

EUROPEAN ASSESSMENT DOCUMENT

EAD 130118-00-0603

October 2016

SCREWS FOR USE IN TIMBER CONSTRUCTIONS

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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1 SCOPE OF THE EAD

1.1 Description of the construction product

The screws are made from special stainless or carbon steel.

The product is not fully covered by the following harmonised technical specification EN 14592:2008+A1:2012. As provided in Regulation (EU) N° 305/2011 Article 19 (1) c) the essential characteristics bending angle, slip modulus for mainly axially loaded screws, spacing, end and edge distances of the screws and minimum thickness of the wood based material and yield strength essential characteristics are additionally given in the EAD.

In terms of geometry they are widely in accordance to EN 14592:2008+A1:2012, Timber structures – Dowel-type fasteners - Requirements. The EAD covers screws with the following geometry:

$$2,4 \text{ mm} \leq d \leq 24,0 \text{ mm}$$

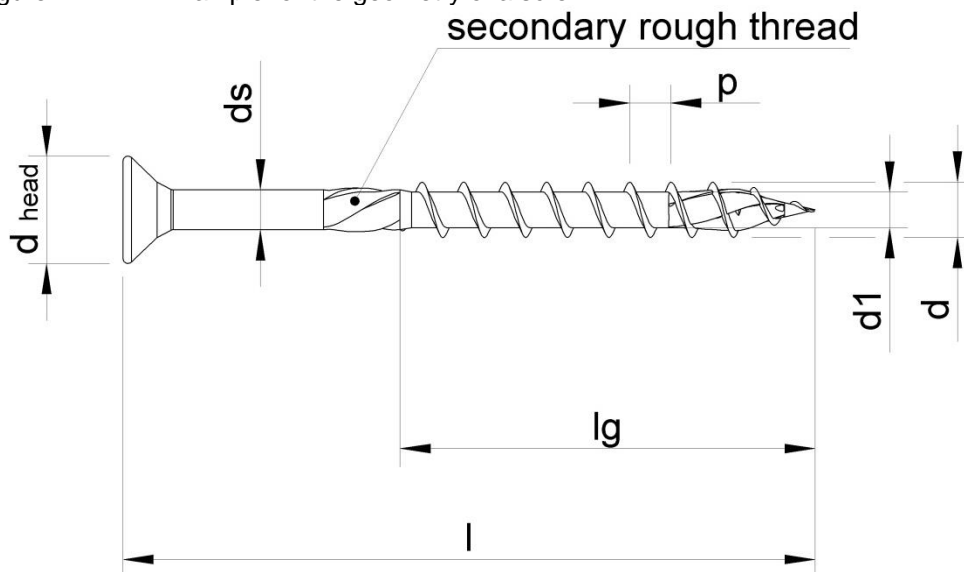
$$0,5 \cdot d \leq d_1 \leq 0,9 \cdot d$$

$$l_g \geq 4 \cdot d$$

The screws may have a thread almost over its total length or only over a part of its length.

Special geometric attributes of the screws may be particular drill tips, a secondary rough thread or a double thread. The screws may have an anti-friction coating.

Figure 1 Example for the geometry of a screw



- l length of the screw
- l_g threaded length of the screw
- d_1 inner thread diameter of the screw
- d outer thread diameter of the screw
- d_s shank diameter of the screw
- d_{head} head diameter of the screw
- p pitch of the screw

The EAD applies to screws with a minimum penetration length of the threaded part of the screw in the timber member l_{ef} of

$$l_{ef} = \min \left\{ \begin{array}{l} \frac{4 \cdot d}{\sin \alpha} \\ 20 \cdot d \end{array} \right.$$

where

α angle between screw axis and grain direction.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

The screws are screwed into the timber member with or without pre-drilling.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The screws are used for connections in timber constructions, e.g.

- timber/timber, wood-based panels/timber, steel/timber connections, steel/ wood-based panels,
- fastening of battens on thermal insulation systems on top of rafters or on wood-based members in vertical façades,
- reinforcement of timber in areas of high tensile stresses perpendicular to the grain or compression stresses perpendicular to the grain (e.g. supports of beams).

The use of the screws shall be limited to static and quasi-static actions.

The general use conditions for which this EAD is valid are given in EN 1995-1-1.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the screw for the intended use of 50 years when installed in the works (provided that the screw is subject to appropriate installation (see 1.1)). These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works¹.

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor

¹ The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the working life referred to above.

by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 1 shows how the performance of screws is assessed in relation to the essential characteristics.

Table 1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance <i>(level, class, description)</i>
Basic Works Requirement 1: Mechanical resistance and stability			
1	Dimensions	2.2.1	Description
2	Characteristic yield moment	2.2.2	Level
3	Bending angle	2.2.3	Description, level
4	Characteristic withdrawal parameter	2.2.4	Level
5	Characteristic head pull-trough parameter	2.2.5	Level
6	Characteristic tensile strength	2.2.6	Level
7	Characteristic yield strength	2.2.7	Level
8	Characteristic torsional strength	2.2.8	Level
9	Insertion moment	2.2.9	Level
10	Spacing, end and edge distances of the screws and minimum thickness of the wood based material	2.2.10	Description, level
11	Slip modulus for mainly axially loaded screws	2.2.11	Level
12	Durability against corrosion	2.2.12	Description, level
Basic Works Requirement 2: Safety in case of fire			
13	Reaction to fire	2.2.13	Class
Basic Works Requirement 4: Safety and accessibility in use			
15	Same as BWR 1		

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

Characterisation of the screws to be assessed shall be done in accordance with available specifications, notably mechanical properties and chemical composition of raw materials.

2.2.1 Dimensions

The relevant dimensions of the screws shall be measured according to the provisions in EN 14592.

The dimensions of the screws including the drill tip dimensions and/or secondary rough thread dimensions shall be documented in the test report.

The EAD covers screws with length, thread length, inner thread, outer thread, shank and head diameter and pitch with maximal tolerances according to Table 2.

