Figure G.1 and Figure G.2
- length of the point, l_p (mm)	0,5 d ≤ l_p ≤ 2,5 d for l > 3 mm 0 d ≤ l_p ≤ 2,5 d for l ≤ 3 mm	see Figure G.2
• **additionally, for nails without round shape head, uncoated or coated:**		
- head area, A_h (mm²)	≥ 2,5 d^2	–
- equivalent head diameter, d_h (mm)	≥ 1,8 d	an equivalent diameter head diameter dh shall be calculated from $d_h = \sqrt{A_h \cdot \pi / 4}$
• **additionally, for nails with a profiled part, uncoated or coated:**		
- profiled length, l_g (mm)	≥ 4,5 d	see Figure G.1 b)
- diameter of the profiled part, $d_{profile}$ (mm)	–	see Figure G.1 b)
- inner diameter, d_i (mm)	–	see Figure G.1 b)
• **additionally, for nails with a secondary profiled part, uncoated or coated:**		
- length of the secondary profiled part, $l_{g,1}$ (mm)	–	see Figure G.1
• **additionally, for nails with Type 3 coating:**		
- coated length, l_H (mm)	≥ 0,5 l	–

Table G.3 — Admissible tolerances on nominal values for nails

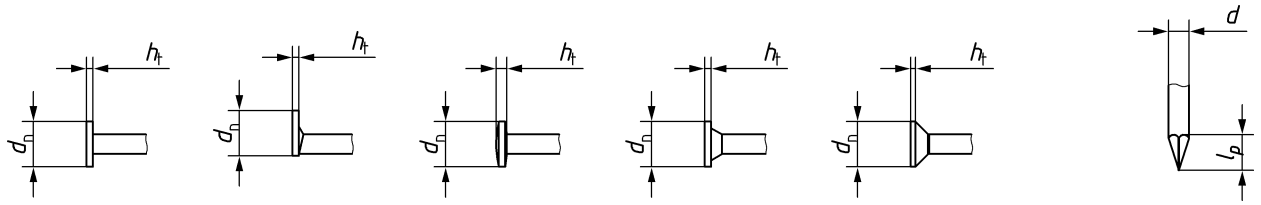
Dimensions	Specifications
length, l (mm)	±2,5 %
profiled length ex. point, l_g (mm)	±5,0 %
diameters, d, d_i (mm)	±2,5 %
diameter $d_{profile}$ < 4 mm (mm)	−0,1/+0,2 mm
diameter $d_{profile}$ ≥ 4 mm (mm)	±2,5 %
head diameter, d_h (mm)	±5,0 %
nail point, l_p (mm)	Max (±0,5 mm; ± 10 %)
secondary profiled part/rough thread length (if present), $l_{g,1}$ (mm)	±5,0 %



Key

d	diameter
d_i	inner diameter
l, l_g	length
$d_{profile}$	profile diameter

Figure G.1 — Nominal diameter d, length l of nails and length lg of the profiled part of nails



Key

d	diameter
d_h	head diameter
h_t	head thickness
l_p	length of the point

Figure G.2 — Geometry of nail heads and points

G.2 Staples

Staples shall be produced from a wire in accordance with the specifications given in Table G.4. The tensile strength of all wires, and the category of stainless steel wires, may be given as description of the type of dowel-type fastener.

Other steel grades may be used, provided it has been documented that the steel has at least the same mechanical properties of materials listed in Table G.4. All relevant information of the alternative steel grades shall be obtained from testing (tensile strength).

Table G.4 — Material and strength specifications for staples

Drawn wire minimum tensile strength in N/mm² (determined in accordance with EN 10218-1:2012)	Standard	
	Carbon Steel	Stainless Steel
800	EN ISO 16120 series	EN 10088 series

Staples shall fulfil the provisions for geometry related properties given in Table G.5. Staple legs shall have a round, deformed circular or rectangular cross-section. Dimensions listed in Table G.5 may be given as description of the type of dowel-type fastener. Dimensions shall be taken on the dowel-type fastener using a calibrated device capable of achieving an accuracy of ± 1 % of the measurement. Admissible tolerances on nominal values of Table G.5 dimensions are given in Table G.6.

