

Eurocode 5 – Trækonstruktioner – Del 3: Udførelse

Eurocode 5 – Design of timber structures – Part 3: Execution



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English Version

Eurocode 5 - Design of timber structures - Part 3: Execution

Eurocode 5 - Calcul des structures en bois - Partie 3 :
Exécution

Eurocode 5 - Bemessung und Konstruktion von
Holzbauten - Teil 3: Ausführung

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European foreword

This document (EN 1995-3:2025) has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI. CEN/TC 250 is responsible for all Structural Eurocodes and has been assigned responsibility for structural and geotechnical design matters by CEN.

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of an identical text or by endorsement, at the latest by September 2027, and conflicting national standards shall be withdrawn at the latest by March 2028.

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.

The first generation of EN Eurocodes was published between 2002 and 2007. This document forms part of the second generation of the Eurocodes, which have been prepared under Mandate M/515 issued to CEN by the European Commission and the European Free Trade Association.

The Eurocodes have been drafted to be used in conjunction with relevant execution, material, product and test standards, and to identify requirements for execution, materials, products and testing that are relied upon by the Eurocodes.

The Eurocodes recognize the responsibility of each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level through the use of National Annexes.

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.

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

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Introduction

0.1 Introduction to the Eurocodes

The Structural Eurocodes comprise the following standards generally consisting of a number of Parts:

- EN 1990 *Eurocode — Basis of structural and geotechnical design*
- EN 1991 *Eurocode 1 — Actions on structures*
- EN 1992 *Eurocode 2 — Design of concrete structures*
- EN 1993 *Eurocode 3 — Design of steel structures*
- EN 1994 *Eurocode 4 — Design of composite steel and concrete structures*
- EN 1995 *Eurocode 5 — Design of timber structures*
- EN 1996 *Eurocode 6 — Design of masonry structures*
- EN 1997 *Eurocode 7 — Geotechnical design*
- EN 1998 *Eurocode 8 — Design of structures for earthquake resistance*
- EN 1999 *Eurocode 9 — Design of aluminium structures*
- EN 19100 *Eurocode 10 — Design of glass structures*
- New parts are under development, e.g. Eurocode for design of fibre-polymer composite structures and design of tensioned membrane structures

The Eurocodes are intended for use by designers, clients, manufacturers, constructors, relevant authorities (in exercising their duties in accordance with national or international regulations), educators, software developers, and committees drafting standards for related product, testing and execution standards.

NOTE Some aspects of design are most appropriately specified by relevant authorities or, where not specified, can be agreed on a project-specific basis between relevant parties such as designers and clients. The Eurocodes identify such aspects making explicit reference to relevant authorities and relevant parties.

0.2 Introduction to EN 1995 (all parts)

EN 1995 (all parts) applies to the design of timber structures and gives specific design rules for buildings and civil engineering timber works.

EN 1995 is subdivided in various parts:

EN 1995-1 in itself does not exist as a physical document but comprises the following three separate documents, the basic part being EN 1995-1-1:

- EN 1995-1-1 *Eurocode 5 — Design of timber structures — Part 1-1: General rules and rules for buildings*
- EN 1995-1-2 *Eurocode 5 — Design of timber structures — Part 1-2: Structural fire design*

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- CEN/TS 19103 *Eurocode 5 — Design of timber structures — Structural design of timber-concrete composite structures – Common rules and rules for buildings* (foreseen to be published as EN 1995-1-3)
- EN 1995-2 *Eurocode 5 — Design of timber structures — Part 2: Bridges*
- EN 1995-3 *Eurocode 5 — Design of timber structures — Part 3: Execution*

EN 1995-2 “Bridges” refers to the common rules in EN 1995-1-1. The Clauses in EN 1995-2 supplement, modify or supersede them, where relevant.

EN 1995-3 “Execution” refers to the common rules in EN 1995-1-1. The Clauses in EN 1995-3 supplement the Clauses in EN 1995 (all parts).

0.3 Introduction to EN 1995-3

EN 1995-3 applies to the execution of timber structures to achieve the intended level of safety and serviceability during their design service life, as given by EN 1990 and EN 1995.

This document has the following main functions:

- to transfer the requirements set during design to the constructor, i.e. to be a link between design and execution;
- to give advice for supervision and inspection of timber structures.

To achieve these functions, a set of documents and drawings giving all the information required for the execution of the work needs to be available. This set of documents is referred to as the “execution specification” in this document. Further items need to be specified in the execution specification taking into account any relevant national legislation.

0.4 Verbal forms used in the Eurocodes

The verb “shall” expresses a requirement strictly to be followed and from which no deviation is permitted in order to comply with the Eurocodes.

The verb “should” expresses a highly recommended choice or course of action. Subject to national regulation and/or any relevant contractual provisions, alternative approaches could be used/adopted where technically justified.

The verb “may” expresses a course of action permissible within the limits of the Eurocodes.

The verb “can” expresses possibility and capability; it is used for statements of fact and clarification of concepts.

0.5 National Annex for EN 1995-3

National choice is allowed in this document where explicitly stated within notes. National choice includes the selection of values for Nationally Determined Parameters (NDPs).

The national standard implementing EN 1995-3 can have a National Annex containing all national choices to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

When no national choice is given, the default choice given in this document is to be used.

When no national choice is made and no default is given in this document, the choice can be specified by a relevant authority or, where not specified, agreed for a specific project by appropriate parties.

National choice is allowed in EN 1995-3 through notes to the following clauses:

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5.3(1)	6.3(1)	6.3(2)	6.6.1(4)
6.6.2(2)	6.8(1)	B.4	B.10.3(1)
B.10.4(2)			

National choice is allowed in EN 1995-3 on the application of the following informative annexes:

Annex A	Annex C	Annex E	Annex F
Annex G			

The National Annex can contain, directly or by reference, non-contradictory complementary information for ease of implementation, provided it does not alter any provisions of the Eurocodes.

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1 Scope

1.1 Scope of EN 1995-3

(1) This document gives minimum requirements for execution of timber structures (buildings and bridges) designed in accordance with EN 1995 (all parts) to ensure that what is built meets the requirements for mechanical resistance, serviceability, durability, and fire performance.

(2) This document gives guidance on moisture control during transport to the building site, storage on site, handling on site and erection.

(3) This document gives guidance on workmanship and deviation limits during execution.

(4) This document assumes that there is an execution specification which states all the specific requirements relevant for the execution of a particular structure.

(5) For products covered by a European technical product specification, this document only covers those aspects of fabrication such as cutting, machining and drilling after placement of the product on the market.

(6) This document does not cover:

- a) parts which are not designed according to EN 1995;
- b) temporary works (such as formwork, scaffolding, propping, shoring, etc.);
- c) specification, production and conformity of timber members in accordance with European technical product specifications;
- d) deviation limits for other properties than mechanical resistance, serviceability, durability and fire performance;
- e) contractual aspects, responsibilities of the various parties, competency requirements or the degree of independence of the personnel undertaking the inspection;
- f) health and safety requirements during execution.

1.2 Assumptions

(1) It is assumed that all relevant provisions of EN 1995 are complied with.

(2) It is recognized in this document that areas such as detailed requirements for competence of personnel, and details related to Quality Management are within the competence of the CEN Member States.

(3) Before the execution begins on a part of the structure, it is assumed that the following are available on site:

- the drawings and specification of that part;
- the execution specification.

(4) Before the start of the execution, it is assumed that the execution specification has been checked for completeness.

(5) It is assumed that previous work (such as foundations) has been inspected and that any work which needs to be done due to deviations from the execution specification has been carried out.

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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.

NOTE See the Bibliography for a list of other documents cited that are not normative references, including those referenced as recommendations (i.e. in 'should' clauses), permissions ('may' clauses), possibilities ('can' clauses), and in notes.

EN 301, *Adhesives, phenolic and aminoplastic, for load-bearing timber structures - Classification and performance requirements*

EN 1090-2:2018+A1:2024, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

EN 1090-3, *Execution of steel structures and aluminium structures - Part 3: Technical requirements for aluminium structures*

EN 1993-1-1, *Eurocode 3 - Design of steel structures - Part 1-1: General rules and rules for buildings*

EN 1995-1-1:2025, *Eurocode 5 — Design of timber structures — Part 1-1: General rules and rules for buildings*

EN 1995-1-2, *Eurocode 5: Design of timber structures - Part 1-2: General - Structural fire design*

EN 1995-2, *Eurocode 5: Design of timber structures - Part 2: Bridges*

EN 14545, *Timber structures - Connectors - Requirements*

EN 15425, *Adhesives - One component polyurethane (PUR) for load-bearing timber structures - Classification and performance requirements*

EN 17334, *Glued-in rods in glued structural timber products - Testing, requirements and bond shear strength classification*

EN 17418, *Two-component epoxy and polyurethane adhesives for on-site repair of cracked timber structures - Testing, requirements and repair strength verification*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1995-1-1, EN 1995-1-2, EN 1995-2 and the following apply.