Table 2: Tolerances of dimensions

Dimension	Range		Tolerance in relation to the relevant dimension
	Above	Up to and including	
l, l_g^a	10 mm	18 mm	± 1,5 mm
	18 mm	30 mm	± 1,7 mm
	30 mm	50 mm	± 2,0 mm
	50 mm	80 mm	± 2,3 mm
	80 mm	120 mm	± 2,7 mm
	120 mm	180 mm	± 3,2 mm
	180 mm	250 mm	± 3,6 mm
	250 mm	315 mm	± 4,1 mm
	315 mm	400 mm	± 4,5 mm
	400 mm	500 mm	± 4,9 mm
	500 mm	630 mm	± 5,5 mm
	630 mm	800 mm	± 6,3 mm
	800 mm	1.000 mm	± 7,0 mm
	1.000 mm	1.250 mm	± 8,3 mm
1.250 mm	-	± 9,3 mm	
d₁, d, d_s	2,4 mm	6 mm	± 0,3 mm
	6 mm	24 mm	±5 %
d_{head}	-	8 mm	± 0,5 mm
	8 mm	12 mm	± 0,6 mm
	12 mm	-	±5 %
p	all		±10 %
^a Larger tolerances may be specified in the ETA. They shall be used in the calculation by specifying the minimum length l or thread length l _g .			

2.2.2 Characteristic yield moment

The characteristic yield moment of the screws shall be determined by tests according to EN 409. The tests shall be carried out with a free length of the screw l_2 of $2 \cdot d$. The minimum number of specimens is 10 for every outer thread diameter. The weakest point within the length of the screw has to be tested.

The yield moment is the value at the plastic bending angle $\alpha = 45/d^{0.7}$ degrees (where d is in mm). The characteristic value of the yield moment shall be calculated according to EN 14358.

2.2.3 Bending angle

The screw shall be clamped and bent over a bending mandrel with a defined diameter of $2 \cdot d$. The weakest point within the length of the screw has to be tested. The screw shall be bent to the extent that it will not break off. The bending angle shall be measured.

The minimum number of specimens is 10 for every outer thread diameter.

2.2.4 Characteristic withdrawal parameter

2.2.4.1 Method 1

For screws in solid softwood according to EN 14081-1 or glued laminated timber made from softwood according to EN 14080 the withdrawal parameter shall be determined according to the test method given in EN 1382. The provisions are valid for screws inserted in the timber member with an angle α between screw axis and grain direction of at least 15° with the exception given below.

At least 20 tests for every influencing parameter such as the outer thread diameter, drill tip, secondary rough thread and the angle between screw-axis and grain are required. For a chosen characteristic density ρ_k the density of the test specimens shall fulfil the requirements of EN ISO 8970.

If necessary, the withdrawal parameter of each test has to be corrected with a factor k_p .

The factor k_p shall be calculated as:

$$k_p = \left(\frac{\rho_k}{\rho} \right)^{0,8} \quad (1)$$

where:

ρ_k characteristic density of the strength class of the timber to which the test results should be related,

ρ density of the test specimen.

From the possibly corrected withdrawal parameters of all test results the characteristic value of the withdrawal parameter shall be calculated according to EN 14358. This characteristic withdrawal parameter corresponds to the chosen characteristic density of the timber.

For angles α between screw axis and grain direction $15^\circ \leq \alpha \leq 45^\circ$ the characteristic withdrawal capacity $F_{ax,\alpha,Rk}$ shall be determined according to equation (2):

$$F_{ax,\alpha,Rk} = k_{ax} \cdot f_{ax,90,k} \cdot d \cdot \ell_{ef} \cdot \left(\frac{\rho_k}{350} \right)^{0,8} \quad (2)$$

where

k_{ax} factor to consider the influence of the angle between screw axis and grain direction and the long-term behaviour

$$k_{ax} = 0,3 + (0,7 \cdot \alpha) / 45^\circ \quad (3)$$

- $f_{ax,90,k}$ short-term characteristic withdrawal parameter for an angle α between screw axis and grain direction of 90° in N/mm^2
- d outer thread diameter of the screw in mm
- l_{ef} penetration length of the threaded part of the screw in the timber member in mm
- ρ_k characteristic density of the wood-based member in kg/m^3

Equations (2) and (3) may be used for angles α between screw axis and grain direction $0^\circ \leq \alpha < 15^\circ$ if the following requirements are satisfied:

1. $f_{ax,0,k}/f_{ax,90,k} \geq 0,6$
 $f_{ax,0,k}$ short-term characteristic withdrawal parameter for an angle between screw axis and grain direction of 0° determined on test specimens made from solid softwood
2. The penetration length of the threaded part of the screws shall be

$$l_{ef,req} = \min \begin{cases} \frac{4 \cdot d}{\sin \alpha} \\ 20 \cdot d \end{cases} \quad \text{for } 0^\circ \leq \alpha \leq 15^\circ$$

3. At least four screws shall be used in a connection with screws inserted in the timber member with an angle between screw axis and grain direction of less than 15° .

2.2.4.2 Method 2

In all other cases not fulfilling the requirements of method 1 the characteristic withdrawal parameter shall be determined by testing according to the test method given in EN 1382. The provisions are valid for screws inserted in the timber member with an angle α between screw axis and grain direction of at least 15° . The timber or the wood based materials for the test specimens represent the density distribution of the strength class for which the withdrawal parameter is determined. For timber generally at least 100 tests for each wood species with different timber specimens are required. For wood based panels produced from veneers, strands or particles a minimum of 20 specimens is required. All parameters influencing the withdrawal parameter have to be examined (e.g. outer thread diameter, drill tip, secondary rough thread, angle between screw-axis and grain).

The characteristic value of the withdrawal parameter for the tested screw in the corresponding strength class or the wood based materials shall be calculated according to EN 14358.

2.2.5 Characteristic head pull-through parameter

2.2.5.1 Method 1

For screws with a head diameter of at least 1,8 times the shank or inner thread diameter the characteristic head pull-through parameter for solid softwood according to EN 14081-1 (minimum strength class C24) and glued laminated timber made from softwood according to EN 14080 (minimum strength class GL24) may be determined by calculation.