Staples may be delivered in loose or collated form (strips).

If a dimension or an area has been assigned a tolerance, then the measured values of the dimensions and areas of the dowel-type fasteners shall be within the range of the values ± tolerances. The indication of the value of the results implies fulfilment with the provisions given in the Annex G. If no tolerance has been assigned, then the measured value shall be greater than or equal to the nominal value.

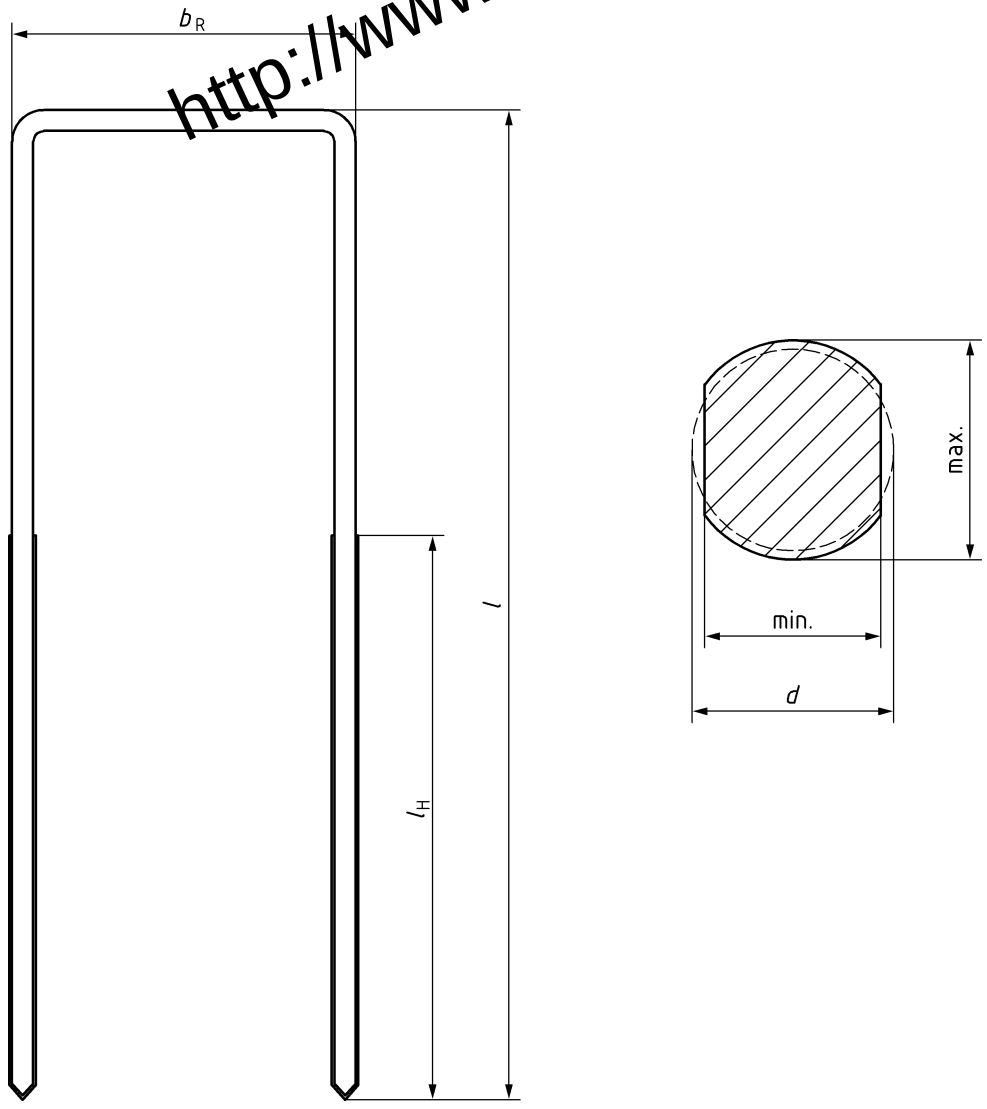
Geometry related properties shall be provided through detailed drawings including tolerances, showing the dimensions of the staple. The examples given in Figure G.3 define the principle that shall be followed.