3.1.1

batch

similar members or connections to be assessed in one operation grouped together for inspection

3.1.2

deviation limit

permitted difference between specified and actual value

Note 1 to entry: Within product standards also the term "maximum permitted deviation" is used.

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3.1.3

erection plan

collection of documents necessary for the erection

Note 1 to entry: An erection plan can include, for example: the execution specification, storage requirements, weather protection measures, sequence of erection, requirements for temporary works, execution methods, checking procedures, handling and assembly procedures and other requirements necessary for the erection.

3.1.4

execution

all activities carried out for the physical completion of the work including procurement, the inspection and documentation thereof

Note 1 to entry: The term covers work on site; it can also signify the fabrication of parts off site and their subsequent erection on site.

[SOURCE: EN 1990:2023, 3.1.1.8]

3.1.5

execution specification

collection of documents that includes all requirements and information necessary for the *execution* (3.1.4) of a timber structure as provided by the party responsible for the structural design

Note 1 to entry: The party responsible for structural design can be more than one party and can include a manufacturer if that manufacturer has design responsibility.

3.1.6

inspection

evaluation of compliance by observation and assessment supported by measurement, testing or interpretation where appropriate

3.1.7

machining

forming by machine of, for example, slots, recesses, mortices, tenons, or notches

3.1.8

moisture control plan

plan to control the moisture content of timber members and assemblies during execution

3.1.9

reference surface

surface of the member on which the spacing, edge and end distances, or penetration of fasteners is measured

Note 1 to entry: In the case of inclined fasteners, deviation limits are calculated on the reference surface from the spacings, edge and end distances and shown on the drawings.

3.1.10

structural design specification

project specific document typically used to describe the chosen materials, fasteners and connectors and specific workmanship requirements

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3.2 Symbols and abbreviations

3.2.1 Latin upper-case letters

A_{head}	head area
A_{nom}	influence area of a screw
$E_{i,\text{mean}}$	mean modulus of elasticity for direction i
$F_{\text{ax,t,d}}$	design axial resistance
$I_{i,b=1}$	moment of inertia for direction i for a width of $b = 1$ mm

3.2.2 Latin lower-case letters

a/b	inclination of tie down to foundation
a_i	spacing, edge or end distance for direction i
$a_{i,\text{mean}}$	mean spacing, edge or end distance for direction i
$a_{i,\text{min}}$	minimum spacing, edge or end distance for direction i
$a_{i,\text{max}}$	maximum spacing for direction i
b	width
b_i	edge distance of slots or distance between slots
b_r	plane reinforcement width
b_{sl}	slot width
d	fastener diameter / diameter of a hole in a beam
d_{head}	head diameter
$d_{\text{head,min}}$	minimum head diameter
$f_{\text{c,k}}$	characteristic compressive strength for screw-press bonding
$f_{\text{c,0,k,sat}}$	characteristic compressive strength parallel to the grain in water saturated timber
h	depth / height / total height of a building / specified penetration
h_{ef}	notch height
h_{h}	height of rectangular hole
h_i	height of a storey i
h_{rl}	distance of lower hole to member edge
h_{rp}	height of plane reinforcement
h_{ru}	distance of upper hole to member edge
h_{s}	height of steel plate
i	number / direction
k_{mod}	modification factor accounting for the effect of the duration of load and moisture content
l	length / screw length
l_{A}	distance of the hole edge to the centre of the support
l_{ef}	effective thread length

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l_h	length of rectangular hole
l_{ten}	tenon length
l_p	point length
$l_{r,l/u}$	reinforced length above/below axis prone to splitting
l_s	embedded length of steel plate
l_t	supported length in mortise
l_w	withdrawal length
l_z	distance between the edges of two holes
l_1	notch length
n	number of fasteners
n_0	number of fasteners parallel to grain
n_{90}	number of fasteners perpendicular to grain
$p_{cal,min}$	calculated minimum pressure
s_i	spacing, end or edge distance for direction i on the reference surface
$s_{i,mean}$	mean spacing or edge distance for direction i of inclined fasteners on the reference surface
t	thickness / notch length
t_{head}	thickness of nail head / thickness of a staple crown
t_i	thickness of member i to be glued on
t_s	thickness of steel plate
x	x-axis
y	y-axis
z	z-axis

3.2.3 Greek upper-case letters

Δ	deviation / offset / clearance
Δ_i	deviation from spacing, end or edge distance a_i or s_i
Δ_{max}	deviation limit / maximum permitted deviation / maximum permitted clearance
$\Delta_{i,max}$	deviation limits for spacing, end or edge distance a_i or s_i

3.2.4 Greek lower-case letters

γ_M	partial factor for material properties
ε	angle of the screw axis to the plane of the reference surface

3.2.5 Abbreviations

For the purposes of this document, the following abbreviations apply.

BGL	Block glued glulam
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CC	Consequence class
CLT	Cross laminated timber
DLW	Densified laminated timber
EAD	European assessment document
FST	Finger jointed timber
GL	Glued laminated timber
GLVL	Glued laminated veneer lumber
GST	Glued solid timber
IL	Inspection level
LVL	Laminated veneer lumber
OSB	Oriented strand board
PW	Plywood
SL	Structural lumber
ST	Solid timber
SWP	Solid wood panel
SWP-C	Multi-layered solid wood panel
SWP-P	Single-layered solid wood panel
TCC	Timber concrete composite

4 Documentation and inspection

4.1 General

(1) Provisions for the inspection of a structure or part of a structure should be specified in the execution specification and should be selected based on the consequence class (CC) according to EN 1990, where relevant, the complexity of the work and the degree of new technology.

NOTE Guidance on the use of inspection levels (IL) for this purpose is given in Annex A.

4.2 Execution specification

(1) The execution specification should include design information such as instructions and drawings.

(2) Depending on the type of structure, the execution specification can include:

- a) the structural design specification;
- b) consequence class(es);
- c) inspection level(s), if applicable, including any special requirements;
- d) special requirements for handling including the minimum number and location of lifting points per lift, for storage including support arrangements (upright or laid flat) and for sequence of erection including the need for an erection plan and temporary support for stability as the erection proceeds;
- e) deviation limits (if different from those given in this document) and checking procedure, identification of members for which the deviation limits apply;

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- f) identification of surfaces requiring contact;
- g) necessary basis for a moisture control plan according to 5.3;
- h) fire protection and treatments for fire and any need for retreatment after post-processing, e.g. after cutting or drilling;
- i) information on treatments to improve durability and any need for a reapplication of treatment where the effectiveness might have been reduced by later works such as cutting, drilling and sanding;
- j) corrosion protection of fasteners and connectors and pre-drilling, where required;
- k) national regulations with regard to the scope of this document;
- l) any execution-related documentation which is required in the product standards to be forwarded to the building site, for example, the requirements in EN 14250.

(3) The execution specification should specify what is to be inspected or checked.

4.3 Execution quality assurance

(1) In order to provide a structure that meets the requirements and assumptions made in the design, appropriate quality management should be in place.

(2) Quality management measures should comprise:

- a project management in charge of supervision of the works;
- a site management in charge of organization of the works and of enabling the correct use of equipment and machinery, the satisfactory quality of materials, and the execution of a conforming structure;
- adequately trained personnel;
- inspection during execution.

NOTE EN ISO 9001 is an example of an acceptable basis for quality management measures.

4.4 Inspection

(1) If required by the execution specification, inspection shall be undertaken.

(2) If part of the inspection cannot be done after completion, it should be undertaken during erection.

(3) The following items should be inspected or checked, if specified in the execution specification:

- a) strength class or grade, timber species, adhesive type, preservative treatment to improve durability or fire performance and the associated documentation;
- b) detailed requirements for fire safety according to the design, see EN 1995-1-2;
- c) the installation of any specified protective layers and detailing required to ensure the durability of structural timber or timber products;

NOTE 1 Such layers and detailing can include, for example, metal flashings, airtight and wind-tight layers in the external envelope of heated and insulated buildings, layers to prevent the intrusion of wood-destroying insects and

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watertight sealing of surfaces and joints exposed to rainwater and splashing (including in shower-rooms and bathrooms) and measures to prevent condensation.