The characteristic value of the head pull-through parameter for a characteristic density of 380 kg/m^3 of the timber and for the following wood based panels

- Plywood according to EN 636 and EN 13986,
 - Oriented Strand Board, OSB according to EN 300 and EN 13986,
 - Solid wood panel according to EN 13353 and EN 13986,
 - Particleboard according to EN 312 and EN 13986
 - Cement-bonded particle board according to EN 633 and EN 13986
 - Fibreboards according to EN 622-2, EN 622-3 and EN 13986
- with thicknesses of more than 20 mm is

$$f_{\text{head,k}} = 10 \text{ N/mm}^2$$

For wood based panels with a thickness between 12 mm and 20 mm the characteristic value of the head pull-through parameter is

$$f_{\text{head,k}} = 8 \text{ N/mm}^2$$

For wood based panels with a thickness of less than 12 mm the characteristic head pull-through capacity shall be based on a characteristic value of the head pull-through parameter of 8 N/mm², and limited to 400 N complying with the minimum thicknesses of the wood based panels of $1,2 \cdot d$ with d as outer thread diameter. In addition the minimum thicknesses of table 3 apply.

Table 3 Minimum thicknesses of wood based panels

Wood based panel	Minimum thickness in mm
Plywood	6
Oriented Strand Boards, OSB	8
Solid wood panels	12
Particleboards	8
Cement-bonded particle boards	8
Fibreboards (hardboards and medium boards)	6

2.2.5.2 Method 2

For screws in solid softwood according to EN 14081-1 or glued laminated timber made from softwood according to EN 14080 which do not fulfil the requirements for using method 1 or for screws with special design of the head which may influence the head pull-through capacity, the head pull-through parameter shall be determined by testing according to the test method given in EN 1383. At least 20 tests for each influencing parameter are required. For one chosen characteristic density ρ_k the density of the test specimens shall fulfil the requirements of EN ISO 8970. If necessary, the head pull-through parameter of each test has to be corrected by a factor k_p according to equation (1). If washers can be used with the screws they shall be included in the test program. The maximum washer diameter is limited to 35 mm.

From the corrected head pull-through parameter of all test results the characteristic value of the head pull-through parameter shall be calculated according to EN 14358. This characteristic head pull-through parameter corresponds to the chosen characteristic density.

2.2.5.3 Method 3

In all other cases not fulfilling the requirements of method 1 or 2, the characteristic head pull-through parameter shall be determined by testing according to the test method given in EN 1383. The timber or the wood based materials represent the density distribution of the strength class for which the head pull-through parameter is provided. For timber generally at least 100 tests for each wood species with different timber specimens are required. For wood based panels produced from veneers, strands or particles a minimum of 20 specimens is required. All parameters influencing the head pull-through parameter have to be examined.

The characteristic value of the head pull-through parameter for the tested screw in the corresponding strength class or the wood based materials shall be calculated according to EN 14358.

2.2.6 Characteristic tensile strength

The characteristic tensile strength of the screws shall be determined for each inner thread diameter in the relevant cross-section by testing according to EN 14592:2008+A1:2012, 6.3.4.5.

The characteristic value of the tensile strength shall be calculated according to EN 14358.

2.2.7 Characteristic yield strength

The characteristic yield strength of the screws shall be determined by using the strength-elongation diagram drawn up by tests as described in clause 2.2.6. The elongation shall be measured in the middle of each screw using a strain gauge.

The start length of the specimen L_0 should be 50 mm or 80 mm (measuring length). After exceeding the yield strength of the screw the applied load shall be reduced to 10 % of the yield load. Then the load shall be increased up to the exceeding of the original load.

The determination of the characteristic yield strength is as follows:

First the midline through the hysteresis loop should be drawn. A further line should be constructed by drawing a parallel graph of the midline through the 0,2%-elongation point.

The yield load is the ordinate value of the intersection from this line with the strength-elongation curve. The yield load shall be divided by the value of the core cross section of the screw, resulting in the yield strength.

The characteristic value of the yield strength shall be calculated according to EN 14358.

2.2.8 Characteristic torsional strength

The characteristic torsional strength of the screws shall be determined by testing according to EN ISO 10666:1999, 4.2.3. At least 10 tests for each outer thread diameter for the longest screw are required.

The characteristic value of the torsional strength shall be calculated according to EN 14358.

For screws made of stainless steel, the elastic limit must not be less than the mean value of the corrected insertion moment when determining the torsional strength.

2.2.9 Insertion moment

The insertion moment of the screws in solid wood (strength classes C16 up to C40 according to EN 14081-1) and glued laminated timber (strength class GL24 up to GL36 according to EN 14080) shall be determined by testing according to EN 15737. The screw insertion moment has to be adjusted with the factor $k_{pE} = (480/\rho)$, where ρ is the density of the test specimen. At least 20 tests for each outer thread diameter for the screw with the longest threaded part are required. If there are screws with anti-friction coating used in the tests this has to be noted in the test report. That applies to special geometries of the screws such as drill tips and secondary rough threads too.

For other wood species or wood based materials the screw insertion moment has to be adjusted to the mean density of the respective material.

The ratio of the characteristic torsional strength to the mean insertion moment has to be at least 1.5.

2.2.10 Spacing, end and edge distances of the screws and minimum thickness of the wood based material

2.2.10.1 Method 1

For screws in solid wood (strength classes C16 up to C40 and D30 up to D70 according to EN 14081-1) and glued laminated timber (strength class GL24 up to GL36 according to EN 14080) the spacing, end and edge distances and the minimum thickness of the wood based material may be determined by calculation according to EN 1995-1-1.

The spacing, end and edge distances and the minimum thickness of the wood based material may be taken from EN 1995-1-1. The outer thread diameter of the screws d shall be used to determine the spacing, end and edge distances and the minimum thickness of the wood based material.