Table G.5 — Geometry specifications for staples

Dimensions	Specifications	Notes
• **any type of staples, uncoated or coated:**		
- leg length, l (mm)	≤ 85 d	see Figure G.3
- nominal leg diameter, d (mm)	-	see Figure G.3
- area of the leg, A_S (mm²)	1,7 mm2 ≤ A_S ≤ 7,5 mm²	–
- crown width, b_R (mm)	≥ 5,8 d	see Figure G.3
• **additionally, for nails with Type 3 coating:**		
- coated length, l_H (mm)	≥ 0,5 l	see Figure G.3
The nominal leg diameter shall be taken as $d = \sqrt{4A_5 / \pi}$, provided the maximum cross-sectional dimension measured around the perimeter is not larger than 1,2 times the minimum dimension; if the maximum dimension is larger than 1,2 times the minimum dimension, only the area within a rectangular mask with side lengths equal to the minimum dimension and 1,2 times the minimum dimension shall be taken into account.		
NOTE For staples with rectangular cross section d is differently defined in EN 1995-1-1:2004.		

Table G.6 — Admissible tolerances on nominal values for staples

Dimensions	Specifications
leg length, l (mm)	±2,5 %
nominal diameters, d (mm)	±2,5 %
area of the leg, A_s (mm²)	±5,0 %
crown width, b_R (mm)	±5,0 %
coated length (if present), l_H (mm)	±5,0 %



Key

b_R	crown width
l	leg length
l_H	coated length
d	nominal diameter

Figure G.3 —Geometry of a staple

G.3 Screws

Screws shall be produced from a wire of carbon steel or stainless steel. The specifications of the wire may be given as description of the type of dowel-type fastener. All relevant information of the steel grade can be obtained from the supplier's declaration.

Screws can have a smooth shank diameter either equal to the maximum outer cross-sectional diameter of the threaded part (e.g. turned down from the original rod diameter) or smaller (e.g. rolled or forged from a wire rod). The threads shall be clean and sharply cut or formed.

Screws shall fulfil the provisions for geometry related properties given in Table G.7. Dimensions listed in Table G.7 may be given as description of the type of dowel-type fastener. Dimensions shall be taken on the dowel-type fastener using a calibrated device capable of achieving an accuracy of ± 1 % of the measurement. Admissible tolerances on nominal values of Table G.7 dimensions are given in Table G.8.

If a dimension or an area has been assigned a tolerance, then the measured values of the dimensions and areas of the dowel-type fasteners shall be within the range of the values ± tolerances. The indication of the value of the results implies fulfilment with the provisions given in the Annex G. If no tolerance has been assigned, then the measured value shall be greater than or equal to the nominal value.