- d) structural details, e.g. number and size and type of fasteners, sizes of pre-drilled holes, checking deviations from the spacing, edge and end distances are within the deviation limits;
- e) detailed requirements for bonding, as listed in Annex B;
- f) grade of carbon and stainless steels in fasteners, connectors and connection metalwork, and corrosion protection of carbon steels;
- g) deviations are within the deviation limits;
- h) deviations from the perfect geometry at the support points in the supporting structure are within the deviation limits;
- i) moisture content at delivery, during execution and on completion of the structure;
- j) methods of handling, storage, protection, assembly and erection;
- k) any damage including mechanical or moisture damage (such as detrimental swelling, shrinkage, unacceptable fissures or decay) or corrosion of fasteners and connections;
- l) specific checks for seismic prone areas.

NOTE 2 Annex E lists additional checks for inspections in seismic prone areas.

4.5 Sample size, acceptance criteria and documentation of quality control

(1) The sample size, acceptance criteria and documentation of quality control should be taken from the execution specification or national regulations.

NOTE Information is given in Annex A.

(2) For bonding, the quality control according to Clause B.10 should be applied.

(3) If required by the execution specification or national building regulations, the party responsible for the execution of the work should keep records of inspections and measurements to show that the completed work meets the requirements of the execution specification.

4.6 Action in the case of damage or deviations from the execution specification

(1) Where the inspection reveals damage or deviations from the execution specification, appropriate measures shall be taken to ensure that the design has not been compromised.

(2) The party responsible for the structural design should be informed and corrective measures shall be agreed before they are carried out.

(3) Corrective measures (if necessary) shall be determined by considering the mechanical resistance, durability, fire design and serviceability.

5 Workmanship

5.1 General

(1) The rules given in this clause should be followed for the execution of timber members, assemblies, and structures.

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(2) The execution specification and the manufacturer's instructions should be complied with.

5.2 Erection plan

(1) If required in the execution specification, an erection plan should be prepared.

(2) The erection plan should include the sequence of erection of parts of the structure and the need for any temporary bracing.

(3) The structural members shall be connected together such that detrimental stresses due to unintended constraints are avoided.

(4) Overloading the structural members during storage, transport and erection shall be avoided.

(5) Twisted, excessively cracked or incompatible members should be replaced.

(6) The erection plan should give information for temporary load conditions, e.g. identification of supports if different from those in the final structure, identification of lifting points and temporary stiffening during erection.

(7) Special care should be taken when lifting structural members from the horizontal to the vertical position such that no twisting deformation (warping) occurs.

5.3 Moisture control plan

(1) If required by the execution specification, a moisture control plan should be prepared to achieve the following objectives.

NOTE 1 Requirements on when moisture control plans are required can be given in the National Annex.

NOTE 2 Information on the moisture control plan can be found in Annex G.

(2) The moisture control plan should consider the expected moisture content in service and assumptions about protection during execution given in the execution specification.

(3) The moisture control plan should include measures to ensure that:

- timber is either installed at a moisture content close to the assumed equilibrium content in service or that it can dry out without detrimental effects, e.g. infestation with mould or damage by wood-destroying fungi;
- timber is sufficiently protected against unsuitable moisture uptake during all stages of erection.

(4) The moisture control plan should require measurement of moisture content to the respective product standard at locations at risk of high moisture and/or where the moisture level is critical for the structure. If necessary, the moisture control plan should require that measurements of temperature are made at the same time as measurements of moisture content.

5.4 Connections

5.4.1 General

(1) The surfaces to be connected should be in close contact before installing dowel-type fasteners.

5.4.2 Screwed connections and connections with rods with wood-screw thread

(1) The provisions for screws should also be applied to rods with wood-screw thread.

(2) Screws should be tightened to refusal, avoiding crushing or splitting of the timber or overstressing of the screw.

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(3) The tightening torque should be smaller than the characteristic torsional moment resistance of the screw as specified in the manufacturer's specification.

NOTE 1 In timber construction, tightening torques of 70 % to 80 % of the characteristic value of the torsional moment resistance are common. Exceeding the torsional moment resistance (e.g. through static friction) can usually be avoided by screwing in slender screws continuously without interruption over at least the last 90 % of the entire length or by using a torque-controlled tool.

NOTE 2 Particularly when the head of the screw meets a sheet metal plate or an angled washer, the speed of rotation during insertion of a screw can be selected based on the operator's response time, the screwdriver being used and the kinetic energy of the rotating parts to ensure that the screw is not overstressed.

(4) Close fitting between the head of the screw and sheet metal plate and angled washers, if any, should be ensured.

(5) Unless otherwise stated in the execution specification or the manufacturer's instructions, pre-drilling may be carried out at the core diameter of the screw.

5.4.3 Other connections

(1) Unless otherwise specified, nails and staple legs should be driven in at right angles to the grain, without splitting or crushing the material being fixed and to such a depth that the surfaces of the nail heads and staples are flush with the timber surface (for deviation limits from the specified penetration depth, see 6.7(3)).

(2) The diameter of any pre-drilled holes for nails shall not exceed about 0,8 times the nail diameter d .

(3) Bolts shall be tightened to refusal, avoiding crushing of the timber, deformation of the washer or overstressing of the bolt, so that the members fit closely, leaving at least one complete thread (i.e. one threaded turn) of the bolt protruding from the nut.

(4) The threaded length of bolts shall allow for tightening to refusal and retightening if needed.

(5) The number of dowels in dowelled connections shall be inspected after erection to ensure that none have fallen out or partially slipped out of position.

(6) Measures shall be taken in order to prevent damage at the bottom edge of PLY, OSB, WFB, WPB and GYB.

(7) For punched metal plate fasteners, inspection on site should be undertaken to ensure that the nails are fully embedded and that the size and location of the plates comply with the execution specification.

(8) Slots shall be produced to fit the split ring and shear plate connectors accurately using suitable tools.

(9) Split ring and shear plate connectors should be inserted to the same depth in both pieces of timber.

5.5 Bonded connections

(1) The rules for bonding given in Annex B should be applied.

6 Geometrical deviations

6.1 General

6.1.1 Measuring geometrical deviations

(1) Geometrical deviations of members or erected structures shall be measured when required in the execution specification. The effect of duration of load and environmental conditions may be considered.

(2) The checker shall record the assumed accuracy of the method selected for the survey.

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6.1.2 Dimension adjustment for moisture content

(1) The deviation limits shall apply to a timber member at the reference moisture content given in the relevant European technical product specification, or – if not given there - in the manufacturer’s specification.

(2) Where the average moisture content of a single member differs from the reference moisture content at the time of measurement, the dimensions should be adjusted using the correction factors/methods given in the relevant European technical product specification, in EN 1995-1-1:2025, 5.5 or in the manufacturer’s specification, before the deviations are checked against the deviation limits.

(3) The moisture content of the timber member shall be measured and recorded on the same working day the deviation is measured.

6.1.3 Deviation limits for geometrical deviations

(1) If one geometrical deviation is covered by different requirements, the strictest deviation limit should be applied.

6.2 Deviation limits for cross section dimensions

(1) Deviations in cross section dimensions in members, adjusted for moisture content, shall be within the deviation limits given in the relevant European technical product specifications.

6.3 Deviation limits for cutting and machining

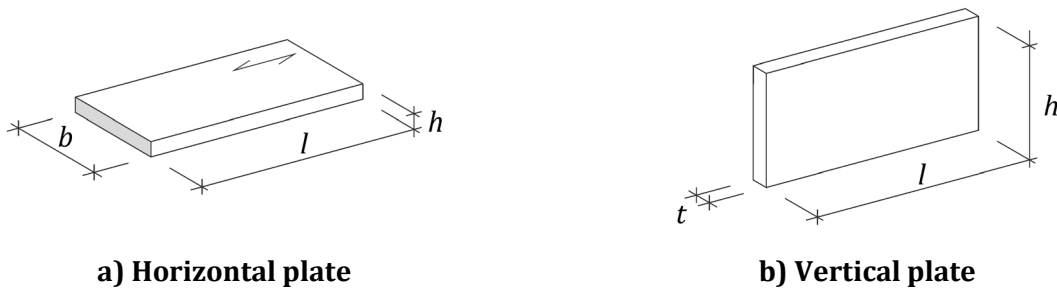
(1) For cut and machined beams, columns, struts and ties, deviations from the specified geometry should be within the deviation limits Δ_{max} .

NOTE The deviation limits Δ_{max} are given in Table 6.1 (NDP) unless the National Annex gives different values.

(2) For cut and machined plate members, deviations from the specified geometry should be within the deviation limits Δ_{max} .

NOTE 1 The deviation limits Δ_{max} are as given in Table 6.2 (NDP) unless the National Annex gives different values.