2.2.10.2 Method 2

See annex A

Are the spacing, end and edge distances less than the distances and thicknesses given in EN 1995-1-1 the verification of resistance according to EN 1995-1-1:2004 +AC:2006 + A1:2008, clause 8.7.2 (1) the failure along the circumference of a group of screws has to be considered also for connections without steel plates. That has to be pointed out in the European Technical Assessment of the screws.

2.2.11 Slip modulus for mainly axially loaded screws

The slip modulus for mainly axially loaded screws shall be determined by displacement measurement of two timber members or a timber and a steel member connected by screws. The influence of the following parameter shall be determined or shall be assessed on the basis of general findings:

- Outer thread diameter
- Penetration length of the screw thread in the timber member
- Ratio between outer thread diameter and inner thread diameter
- Density of the timber member
- Moisture content of the timber member
- Screwing in with or without pre-drilling of the timber member
- Angle between screw axis and grain direction of the timber member
- Inclined or crossed arrangement of the screws.

2.2.12 Durability against corrosion

The type and thickness of the corrosion protection shall be described in the European Technical Assessment.

Corrosion protection according to the examples given in EN 1995-1-1

Examples of the minimum corrosion protection for screws used in load-bearing timber structures are given in EN 1995-1-1 or in relevant national standards, depending upon the service conditions. The admissible service conditions and the admissible corrosive category according to EN ISO 12944-2 shall be considered.

If a hot dip galvanized zinc coating according to EN ISO 1461 is used its thickness shall be determined by EN ISO 1460 – gravimetric method – or by EN ISO 2178 – non-destructive magnetic method -.

In the case of using electroplated zinc coating according to EN ISO 4042 its thickness shall be determined by EN ISO 4042.

If stainless steel is used the steel shall be classified according to EN 1993-1-4 in conjunction with EN ISO 3506-1.

It should be considered that some type of hardwood has substances which cause corrosion of the screws under certain service conditions. In the case hardwood is used the durability of the corrosion protection or the stainless steel shall be verified.

Contact between screws and other components of the joint made from metal shall not result in corrosion in the intended use.

Contact between screws and timber preservative treated against biological attack or fire retardants shall not result in corrosion in the intended use. If screws are used in preservative treated timber the compatibility has to be verified.

Alternative corrosion protection

If the existing corrosion protection is deviating from the examples according to EN 1995-1-1 the equivalence of the corrosion protection shall be verified considering the admissible corrosive category according to EN ISO 12944-2.

When assessing the equivalence of corrosion protection coatings with the corrosion protection given in EN 1995-1-1, the part of the screw passing through the timber member and the one exposed to the atmosphere shall be assessed separately. It is assumed that the minimum requirements for the building materials or the corrosion protection of fasteners according to EN 1995-1-1:2004+AC:2006+A1:2008, table 4.1 in the different service classes in accordance with footnote b, apply only for insignificant or low corrosion loads (corrosive categories C1 and C2 according to EN ISO 12944-2:1998).

For the test specimens the steel shall be used from which the screws are made. The following aspects shall, inter alia, be taken into account:

- the real thickness of the corrosion protection coating; here the entire screw shall be included
- application process of the coating, defects shall be taken into account when carrying out the tests
- abrasion of the coating when the screws are turned in
- environmental conditions according to EN ISO 12944-2 in which the screws are to be used

Outdoor exposure tests shall be carried out. In this process the screws shall be stored over a period of at least 5 years in the highest corrosive category desired according to EN ISO 12944-2. The screws shall, however, be stored at least in corrosive category C4. At least 5 screws shall be provided for each exposure period. The taking of test specimens prior to the expiry of the entire exposure time shall be taken into account. For example, if screws are taken on an annual basis, at least 5 screws per year shall be exposed.

The existing corrosion of the test specimens shall be assessed by means of a metallographic cross-section taken at the points which are subject to the highest corrosive attack.

If a corrosion protection deviating from EN 1995-1-1:2004+AC:2006+A1:2008 was verified it shall be declared that the alternative corrosion protection was successfully tested. The admissible service class according to EN 1995-1-1 and the admissible corrosive category according to EN ISO 12944-2 shall be given.

Alternative to the above described test procedure the alternative corrosion protection may be considered as not existing. In this case type and thickness of the alternative corrosion protection shall also be described in the European Technical Assessment.

2.2.13 Reaction to fire

The screws are considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire in accordance with the EC Decision 96/603/EC (as amended) without the need for testing on the basis of it fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

Due to the fact that any lubrication film on screws for use in timber constructions is very thin, it may be assumed that it does not make any contribution to fire growth or the fully developed fire and has no influence to the smoke hazard. Thus screws for use in timber constructions with lubrication film need not to be tested.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is: Decision 1997/176/EC

The system is: 3

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 4.

Table 4 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Raw material specification	Suppliers declaration according to EN 10204	Product specification of the manufacturer	-	Per material batch
2	Dimensions of the screws	2.2.1	Drawings in the European Technical Assessment including tolerances	5 per production batch	Daily
3	Bending angle	2.2.3	2.2.3	5	Per production or heat treatment batch
4	Characteristic tensile strength	2.2.6	2.2.6	5 per screw type and outer thread diameter	Every 6 months
5	Characteristic torsional strength	2.2.8	2.2.8	5	Per production or heat treatment batch
6	Mean insertion moment	2.2.9	2.2.9	10 (screws with the maximum length per screw type and outer thread diameter)	Every 6 months
7	Durability (Corrosion protection)	Suppliers declaration	2.2.12	5	Per corrosion treatment batch

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment is of relevance.