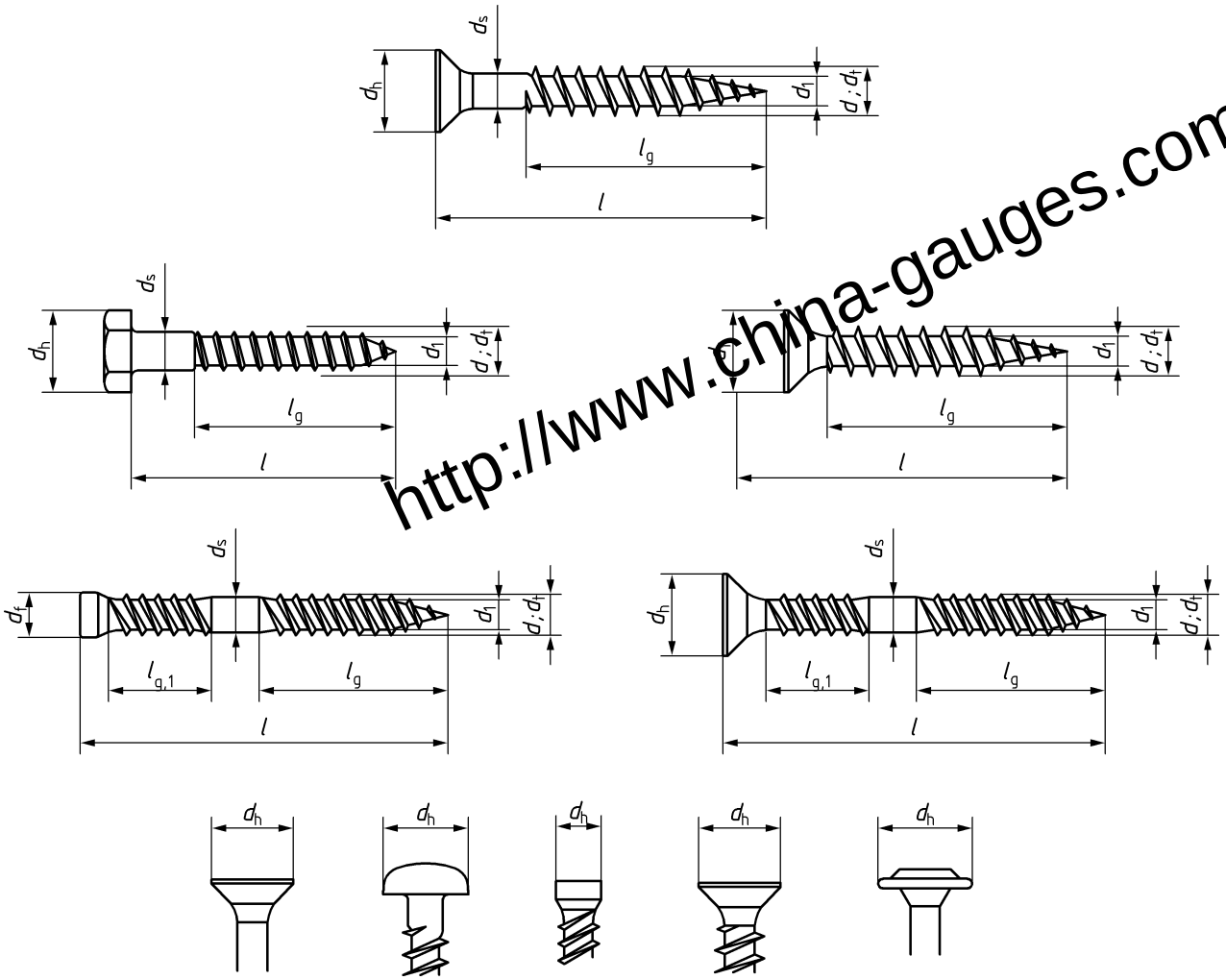
Geometry related properties shall be provided through detailed drawings including tolerances, showing the dimensions of the screw including the length of the threaded parts, drill tip dimensions or secondary rough thread dimensions. The examples given in Figure G.4 define the principle that shall be followed.

Table G.7 — Geometry specifications for screws

Dimensions	Specifications	Notes
• **fully threaded screws, uncoated or coated:**		
- length, l (mm)	–	see Figure G.4
- thread length, l_g (mm)	$l_g \geq 4\ d$	see Figure G.4
- nominal diameter, d (mm)	2,4 mm ≤ d ≤ 24,0 mm	see Figure G.4
- target diameter, d_t (mm)	0,95 $d \leq d_t \leq d$	see Figure G.4
- inner thread diameter, d_i (mm)	0,5 $d_t \leq d_i \leq$ 0,9 d_t	see Figure G.4
- head diameter, d_h (mm)	-	see Figure G.4
• **additionally, for partially threaded screws, uncoated or coated:**		
- diameter of the shank, d_s (mm)	–	see Figure G.4
• **additionally, for double threaded screws, uncoated or coated:**		
- diameter of the shank, d_s (mm)	–	see Figure G.4
- diameter of the secondary thread, d_1 (mm)	–	see Figure G.4
- secondary thread length, $l_{g,1}$ (mm)	–	see Figure G.4