NOTE 2 Labels and symbols given to the dimensions of horizontal and vertical flat plate members are shown in Figure 6.1. A wall can be considered as a vertical member. Floors and flat roofs can be considered as horizontal members. For flat roof plate members installed at an angle to the horizontal, the labels and symbols are generally the same as used for horizontal members.



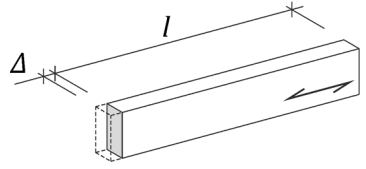
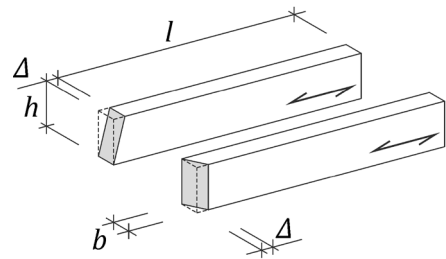
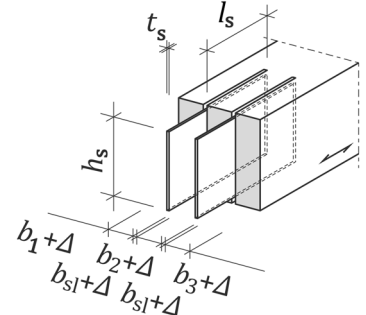
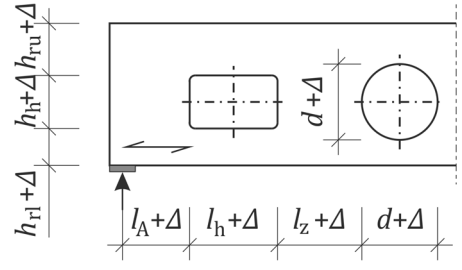
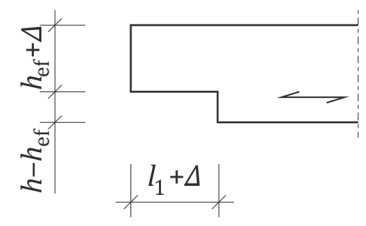
Key

- b width
- l length
- t thickness
- h depth of horizontal or height of vertical plate member

Figure 6.1 — Symbols for dimensions of plate members

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Table 6.1 (NDP) — Deviation limits Δ_{\max} for beams, columns, struts, or ties

	Cut/machined geometry	Diagram	Δ_{\max} [mm]
1	Length		$\pm \max\{5; l/1000\}^a$
2	Pressure contact (e.g. bearing, butt joint, carpentry connections)		$\pm \max\{2; (h + b)/1000\}^b$
3	Slots for steel plates		Slot width b_{sl} : $t_s \leq b_{sl} \leq t_s + \max\{h_s/150; l_s/150; 3\}$ Edge distances of slots or distances between slots b_i ($i = 1, 2, \dots$): $\pm \min\{5; b_i/10\}$
4	Holes in beams		Deviation limits for locating dimensions h_{rl}, h_{ru}, l_A , or l_z : $\pm \max\{10; h_{rl}/100\}$; or $\pm \max\{10; h_{ru}/100\}$; or $\pm \max\{10; l_A/100\}$; or $\pm \max\{10; l_z/100\}$; Deviation limits for hole dimensions l_h, d or h_h : $\pm \max\{5; l_h/50\}$; or $\pm \max\{5; h_h/50\}$; or $\pm \max\{5; d/50\}$;
5	Notches		Deviation limits for dimensions $(h - h_{ef})$ or l_1 : $\pm \max\{5; (h - h_{ef})/100\}$, or $\pm \max\{5; l_1/100\}$
Key b width, in mm b_i edge distance of slots or distance between slots ($i = 1, 2 \dots$), in mm			

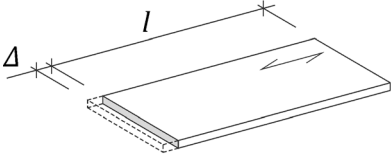
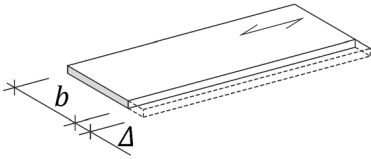
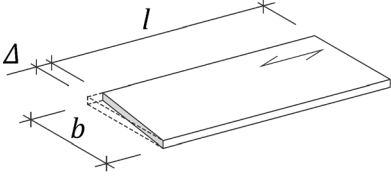
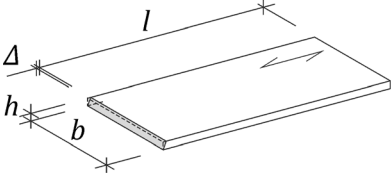
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b_{sl}	slot width, in mm
d	diameter of a hole in a beam, in mm
h	height, in mm
h_{ef}	notch height, in mm
h_h	height of rectangular hole, in mm
h_{rl}	distance of lower hole to member edge, in mm
h_{ru}	distance of upper hole to member edge, in mm
h_s	height of steel plate, in mm
l	length, in mm
l_A	distance of the hole edge to the centre of the support, in mm
l_s	embedded length of steel plate in slot, mm
l_z	distance between the edges of two holes, in mm
l_1	notch length, in mm
t_s	thickness of steel plate, in mm
Δ	deviation, in mm
^a	As products are usually machined after being placed on the market, deviation limits in product specifications may differ.
^b	The suggested deviation limits can be increased for contact surfaces in bearing with the use of a cast filler compound, subject to agreement with the party responsible for the structural design of the works. For carpentry connections, a maximum clearance of 8 mm is permitted before filling,

(3) The deviation limits given in Table 6.2 are for horizontal plate members; those for vertical plate members are found by replacing width b with height h and depth h with thickness t .

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Table 6.2 (NDP) — Deviation limits Δ_{max} for horizontal plate members

Ref.	Cut/machined geometry	Diagram	Δ_{max} in mm
1	Length l		$\pm \max\{5; l/1000\}$
2	Width b		$\pm \max\{5; b/1000\}$
3	Cut end for width b and thickness h		$\pm \max\{5; (b + h)/1000\}^a$
			
<p>NOTE Deviation limits on depth h are according to the relevant European technical product specification.</p> <p>^a Δ applies to length l</p>			

6.4 Hole diameters for dowel-type fasteners

6.4.1 General

(1) The specified dowel-type fasteners shall be used in holes of the specified size to ensure the strength and serviceability of the erected structure and its parts.

NOTE A part of the deflection of some trusses and bracing systems under load depends on joint slip due to the difference between the diameter of the selected dowel-type fastener and the hole into which it fits in the metal or timber members in the connections.

6.4.2 Hole diameters in metal

(1) Deviations from the specified hole diameters in metal for bolts, dowels and screws shall be in accordance with EN 1090-2 and EN 1090-3.

NOTE Clearance between steel plates and dowels or bolts is given in EN 1090-2:2018+A1:2024, Table 11.

(2) The form-fit between the head and the steel plate, e.g. underside of head of the screw and the countersunk hole in the metal plate, shall be ensured.

(3) Deviations from specified hole diameters in metal for nails in nailing plates shall be in accordance with EN 14545.

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(4) Where there is a metal to wood connection, the offset between the holes in the metal and timber members should be within the deviation limit for offsets in 6.5.

6.4.3 Hole diameters in wood

- (1) The correct drill bit size shall be selected and used to drill a hole of a specified diameter.
- (2) The drill diameter for coach screw shaft and dowels should be chosen to achieve a tight fit with regard to the diameter, layer thickness for corrosion protection (e.g. hot dip galvanised dowels +0,3 mm), wood density (hardwood +0,1 mm) and friction along the length of the dowels.
- (3) The drill diameter for bolts should be no larger than $d+1$ mm, where d is the bolt diameter.

6.5 Offset of holes

(1) The deviation limit for offset of the axes of the matching holes at the shear plane to ensure installation of the fasteners should be 1 mm for predrilled screws or rods, dowels and fitting bolts, or 2 mm for bolts as shown in Figure 6.2.

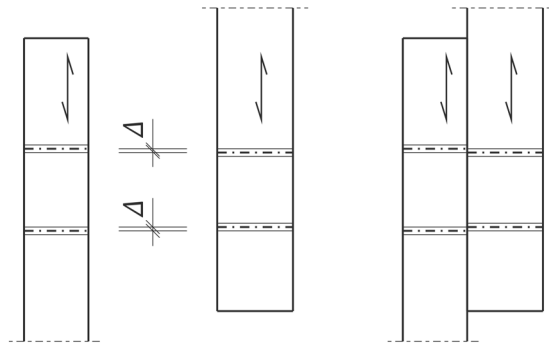


Figure 6.2 — Offset Δ of axes for predrilled screws or rods, dowels or bolt holes drilled separately

6.6 Location of fasteners and shear connectors

6.6.1 Timber-to-timber and steel-to-timber connections

- (1) 6.6.1 should only be applied to the timber member of a steel-to-timber connection.
- (2) The spacings, end and edge distances a_i of fasteners or the spacings, end and edge distances of fasteners on the reference surface s_i should be provided in the project drawings or details.