EN 300	Oriented strand boards (OSB) – Definition, classification and specifications
EN 312	Particleboards - Specifications
EN 409:2009	Timber structures – Test methods – Determination of the yield moment of dowel type fasteners – nails
EN 622-2	Fibreboards – Specifications – Part 2: Requirements for hardboards
EN 622-3	Fibreboards - Specifications - Part 3: Requirements for medium boards
EN 634-2	Cement-bonded particleboards - Specifications - Part 2: Requirements for OPC bonded particleboards for use in dry, humid and external conditions
EN 636	Plywood – Specifications
EN 1380:2009	Timber structures – Test methods – Load bearing nails, screws, dowels and bolts
EN 1382:1999	Timber structures – Test methods – Withdrawal capacity of timber fasteners
EN 1383:1999	Timber structures – Test methods – Pull through resistance of timber fasteners
EN 1993-1-4	Design of steel structures – Part 1-4-: General rules – Supplementary rules for stainless steels
EN 1995-1-1:2004+A1:2008	Design of timber structures – Part 1-1: General – Common rules and rules for buildings
EN 10204	Metallic products – Types of inspection documents
EN 13353	Solid wood panels (SWP) – Requirements
EN 13986	Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking
EN 14080	Timber structures - Glued laminated timber – Requirements
EN 14081-1	Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements
EN 14358:2006	Timber structures – Calculation of characteristic 5-percentile values and acceptance criteria for a sample
EN 14592:2008+A1:2012	Timber structures – Dowel-type fasteners – Requirements
EN 15737:2009	Timber structures – Test methods – Torsional resistance of driving in screws
EN 26891:1991	Timber structures; Joints made with mechanical fasteners; General principles for the determination of strength and deformation characteristics
EN ISO 1460:1994	Metallic coatings – Hot dip galvanized coatings on ferrous materials – Gravimetric determination of the mass per unit area
EN ISO 1461:2009	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods

EN ISO 2178:1995	Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method
EN ISO 3506-1	Mechanical properties of corrosion-resistant stainless steel fasteners – Part 1: Bolts, screws and studs
EN ISO 4042:1999	Fasteners - Electroplated coatings
EN ISO 8970:2010	Timber structures – Testing of joints made with mechanical fasteners – Requirements for wood density
EN ISO 10666: 1999	Drilling screws with tapping screw threads – Mechanical and functional properties
EN ISO 12944-2: 1998	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 2: Classifications of environments
ISO 6892-1:2009	Metallic materials – Tensile testing – Part 1: Method of test at room temperature

ANNEX A - DETERMINATION OF MINIMUM TIMBER CROSS-SECTION AND MINIMUM SPACING, END AND EDGE DISTANCES FOR SCREWS

1 Test method for axially loaded screws

The minimum timber width and thickness as well as the minimum spacing, end and edge distance requirements are determined by screw-in tests, where the screws are driven into specimens perpendicular to the grain. Subsequently, the splitting area caused by inserting the screws is evaluated. The test results are valid for the timber species, the screw and the diameter used in the test and for:

- Timber with a thickness equal or larger than the thickness used in the tests,
- Timber with a width equal or larger than the width used in the tests,
- The minimum end and edge distances used in the tests,
- The minimum spacing used in the tests.

The spacing parallel to the grain shall not be less than $a_1 = 5 d$, where d is the outer thread diameter.

Test results with sawn timber are valid also for glued laminated timber. For wood-based materials like LVL, separate tests are required. The test specimens shall fulfil the following requirements:

- The sawn timber density shall not be less than 480 kg/m³ for *Picea abies* (Norway spruce) or *Abies alba* (Fir), 550 kg/m³ for *Pinus sylvestris* (Scots pine) and 650 kg/m³ for *Pseudotsuga menziesii* (Douglas-fir) or *Larix decidua* (Larch),
- The angle between the screw axis and the annual ring orientation shall be about 0° (tangential) or about 90° (radial),
- There shall be 10 specimens with a radial and 10 specimens with a tangential annual ring orientation,
- The specimens shall be conditioned prior to inserting in the screws at a temperature of (20 ± 2) °C and a relative humidity of (65 ± 2) %,

A minimum of 3 screws per specimen in a row parallel to the grain are driven into and through the timber conditioned at 20°C/65%. The screw head should be flush with the timber surface. Each screw should be inserted using a template to avoid an inclination of the screw. Friction effects reducing the splitting tendency should be eliminated (see Fig. 1 to 2).



Fig. 1: Inserting a screw using a template made of timber.

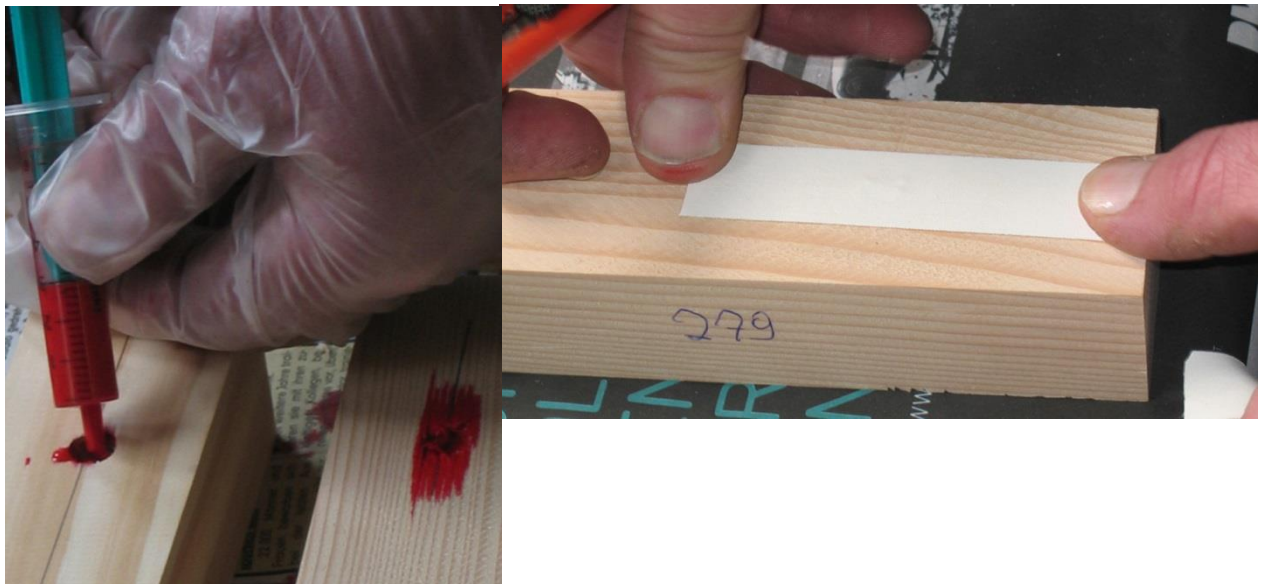


Fig. 2: Inserting a screw (left), specimens with 2 rows of 3 screws (right).