Table G.8 — Admissible tolerances on nominal values for screws

Dimensions	Specifications
length, l (mm)	±50 / (l 0,6) %
thread length, l_g (mm)	±50 / (l_g 0,6) %
diameters, d, d_i, d_t, d_s, d_1 < 6 mm (mm)	±0,3 mm
diameters, d, d_i, d_t, d_s, d_1 ≥ 6 mm (mm)	±5 %
head diameter, d_h (mm)	±5,0 %
secondary thread length (if present), l_g (mm)	±50 / (l_g 0,6) %



Key

d	nominal diameter (outer thread diameter)
d_s	diameter of the smooth shank of a screw
d_i	inner threaded diameter of screws
d_t	target diameter
d_h	head diameter
l	length
l_g	thread length
$l_{g,1}$	secondary thread length

Figure G.4 — Geometry of screws. Examples of the definition of d, d_i, d_t, d_h, l, l_g and $l_{g,1}$

G.4 Dowels

Dowels shall be produced from rods in accordance with the specifications given in Table G.9. The tensile strength of all wires, and the category of stainless steel wires, may be given as description of the type of dowel-type fastener.

Other steel grades may be used, provided it has been documented that the steel has at least the same mechanical properties of materials listed in Table G.9. All relevant information of the alternative steel grades shall be obtained from testing.

Table G.9 — Material and strength specifications for dowels

Rod minimum yield stress in N/mm² (determined in accordance with EN 10025-2:2019, EN 10277:2018)	Rod percentage elongation in % (determined in accordance with EN ISO 6892-1:2019)	Standard	
		Carbon Steel	Stainless Steel
235	8	EN 10025-2:2019 EN 10025-3:2019 EN 10149-1:2013 EN 10277:2018	EN 10088-1:2014

Dowels shall have a cross section with circular or fluted shank. Dowels shall fulfil the provisions for geometry related specifications given in Table G.10. Dimensions listed in Table G.10 may be given as description of the type of dowel-type fastener. Dimensions shall be taken on the dowel-type fastener using a calibrated device capable of achieving an accuracy of ± 1 % of the measurement. Admissible tolerances on nominal values of Table G.10 dimensions (measured on the finished dowel with corrosion protection if any) are given in Table G.11.

If a dimension or an area has been assigned a tolerance, then the measured values of the dimensions and areas of the dowel-type fasteners shall be within the range of the values ± tolerances. The indication of the value of the results implies fulfilment with the provisions given in the Annex G. If no tolerance has been assigned, then the measured value shall be greater than or equal to the nominal value.

Geometry related properties shall be provided through detailed drawings including tolerances, showing the dimensions of the dowels including the nominal diameter, the length and the inner diameter in case of fluted dowels.

Table G.10 — Geometry specifications for dowels

Dimensions	Specifications	Notes
• **any type of dowels, uncoated or coated:**		
- length, l (mm)	–	–
- nominal diameter, d (mm)	6,0 mm ≤ d ≤ 30 mm	–
• **additionally, for fluted shank dowels, uncoated or coated:**		
- inner diameter, d_i (mm)	≥ 0,95 d_o	for fluted cross-section do is the outside diameter

Table G.11 — Admissible tolerances on nominal values for dowels

Dimensions	Specifications
— diameters, d, d_i (mm)	- 0,1/+0,5 mm

G.5 Bolts and nuts

Materials and strength classes for bolts and nuts shall be in accordance with the specifications given in Table G.12. The strength class of bolts and nuts may be given as description of the type of dowel-type fastener. For stainless steel bolts and nuts, if one or more washers are used in the assembly, the material of the washer shall be at least in the same stainless steel corrosion resistance class of the bolt and nut according to Table 3.

Table G.12 — Material and strength class specifications for bolts and nuts

Carbon Steel			
Screw part		**Nut**	
Strength class	**Standard**	**Strength class**	**Standard**
4.6	EN ISO 898-1:2013[19]	5, 6, 8	EN ISO 898-2:2012
4.8			
5.6		5, 6, 8	
5.8			
6.8		6, 8	
8.8		8	
Stainless Steel			
Screw part		**Nut**	
Strength class	**Standard**	**Strength class**	**Standard**
50	EN ISO 898-1:2013[19]	50, 70, 80	EN ISO 898-2:2012
70		70, 80	
80		80	

The screw part of the bolt and the nut shall have a metric ISO thread according to ISO 965 (all parts) and when applicable EN ISO 10684:2004[20]. The screw part of the bolt and the nut shall be designed and manufactured in such a way, that they comply with the specifications given in Table G13 and are fully loadable (reach full loading capacity) as defined in EN ISO 898-1:2013, 8.2[19]; for nuts, EN ISO 898-2:2012, Clause 5 applies.