NOTE In the case of inclined fasteners, locations on the reference surface s_i are calculated from spacings, edge and end distances and are shown on the drawings (see Figure 6.3).

(3) For dowel-type fasteners and shear connectors, the spacing, edge or end distance should not deviate by more than the values given in Table 6.3.

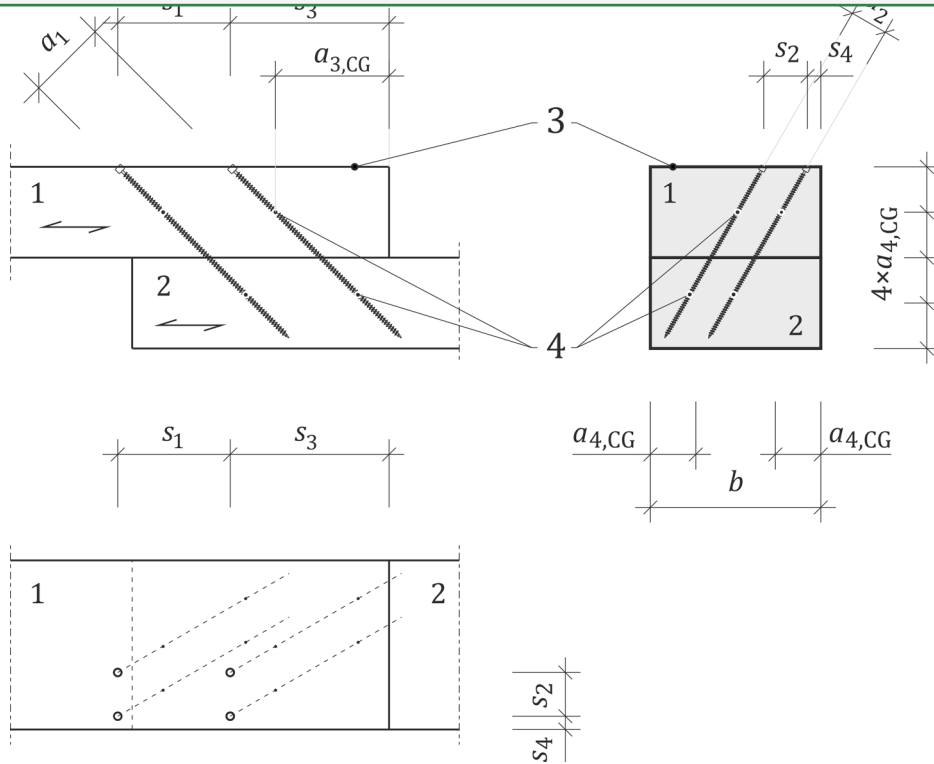
(4) To ensure an angular deviation limit of the axis of a screw at the entry point from the specified angle ε to the plane of $\pm 5^\circ$ measures for proper installation shall be taken, e.g. use of a guide and / or predrilled pilot holes with a length of at least $5d$. The deviation limit for timber-to-timber connections shall be within Δ_i .

NOTE The values of Δ_i for timber-to-timber connections are as given in Table 6.3 (NDP) unless the National Annex gives other values.

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Table 6.3 (NDP) — Deviation limits Δ_i in timber-to-timber connections

Fasteners	Specified value	Δ_i ^a
Spacings, end and edge distances of individual fasteners		
Nails, staples or screws with/without pre-drilling $d \leq 6$ mm	a_i or s_i	$\max\{0,1a_i; d\}$ or $\max\{0,1s_i; d\}$
Nails, screws, rods with wood screw thread, dowels, bolts or bonded-in rods $d > 6$ mm	a_i or s_i	$\min\{0,1a_i; 0,5d\}$ or $\min\{0,1s_i; 0,5d\}$
Shear connectors	a_i	$0,1a_i$
Mean edge distances of rows of fasteners		
Nails, staples or screws with/without pre-drilling $d \leq 6$ mm	$a_{i,\text{mean}}$ or $s_{i,\text{mean}}$	$\max\{0,05a_i; d\}$ or $\max\{0,05s_i; d\}$
Nails, screws, rods with wood screw thread, dowels, bolts or bonded-in rods $d > 6$ mm	$a_{i,\text{mean}}$ or $s_{i,\text{mean}}$	$\min\{0,05a_i; 0,5d\}$ or $\min\{0,05s_i; 0,5d\}$
Shear connectors	$a_{i,\text{mean}}$	$0,05a_i$
Overall spacings of outermost fasteners in a connection		
All types of fasteners	$(n_0 - 1) \times a_1$ and $(n_{90} - 1) \times a_2$ $(n_0 - 1) \times s_1$ and $(n_{90} - 1) \times s_2$	$\max\{0,1a_i; 0,5d\}$ or $\max\{0,1s_i; 0,5d\}$
Angular deviations		
Axis of a nail, screw, rod with wood screw thread or bonded-in rods at the entry point	ε	$\pm 5^\circ$
^a Provisions on offsets in accordance with 6.5 apply additionally.		



Key

- a_i spacing, end or edge distance i ($i = 1 \dots 4$)
- s_i spacing, end or edge distance s_i ($i = 1 \dots 4$) of inclined fasteners on the reference surface
- 1, 2 timber member
- 3 reference surface
- 4 centroid of the screw j thread in member 1 or 2

Figure 6.3 — Spacings, end and edge distances a_i or s_i

6.6.2 Panel-to-timber connections

(1) Within the timber, deviations from the specified end or edge distances for any of the fasteners in a row should be within the deviation limits given in Table 6.3. In addition, the mean value of the edge distances for the row of fasteners should be not less than the specified edge distance.

(2) In the panel, deviations from the spacings or edge distances s_i for a row of fasteners should be within the deviation limits Δ_i panel-to-timber connections.

NOTE The values of Δ_i for panel-to-timber connections are as given in Table 6.4 (NDP) unless the National Annex gives other values.

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Table 6.4 (NDP) — Deviation limits Δ_i in panel-to-timber connections

Fastener spacing, edge distance, or angular deviation	Deviation limit Δ_i ^a
Spacings and end distances in the panel:	
For $a_i < 50$ mm	$\pm 0,1 a_i$
For $a_i \geq 50$ mm	$+ 0,1 a_i$ / - no limit; and $a_{\text{mean},i} \geq a_i$
Edge distances in the panel:	
For n fasteners	$a_{i,\text{mean}} \geq a_i$
For $> 0,15 n$ of n fasteners	$- 0,25 a_i$ / $+ \text{no limit}$
Angular deviations	
The angle of the crown of staples to the grain	$\pm 5^\circ$
Key	
$a_{i,\text{mean}}$	mean spacing or edge distances for direction i , in mm
n	number of fasteners
a_i	spacing or edge distance i , in mm
$\Delta_{i,\text{max}}$	deviation limits for s_i , in mm
^a Provisions on offsets in accordance with 6.5 apply additionally.	

6.7 Penetration of dowel-type fasteners

(1) The specified position of fasteners along their axis is achieved when the reference point on the fastener given in Table 6.5 coincides with its intended position (see Figure 6.4).

NOTE For screw-press bonding penetrations are specified in B.8.4.2(2).

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Table 6.5 — Reference point on fasteners for measuring deviation from specified position

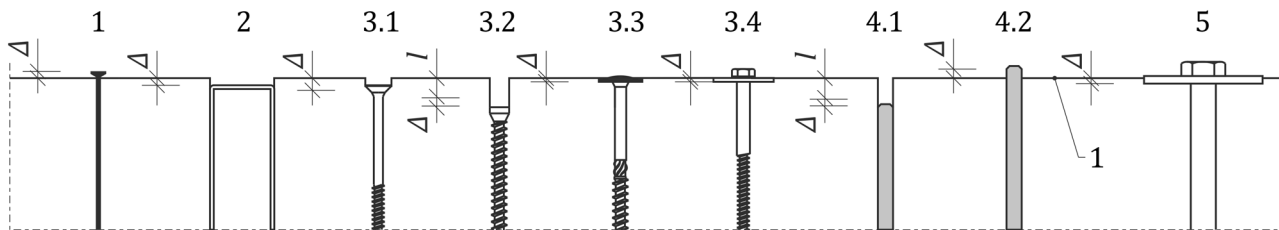
	Fastener type	Reference point	Typical specified location
1	Nail	top of head	at reference surface
2	Staple	top of crown	at reference surface
3	Screw:		
3.1	Countersunk head	top of head	at reference surface
3.2	Cylindrical head		at reference surface, or at specified depth below reference surface ^a
3.3	Flat head	underside of head ^b	at reference surface
3.4	Coach screw (with washer)	underside of head or underside of washer	at reference surface
4	Dowel or rod	end of dowel or rod	at reference surface, or at specified depth above or below reference surface
5	Bolt with washer	underside of washer	at reference surface

^a Where a screw's axis is not at 90° to the surface, depth becomes distance along the axis from the surface to the specified location on the axis.