After storing the specimens containing the screws at a temperature of (20 ± 2) °C and a relative humidity of (65 ± 2) % for at least 24 h, the screws are unscrewed.

The opening caused by the exit of the screw point closest to the end grain is sealed at the timber surface, e.g. by using a tape. Subsequently, the low-viscosity dye wood stain "COLOR-Beize" shade No. 7704 of the company CLOU is filled into the hole caused by the screw (see Fig. 3).

Fig. 3: Sealing a specimen and pouring the dye.



The distribution of the dye by capillary action colours the split area. After the dye has dried, the coloured split areas are made visible by opening the specimens along the split surface (see Fig. 4).

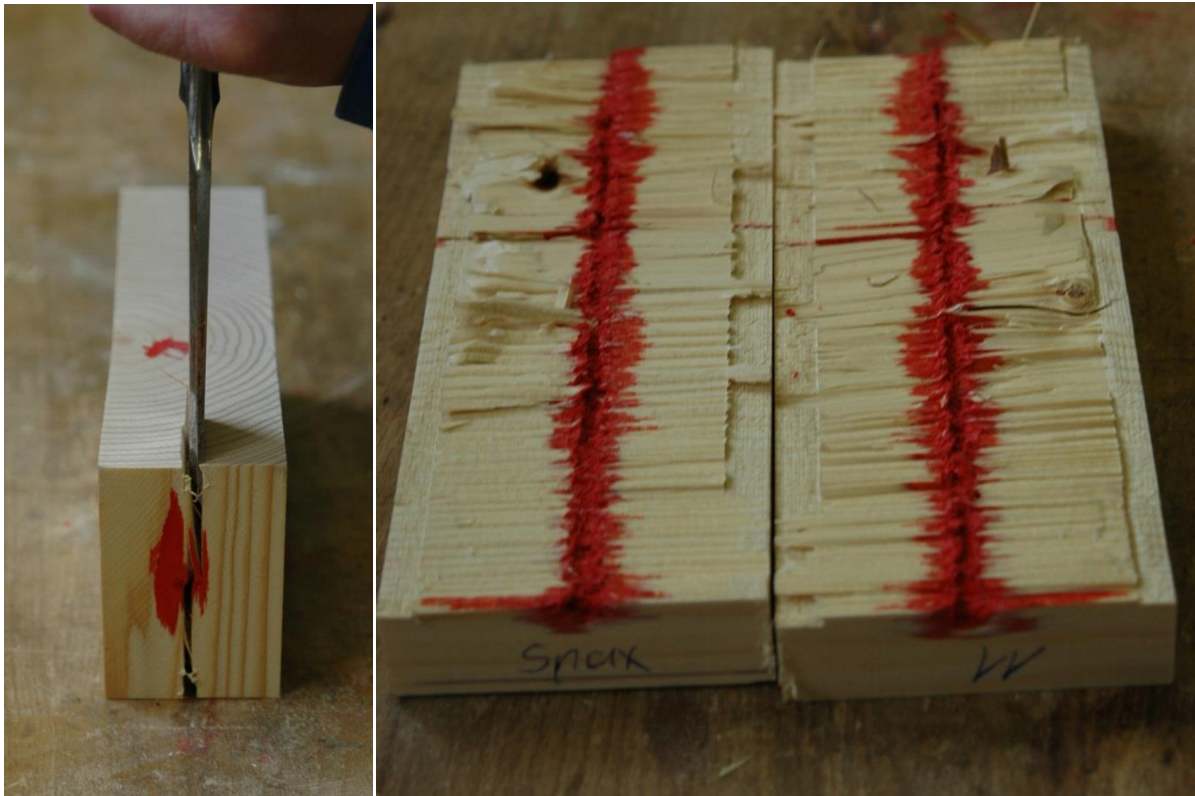


Fig. 4: Opening of the specimens (left) and opened specimens (right).

The size of the split caused by driving in the screw into the timber is quantified e.g. using a digital image recorder. Fig. 5 shows a typical split image of a specimen with blue lines showing the borders of the split area.

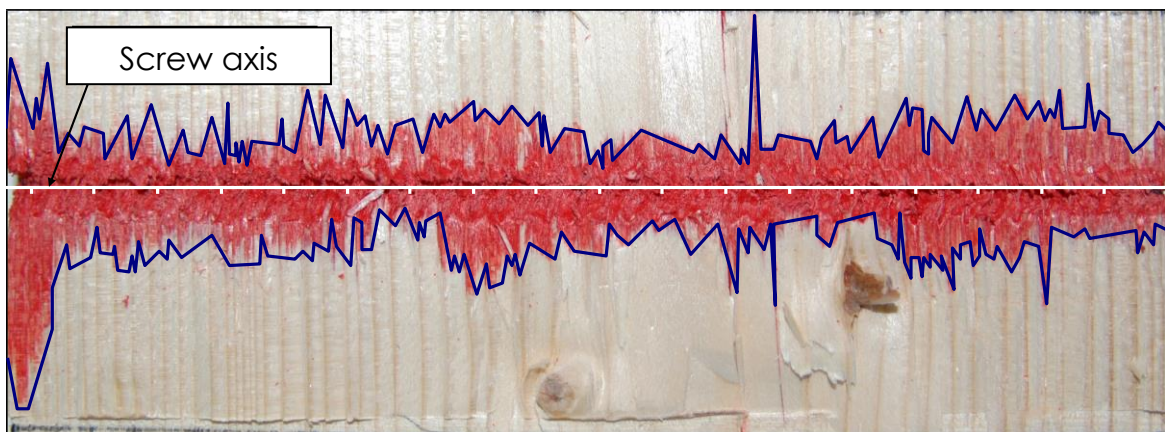


Fig. 5: Opened specimen with red coloured split area and blue lines indicating the borders of the split area.