Bolts shall fulfil the provisions for geometry related properties given in Table G.13. Dimensions listed in Table G.13 may be given as description of the type of dowel-type fastener. Dimensions shall be taken on the dowel-type fastener using a calibrated device capable of achieving an accuracy of ± 1 % of the measurement. Admissible tolerances on nominal values of Table G.13 dimensions are given in ISO 965 (all parts).

If a dimension or an area has been assigned a tolerance, then the measured values of the dimensions and areas of the dowel-type fasteners shall be within the range of the values ± tolerances. The indication of the value of the results implies fulfilment with the provisions given in the Annex G. If no tolerance has been assigned, then the measured value shall be greater than or equal to the nominal value.

[19] As impacted by EN ISO 898-1:2013/AC:2013.

[20] As impacted by EN ISO 10684:2004/AC:2009.

Geometry related properties shall be provided through detailed drawings including tolerances, showing the dimensions of the bolts and nuts including the nominal diameter, the nominal length and the length of the threaded part.

Table G.13 — Geometry specifications for bolts and nuts

Dimensions	Specifications	Notes
• **any type of bolts, uncoated or coated:**		
- length, *l* (mm)	–	–
- thread length, *l* (mm)		–
- nominal diameter, *d* (mm)	6 mm ≤ *d* ≤ 30 mm	–

Bibliography

[1] EN 338:2016, *Structural timber - Strength classes*

[2] EN 10263-4:2017, *Steel rod, bars and wire for cold heading and cold extrusion - Part 4: Technical delivery conditions for steels for quenching and tempering*

[3] EN 10263-5:2017, *Steel rod, bars and wire for cold heading and cold extrusion - Part 5: Technical delivery conditions for stainless steels*

[4] EN 10269:2013, *Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties*

[5] EN ISO 683-1:2018, *Heat-treatable steels, alloy steels and free-cutting steels - Part 1: Non-alloy steels for quenching and tempering (ISO 683-1:2016)*

[6] EN ISO 780, *Packaging - Distribution packaging - Graphical symbols for handling and storage of packages (ISO 780)*

[7] EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461)*

[8] EN ISO 3506-2, *Mechanical properties of corrosion-resistant stainless steel fasteners - Part 2: Nuts (ISO 3506-29)*

[9] EN ISO 6270 (all parts), *Paints and varnishes - Determination of resistance to humidity*

[10] EN ISO 6988, *Metallic and other non-organic coatings - Sulfur dioxide test with general condensation of moisture (ISO 6988)*

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

[12] EN ISO 9223:2012, *Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation (ISO 9223:2012)*

[13] EN ISO 9224:2012, *Corrosion of metals and alloys - Corrosivity of atmospheres - Guiding values for the corrosivity categories (ISO 9224:2012)*

[14] ISO/TR 16335:2013, *Corrosion of metals and alloys - Corrosion tests in artificial atmospheres - Guidelines for selection of accelerated corrosion test for product qualification*

[15] ASTM G85:2011, *Standard Practice for Modified Salt Spray (Fog) Testing, Annex 5: Dilute electrolyte cyclic fog dry test*

[16] 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

[17] Commission Decision 96/603 of 4 October 1996 establishing the list of products belonging to Classes A 'No contribution to fire' provided for in Decision 94/611/EC implementing Article 20 of Council Directive 89/106/EEC on construction products

[18] Commission Decision 2000/147/EC of 8 February 2000 implementing Council Directive 89/106/EEC as regards the classification of the reaction to fire performance of construction products

Annex NA
(informative)

Corrosion Resistance

NA.1 Introduction

This Annex is intended to provide additional informative guidance to that provided in the European Standard clauses cited below, to assist users in determining the appropriate level of fastener corrosion protection necessary for their particular application.