^b Where the underside of the head is flat.

(2) Deviation from the specified position shall be taken as the distance on the fastener centreline between the reference point and the specified surface, or location relative to the surface. A deviation shall be taken as being positive in the direction in which a fastener moves when inserted.

(3) Deviations from the specified penetration should be within the deviation limits given in Table 6.6. Examples of deviations from some specified penetrations are shown in Figure 6.4.



Key

1 reference surface

NOTE Numbering corresponds to Table 6.6.

Figure 6.4 — Examples of deviation from specified position for various fastener types

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Table 6.6 — Deviation limits Δ from the specified penetration

	Fastener type/connected materials	Δ [mm]
1	Nail or staple:	
1.1	ST, FST, GST, GL, BGL, CLT, LVL, GLVL	$- l_{\text{head}} / + \min\{2; t/10\}$
1.2	Wood-based panel (PLY, STB, WFB) or gypsum board (GYP)	$- l_{\text{head}} / + t/10$
1.3	Formed sheet metal	$- l_{\text{head}} / + 0$
2	Screw:	
2.1	General	± 5
2.2	Axial load on head from timber member	$- \min\{1; t/10\} / + \min\{5; t/10\}$
2.3	Axial compressive load on head from steel bearing plate	± 1
2.4	Axial tensile load on head from steel plate	$\pm 0^a$
3	Dowel or rod	$\pm \min\{5; d/4\}$
4	Bolt with washers	$- 0 / + 3$
Key		
t	timber thickness, in mm	
l_{head}	thickness of nail head or staple crown, in mm	
^a	Applies to a countersunk headed screw only when a matching hole is drilled so that the top of the screw is flush with top of steel plate.	

6.8 Prefabricated wall, floor and roof assemblies

(1) Deviations from the specified geometry of prefabricated wall, floor and roof assemblies should be within the deviation limits Δ_{max} for horizontal and vertical plate members.

NOTE The deviation limits are as given in Table 6.2 (NDP) unless the National Annex gives different values.

6.9 Erected members and structures

(1) For angular deviations from vertical, twist and bow, the deviation limits given in EN 1995-1-1 shall be applied.

NOTE See in EN 1995-1-1:2025, Clause 7.

(2) Deviations in the member or structure after erection (including erection of bracing) should be within the deviation limits. If a measured deviation is not within the deviation limits given in EN 1995-1-1:2025, Clause 7 or in the execution specification, the deviation should not exceed the deformation in the design model under a load combination which matches the load level on site at the time when the deviation was measured.

6.10 Supports, anchorages and bearings

(1) The installation of the respective timber member should only be started when the respective location and level of the supports, anchorages and bearings fulfil the acceptance criteria in the execution specification.

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6.11 Carpentry joints

(1) Annex D gives deviation limits for some commonly used carpentry joints.

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Annex A (informative)

Inspection levels, sample size, acceptance criteria and documentation of quality control

A.1 Use of this annex

(1) This informative annex provides supplementary guidance on the choice of inspection levels, sample size, acceptance criteria and documentation of quality control.

NOTE National choice on the application of this informative annex is given in the National Annex. If the National Annex contains no information on the application of this Informative annex, it can be used.

A.2 Scope and field of application

(1) This informative annex provides additional information about a system for appropriate measures to limit the probability of gross human error and omissions.

(2) This informative annex contains guidance on choice of inspection levels, assessment amount, the number of elements to inspect and number of non-conforming elements allowed. It also gives information on documentation of quality control.

A.3 Inspection levels

(1) The inspection level (IL) according to EN 1990 for a structure or part of the structure should be specified in the execution specification and should be selected based on the consequence class (CC) according to EN 1990, where relevant, the complexity of the work and the degree of new technology.

(2) A different inspection level may be specified for key members or connections within a structure, or for items which will be hidden in the completed structure and cannot be inspected afterwards.

A.4 Sample size, acceptance criteria and documentation

(1) Inspection Level (IL), documentation, sample size and maximum number of non-conforming members and connections should be taken from Table A.1 in conjunction with Table A.2.

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Table A.1 — Inspection Level (IL), documentation, sample size and maximum number of non-conforming members and connections based on consequence class (CC)

Consequence class (CC) ^{a,b}	Inspection Level (IL)	Documentation of inspection and measured deviations	Sample size and maximum number of non-conforming members and connections as percentages of the numbers in Table A.2
CC1	IL1	No	20 %
CC2 (single family houses or similar ^c)	IL2-A	No	20 %
CC2 (except single family houses or similar ^c)	IL2-B	Yes	50 %
CC3	IL3	Yes	100 %

^a Assignments differ from EN 1990.
^b Table B.2 gives the frequency and number of members and connections to be inspected for bonded-in rods and bonded on reinforcements.
^c Single family houses include semi-detached and terraced houses, as well as individual houses.

Table A.2 — Sample size and maximum number of non-conforming members and connections as basis for Table A.1

Total number of members and connections in a batch	Sample size	Maximum number of non-conforming members and connections in the control sample
1	1	0
2 to 8	2	0
9 to 15	3	0
16 to 25	5	0
26 to 50	8	0
51 to 90	13	1
91 to 150	20	2
151 to 280	32	3
281 to 500	50	5
501 to 1 200	80	7
1 201 to 3 200	125	10
3 201 to 10 000	200	14
10 001 to 35 000	315	21
35 001 to 150 000	500	21

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EXAMPLE Consider a multi-storey building with 48 wall panels (made of the same material and a similar manufacturing process): According to Table A.1 inspection level IL2-B applies. Therefore, the number of elements to inspect is 50 % of the number of elements in Table A.1 i.e. number of elements to assess = $0,5 \times 8 = 4$. The same procedure applies to all load-bearing elements in the building such as columns, rafters, purlins, floor and roof elements. The inspection report would generally record the total number of elements, how many and which were inspected, whether any non-conformances were found and what corrective measures were taken.

(3) If the number of non-conformances exceeds the limit in Tables A.1 and A.2, the number of elements to inspect from the next batch size up shall be inspected.

(4) If the number of non-conformances still exceeds the limit:

- the cause shall be eliminated;
- the inspection procedure shall be repeated;
- the non-conformances shall be treated according to 4.6.

A.5 Documentation of quality control

(1) Documentation can include:

a) material documentation;

NOTE 1 Material documentation can include, for example, delivery notes, wood species, preservative treatment (where relevant) or Declarations of Performance.

b) the person and/or parties responsible, including contact details;

c) the time/date of execution;

d) records of any bonding operation as listed in Annex B.10.2;

e) records of any extreme weather conditions such as heavy rain, heavy snow or extreme temperatures; also if/how/when the structure was protected and if/how/when cleaning of excess water or snow was undertaken (if relevant);

NOTE 2 It is assumed that the general weather conditions on site during the execution will be available from a local meteorological office, if needed.

f) records of any damage or deviations from the execution specification, and corrective measures taken.

(2) For bridges, documentation shall include the points in A.5(1). In addition, records for the following shall be kept for inspection levels IL2-B and IL3:

a) design service life;

b) technical information about the bridge as built, including the structural report, as-built drawings and photos, including bridge class, loads, etc.

c) project specific records of temperature and relative humidity.

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Annex B **(normative)**

Bonding

B.1 Use of this annex

(1) This normative annex contains provisions for bonding.

B.2 Scope and field of application

(1) This normative annex covers bonding operations for structural connections and reinforcements, which are not already covered by European technical product specifications.

NOTE Examples of fields of application are:

- bonded-in rods, see Clause B.7;
- bonded-on wood-based panels or laminations, see Clause B.8;
- adhesive fillings to ensure pressure contact between members, see Clause B.9;
- adhesively bonded timber concrete composite bridges, see Clause B.10.

(2) Except for Clauses B.9 and B.10, this normative annex covers bonding work under factory or factory-like conditions.