For the evaluation of the split area the definitions in Fig. 6 are used:

- $A_{Ri,1}$: Split area between the screw axis and the end grain,
- $A_{Ri,3}$: Split area away from the end grain,
- $a_{1,c}$: End distance,
- $a_{Ri,1}$: Maximum split length towards the end grain,
- $a_{Ri,3}$: Maximum split length away from the end grain.

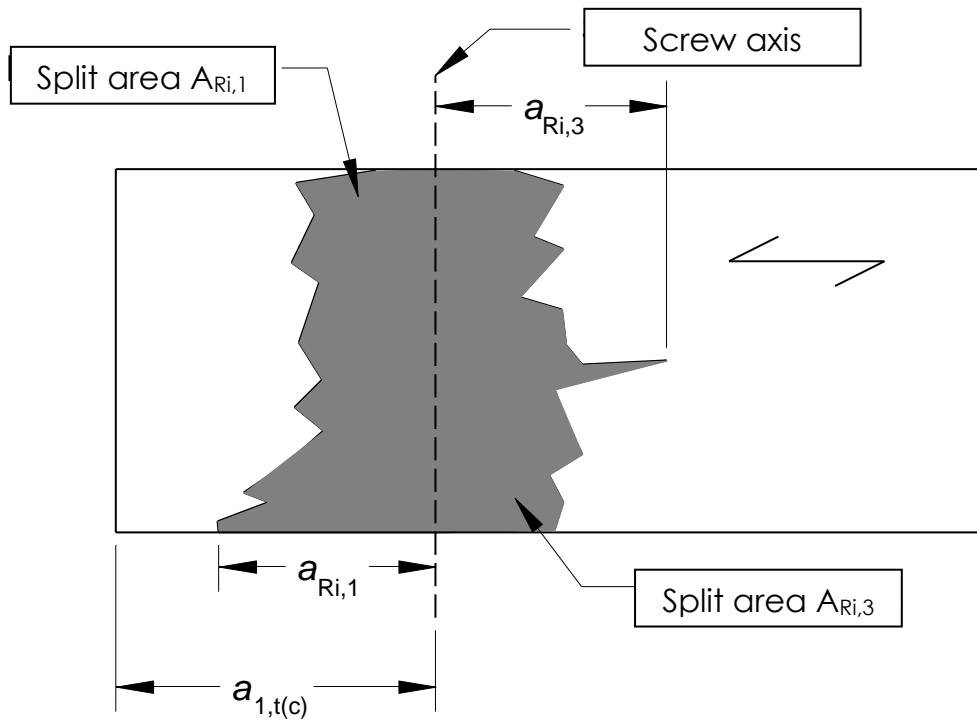


Fig. 6: Definition and notation of split dimensions.

A further parameter e_{085} is defined to describe the split expansion, see Fig. 7. 85 % of the respective split areas $A_{Ri,1}$ or $A_{Ri,3}$ are within a distance of $e_{085,1}$ or $e_{085,3}$ from the screw axis.

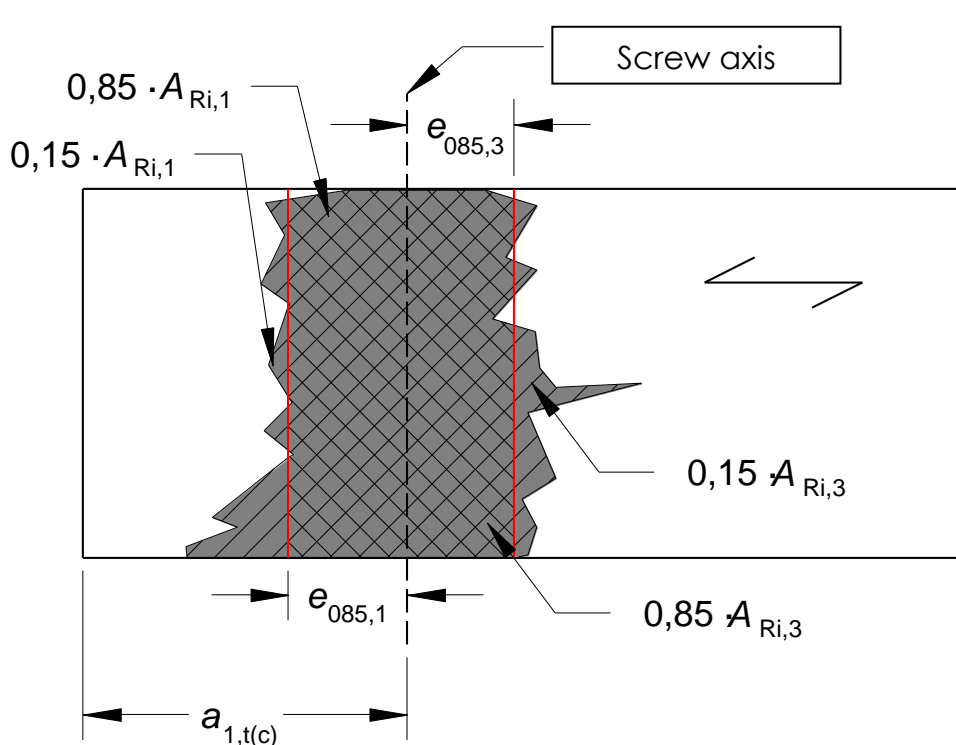
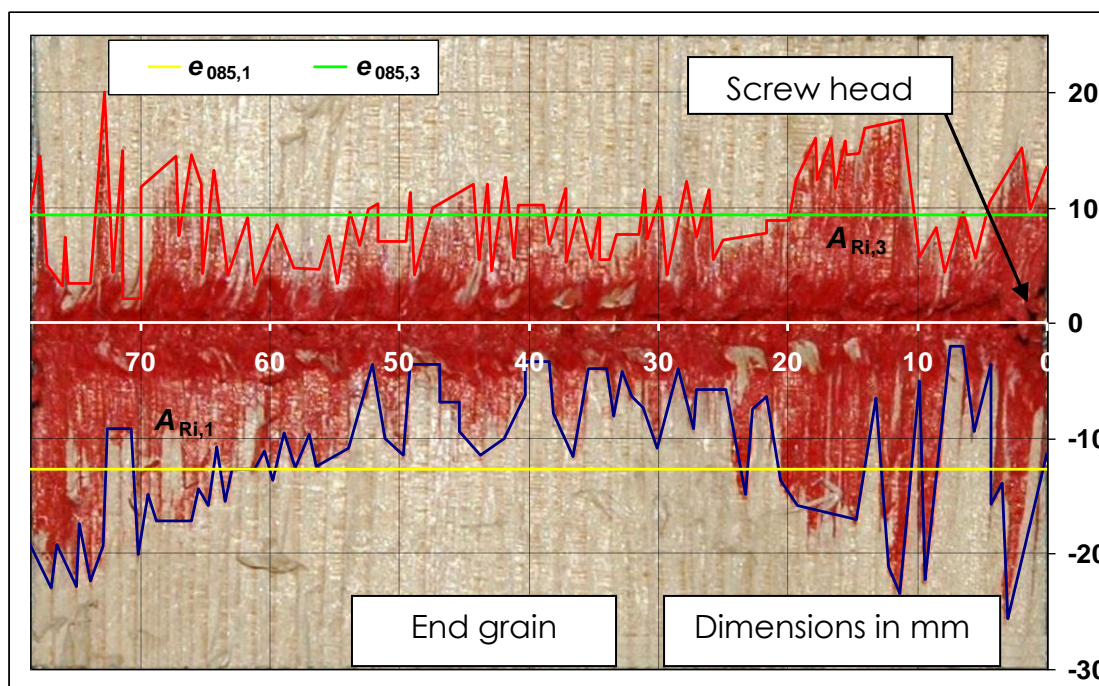