NA.2 EN 14592:2022 — Clause 4.1.2.3 Tables 1 & 2 — Zinc coating thicknesses

According to EN 10346:2015 Table 12, a 10µm coating thickness is equivalent to a Z140 electroplated zinc specification, and a 20µm coating thickness is equivalent to a Z275 electroplating zinc specification. No electroplated zinc coating equivalents are available for 55µm or 110µm coating thicknesses, so an appropriate hot-dip galvanising specification should be selected from BS EN ISO 10684:2004.

NA.3 NA.3 EN 14592:2020 — Clause 4.1 and Annex B — Atmospheric and Timber Corrosivity Categories

Table NA.1 below sets out the service class definitions provided in the UK National Annex to EN 1995-1-1 (Eurocode 5) for various types of timber construction, and the corresponding Timber Category (T category) and Atmospheric Category (C category) that may be assumed when using EN 14592 Tables 1–6 to arrive at an appropriate worst case fastener corrosion protection specification. The guidance in Table NA.1 is limited to softwoods with a pH > 4.

Table NA.1 — Assignment of Corrosivity Classes and Minimum Corrosion Protection Specifications for Various Types of Timber Construction

Type of Construction	Service Class (from UK NA to BS EN 1995-1-1:2004+A2:2014)	Timber Corrosivity Category (T category)	Atmosphere Category[2] (C category)	Min zinc coating specification (see Tables 1 & 2)	Min stainless corrosion resistance class[5] (see Tables 3 & 4)	Min alternative coating type specification (see Tables 5 & 6)
Cold Roofs	SC2	T3	C2nw[4]	Z275 (20µm)	CRC II	See Annex A.2 & A.4
Cold Roofs (with treatments containing copper or salts as chlorides[1])	SC2	T4	C2nw	Hot-dip 55µm	CRC III	See Annex A.3 & A.4
Warm Roofs	SC1	T2	C1 or C2nw[3]	Z140 (10µm)	-	See Annex A.4
Intermediate Floors	SC1	T1	C1	-	-	-
Ground Floors	SC2	T3	C2nw	Z275 (20µm)	CRC II	See Annex A.2 & A.4
Ground Floors (with treatments containing copper or salts as chlorides[1])	SC2	T4	C2nw	Hot-dip 55µm	CRC III	See Annex A.3 & A.4
Timber Frame walls, internal and party walls	SC1	T1	C1	-	-	-
Timber Frame walls, external	SC2	T3	C2nw	Z275 (20µm)	CRC II	See Annex A.2 & A.4
Timber Frame walls, external (with treatments containing copper or salts as chlorides[1])	SC2	T4	C2nw	Hot-dip 55µm	CRC III	See Annex A.3 & A.4

Table NA.1 *(continued)*

Type of Construction	Service Class (from UK NA to BS EN 1995-1-1:2004+A2:2014)	Timber Corrosivity Category (T category)	Atmosphere Category[2] (C category)	Min zinc coating specification (see Tables 1 & 2)	Min stainless corrosion resistance class[5] (see Tables 3 & 4)	Min alternative coating type specification (see Tables 5 & 6)
External uses where member is protected from direct wetting	SC2	T3	C2nw	Z275 (20µm)	CRC II	See Annex A.2 & A.4
External uses where member is protected from direct wetting (with treatments containing copper or salts as chlorides[1])	SC2	T4	C2nw	Hot-dip 55µm	CRC III	See Annex A.3 & A.4
External uses, fully exposed	SC3	T5	Refer to BS EN 14592 Table B.2	n.a	CRC III	n.a

1 Treatment is defined as those treatments which are shown to affect the corrosion rate only, and are assumed to contain copper or salts as chlorides, applied by pressure impregnation or dipping.

2 Atmosphere Category assumes Low Pollution environments. Refer to BS EN 14592 Table B.1 for other environments.

3 Warm roof construction can be considered over Heated Spaces or Unheated Spaces.

4 'nw' indicates that the timber concerned is in an environment where it is not weathered. See Annex B.

5 BS EN 14592 Table 3 provides a cross reference between the CRC and the BS EN ISO 3506-1 A grades.

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