NOTE Factory like conditions provide shelter from direct weathering and dirt, prevent undue movement of the parts during curing of the adhesive, and provide temperature and relative humidity conditions and control as in factory production environment.

B.3 General rules

(1) Bonding shall be carefully planned in advance and shall be undertaken with suitable equipment, in the factory or under factory-like conditions so that all the requirements of this document can be ensured.

(2) The adhesive manufacturer's instructions should be followed, including:

- a) adhesive storage time and conditions;
- b) mixing ratio (if required), pot life (if required) and assembly time of the adhesive;
- c) conditions during bonding and curing, e.g. air temperature;
- d) moisture content of the timber product;
- e) temperature of the timber/steel surfaces and of the adhesive;
- f) surface preparation (e.g. regarding flatness, soiling, dust or moisture content), cleaning if necessary, and pre-treatment if any;
- g) maximum time of preparation of the timber surface before bonding;
- h) pressure to be applied (if required), adhesive application rate, glue line thickness, adhesive mixing time and equipment, and maximum time of preparation of the timber surface before gluing;

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- 1) press time (if required), curing time, and information on handling until full strength (e.g. avoidance of deformation, shock or vibration).
- (3) Moisture content should be determined with a measurement device according to EN 13183-2 or EN 13183-3 having an accuracy of at least 2 %. For LVL or GLVL, plywood and OSB a sufficient moisture content can be assumed if properly stored.

B.4 Competency

(1) Proof of the qualification should be demonstrated by suitable training. The training should include the following:

- a) legal and normative requirements of bonding in timber construction;
- b) influences on bonding according to B.3(2);
- c) bonding techniques and systems;
- d) environmental aspects;
- e) bonding trials;
- f) methods of checking bonded connections;
- g) safety aspects of bonding.

NOTE 1 Reliable bonding relies on the skill and experience of the person responsible for the execution, for the specific type of bonding being undertaken.

NOTE 2 Minimum appropriate skill and experience of personnel responsible for the execution can be specified in the National Annex.

B.5 Equipment and premises

(1) Adequate premises and bonding equipment shall be available, including:

- premises to ensure and control that the climate during bonding and curing complies with the conditions specified by the adhesive manufacturer;
- calibrated equipment for weighing and measuring wood moisture, air temperature and relative humidity;
- equipment for surface preparation and pre-treatments, if any;
- equipment for mixing and application of adhesives;
- equipment for hydraulic or pneumatic pressure including pressure control, if used;
- equipment for checking the strength, if checks are done at the factory.

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B.6 Materials

B.6.1 Timber products for surface bonding

(1) The following timber products may be glued onto softwood products made of SL, GST, GL, BGL, LVL, GLVL and CLT as well as on PW, OSB, SWP-P and SWP-C (e.g. as webs):

- a) structural lumber (SL);
- b) glued laminated timber (GL) made of softwood and poplar;
- c) glued solid timber (GST) made of softwood and poplar;
- d) cross-laminated timber (CLT);
- e) laminated veneer lumber (LVL) or glued laminated veneer lumber (GLVL);
- f) plywood (PW), solid wood panels (SWP) or oriented strand boards (OSB).

B.6.2 Screws and washers for surface bonding

(1) Partly-threaded screws according to EN 14592 with diameter $d \geq 4,0$ mm should be used.

NOTE Partly-threaded screws according to EAD 130118-01-0603 can be used.

(2) The ratio of head or washer diameter and screw diameter shall not be less than 1,8.

(3) Washers may be used to enlarge the head area to fulfil the requirements in Table B.1.

B.6.3 Adhesives

(1) It shall be checked if the adhesive used complies with EN 1995-1-1.

NOTE See 5.1.5 in EN 1995-1-1:2025.

(2) For glued-on panels and laminations, the following adhesives shall be used which are classified as Type I adhesives with the following subclasses according to EN 301 or EN 15425 respectively:

- a) EN 301 I 70 GP 0,6M;
- b) EN 301 I 90 GP 0,6M;
- c) EN 301 I 90 GF 1,5M;
- d) EN 15425 I 70 GP 0,3;
- e) EN 15425 I 90 GP 0,3;
- f) EN 15425 I 70 SP 0,5;
- g) EN 15425 I 90 SP 0,5.

(3) If pressure contact is not possible between two surfaces, then an adhesive according to EN 17418 shall be used.

(4) The species of both surfaces shall be positively tested according to EN 301, EN 15425 or EN 17418, respectively. Test results with spruce (*picea abies*) may also be applied for silver fir (*abies alba*) and scots pine (*pinus sylvestris*).

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B.7 Bonded-in rods

B.7.1 Pre-drilled holes

- (1) Pre-drilled holes for bonded-in rods shall be at least 2 mm bigger than the nominal diameter of the rods.
- (2) The adhesive shall be chosen so that the glue line thickness does not exceed the maximum glue line thickness according to EN 17334 for the chosen adhesive or that specified by the adhesive manufacturer.
- (3) The surfaces of the pre-drilled holes shall be clean cut and not burned.
- (4) The pre-drilled holes shall be cleaned from sawdust and drilling chips and kept clean after drilling.
- (5) It should be ensured that the rods are centred within the holes.
- (6) Spacers may be used.

B.7.2 Rods

- (1) It shall be ensured that the rod of the specified material and strength grade are used.
- (2) The rods should be free of substances that could affect bonding such as dust, grease, oil, release agents and other contaminants.

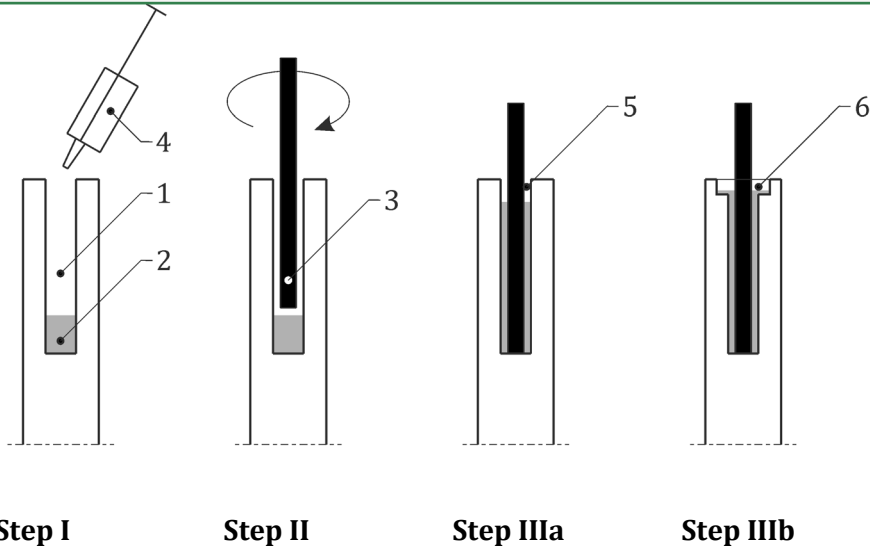
B.7.3 Bonding process

B.7.3.1 General

- (1) At installation, the wood moisture content should not exceed 15 %.
- (2) The amount of adhesive required for the bonding process should be calculated prior to the bonding process and should be checked during the application process. The excess or loss of adhesive should be recorded.
- (3) The adhesive shall be poured into the pre-drilled holes in such a way that no large air voids occur along the anchorage length of the rods in the timber.
- (4) The following alternative installation procedures may be followed for bonded-in rods.

B.7.3.2 Procedure (i)

- (1) In this method, the pre-drilled holes are visible and accessible from above, see Figure B.1.
- (2) Depending on the intended oversize of the drilled hole compared to the nominal diameter of the rod, the required quantity of adhesive shall be calculated including a safety margin. The specified quantity of adhesive shall be injected into the drilled hole.
- (3) The quantity of the adhesive shall be filled-in in such a way that, following the full introduction of the rod, the specified bond length is achieved.
- (4) The rod shall be inserted centrally into the drilled hole and turned slightly.



Key

- 1 hole drilled
- 2 adhesive
- 3 rod
- 4 device for application of the adhesive
- 5 insufficient amount of adhesive not achieving the specified bond length
- 6 excessive adhesive emerging from the drilled hole ensuring the specified bond

Figure B.1 — Procedure (i) for installation of bonded-in rods

B.7.3.3 Procedure (ii)

(1) Along the pre-drilled hole for the rod, additional lateral filling and ventilation holes shall be drilled from one side of the member to inject the adhesive and to allow the air to escape from the cavities, see Figure B.2. The number of these injection holes and their diameters depend on the length of the pre-drilled hole and the injection device used.