Fig. 7: Definition of split dimensions e_{085} .

Fig. 8 shows as an example the split dimensions $e_{085,1}$ and $e_{085,3}$.

The cross-section dimensions and the spacing, end and edge distances used in the tests may be assumed as minimum dimensions for the screw and timber species tested, if the following conditions are fulfilled:

Maximum split dimension $e_{085,1,max}$ of 20 test specimens: $e_{085,1,max} \leq 0,4 \cdot a_{1,c}$

Mean split dimension $e_{085,1,mean}$ of 20 test specimens: $e_{085,1,mean} \leq 0,25 \cdot a_{1,c}$

Here, $a_{1,c}$ is the end distance used in the tests.

If at least three different diameters of a screw lead to similar results, e.g. to a minimum end distance of 5 d, the respective minimum dimension for other screw diameters between the tested diameters may be assumed to be the same multiple of the outer thread diameter.

2 Test method for laterally loaded screws

Since the splitting of timber in the connection area may be caused by both, the insertion of the screws as well as the lateral loading in connections with laterally loaded fasteners, the test method shown for axially loaded screws is not sufficient to determine minimum requirements for laterally loaded screws. However, the minimum timber width and thickness and the minimum spacing, end and edge distances determined for laterally loaded screws may also be used for axially loaded screws.

The minimum timber width and thickness as well as the minimum spacing, end and edge distance requirements are determined by tensile tests according to EN 1380, where the screws are driven into specimens perpendicular to the grain. Subsequently, the load-deformation behaviour of the tested connections is evaluated. The test results are valid for the timber species, the screw and the diameter used in the test and for:

- Timber with a thickness equal or larger than the thickness of the side members used in the tests,
- Timber with a width equal or larger than the width of the side members used in the tests,
- The minimum end and edge distances in the side members used in the tests,
- The minimum spacing in the side members used in the tests.

Test results with sawn timber are valid also for glued laminated timber. For wood-based materials like LVL, separate tests are required. The test specimens shall fulfil the following requirements:

- The sawn timber density shall not be less than 480 kg/m³ for *Picea abies* (Norway spruce) or *Abies alba* (Fir), 550 kg/m³ for *Pinus sylvestris* (Scots pine) and 650 kg/m³ for *Pseudotsuga menziesii* (Douglas-fir) or *Larix decidua* (Larch),
- The angle between the screw axis and the annual ring orientation shall be about 0° (tangential) or about 90° (radial),
- There shall be 5 specimens with a radial and 5 specimens with a tangential annual ring orientation,
- The specimens shall be conditioned prior to inserting in the screws at a temperature of (20 ± 2) °C and a relative humidity of (65 ± 2) %,

A minimum of 4 screws per row parallel to the grain are used. The screw head should be flush with the timber surface.

After storing the specimens containing the screws at a temperature of (20 ± 2) °C and a relative humidity of (65 ± 2) % for at least 24 h, the connections are tested according to EN 26891.

The cross-section dimensions and the spacing, end and edge distances used in the tests may be assumed as minimum dimensions for the screw and timber species tested, if the following conditions are fulfilled:

A relative displacement of 10 mm is reached between side and middle member before the connection load falls below 80 % of the maximum load reached before 10 mm displacement. If the specimens contain two identical connections in series, this condition must be fulfilled for the connection which first reaches a deformation of 10 mm.

If at least three different diameters of a screw lead to similar results, e.g. to a minimum end distance of 5 d, the respective minimum dimension for other screw diameters between the tested diameters may be assumed to be the same multiple of the outer thread diameter.

Alternatively, the absolute minimum timber thickness determined for a screw may be used for smaller diameters of the same screw. If a screw with a diameter $d = 12$ mm was e.g. successfully tested with a minimum thickness of $12 d = 144$ mm, a minimum thickness of 144 mm may also be used for smaller diameters of the same screw.