(2) The rod shall be inserted centrally in the pre-drilled hole.

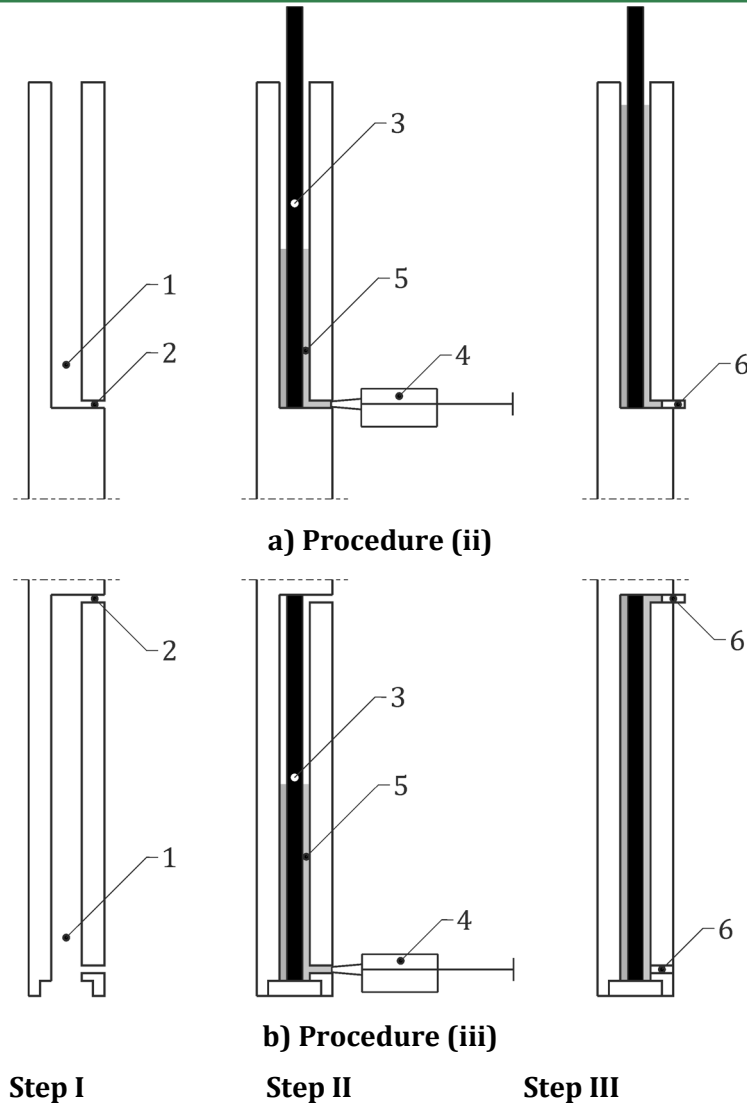
(3) Loss of adhesive should be avoided. For horizontally oriented rods or vertical rods pre-drilled from below, the pre-drilled hole should be sealed before the adhesive is filled in.

(4) The adhesive shall be injected through an injection hole into the cavity between the rod and the wall of the pre-drilled hole. The filling of the adhesive shall start at the bottom injection hole and continue until the adhesive emerges from the next higher ventilation hole.

(5) The lowest injection hole shall then be closed, e.g. by valves, wood or plastic dowels.

(6) Injection of the adhesive into the next higher injection hole and closing the previous injection hole shall be carried out until the adhesive emerges from the uppermost ventilation hole for filling control.

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Key

- 1 pre-drilled hole for the rod
- 2 holes drilled for injection and ventilation
- 3 rod
- 4 device for injection of the adhesive
- 5 adhesive
- 6 holes are closed with a valve, wood or plastic dowels

Figure B.2 — Procedures (ii) and (iii) for installation of bonded-in rods

B.7.3.4 Procedure (iii)

- (1) Lateral injection and ventilation holes shall be drilled along the pre-drilled hole, see Figure B.2b).
- (2) The rod shall be inserted centrally into the prepared pre-drilled hole.
- (3) The adhesive shall be pressed into the cavities between the rod and the wall of the pre-drilled hole with a special pressure device.
- (4) In the area of the wood surface, the drill holes for the rods shall be closed flush with suitable wooden parts.

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NOTE Depending on the bond length of the rod, several ventilation holes and incremental pressing in of the adhesive can be necessary.

B.7.4 Tightening of groups of bonded-in-rods

(1) Where a connection consists of multiple axially loaded threaded bonded-in rods acting together, that are connected with other members, the nuts should be tightened uniformly so that the tensile forces are evenly distributed between the individual threaded rods.

(2) To limit the tensile load applied to the rods during tightening of the nuts, a torque-limiting wrench should be used.

B.8 Bonded-on wood-based panels and laminations

B.8.1 General

(1) This subclause applies exclusively to members in Service Classes 1 and 2.

(2) The wood moisture content should not exceed 15 %.

Table B.1 — Products, geometrical parameters and calculated minimum pressure for screw-

Group	Material or product	Equilibrium moisture content at 20 °C and 65 % relative air humidity
1	ST, FST, GST, GL or BGL, SWP-P, SWP-C, CLT, LVL and GLVL	12 %
2	PW, OSB	10 %

(3) In general, the difference between the moisture content of the individual wood members of the same type or group (see Table B.1) should not exceed 3 %. If a product of group 1 is glued onto a product of group 2 the difference between the moisture content of the individual wood members may be up to 5 %.

(4) For ST, FST, GST, GL, BGL, the angle between the wood fibre orientation and the bonding surface shall be less than or equal to 15° (e.g. between the narrow side of a glulam beam and a bonded-on lamination), see Figure B.3.

(5) Bonded-on wood-based panels and laminations may be applied in several layers.

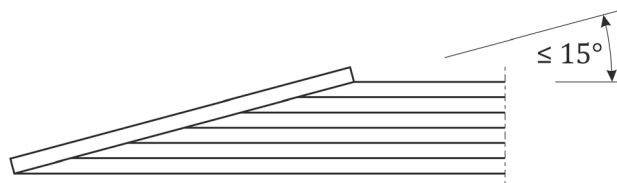


Figure B.3 — Angle between fibre orientation and bonding surface

B.8.2 Surface preparation

(1) Unless otherwise specified by the adhesive manufacturer, planing or sanding of ST, FST, GST, GL, BGL made of Norway spruce (*Picea abies*), Silver fir (*Abies alba*) and Scots pine (*Pinus sylvestris*) may be carried out up to 24 h before bonding. For wood species other than Norway spruce, Silver fir and Scots pine the maximum time before bonding may be 6 h.

(2) The time periods in B.8.2(1) may be extended up to 10 days for Norway spruce, Silver fir and Scots pine and up to 3 days for other wood species if by additional delamination testing according to EN 14080

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or EN 14374 for LVL it is demonstrated that suitable storage conditions reliably prevent detrimental changes in the surfaces (changes in flatness or soiling, e.g. due to dust or escaping wood constituents).

(3) The execution specification should specify whether tests according to B.8.2(2) shall be carried out.

(4) OSB should be ordered sanded from the manufacturer or be sanded before bonding.

(5) The dimensional deviations of the surfaces to be bonded shall be chosen considering the adhesive type and amount, member stiffness and the pressing force to ensure that the required glue line thickness is achieved.

B.8.3 Bonding process

(1) The application of adhesive shall ensure an even distribution of the required volume of adhesive and, if applicable, reliable mixing of the parts of the adhesive.

(2) Surplus adhesive should be removed using methods and materials recommended by the adhesive manufacturer and without damaging the surfaces.

(3) In general, an EN 301 I 90 GF 1,5M adhesive should be used. If the maximum glue line thickness according to the adhesive class can be ensured by documented regular measurements, other adhesive classes according to B.6.3 may also be used.

(4) The glue line thickness shall comply with the manufacturer's specifications and the adhesive class.

(5) The glue line thickness shall be checked with a magnifying glass allowing measurements having an accuracy of 10 %.

(6) The wood temperature at the adhesive joint during curing under pressure and during the required post-curing period should be greater than or equal to 18 °C, and not lower than specified by the adhesive manufacturer.

B.8.4 Pressing

B.8.4.1 Hydraulic pressing

(1) The pressing force shall be selected depending on the material and thickness of the members to be bonded, the surface quality and flatness, the type of wood, the adhesive, the deformation of the members to be bonded during pressing and the type of processing, to fulfil the requirements for glue line thickness according to the adhesive manufacturer's instructions.

B.8.4.2 Screw-press bonding

(1) For screws with a constant lead angle of the thread, there shall be no thread in the part to be bonded on, see Figure B.4.

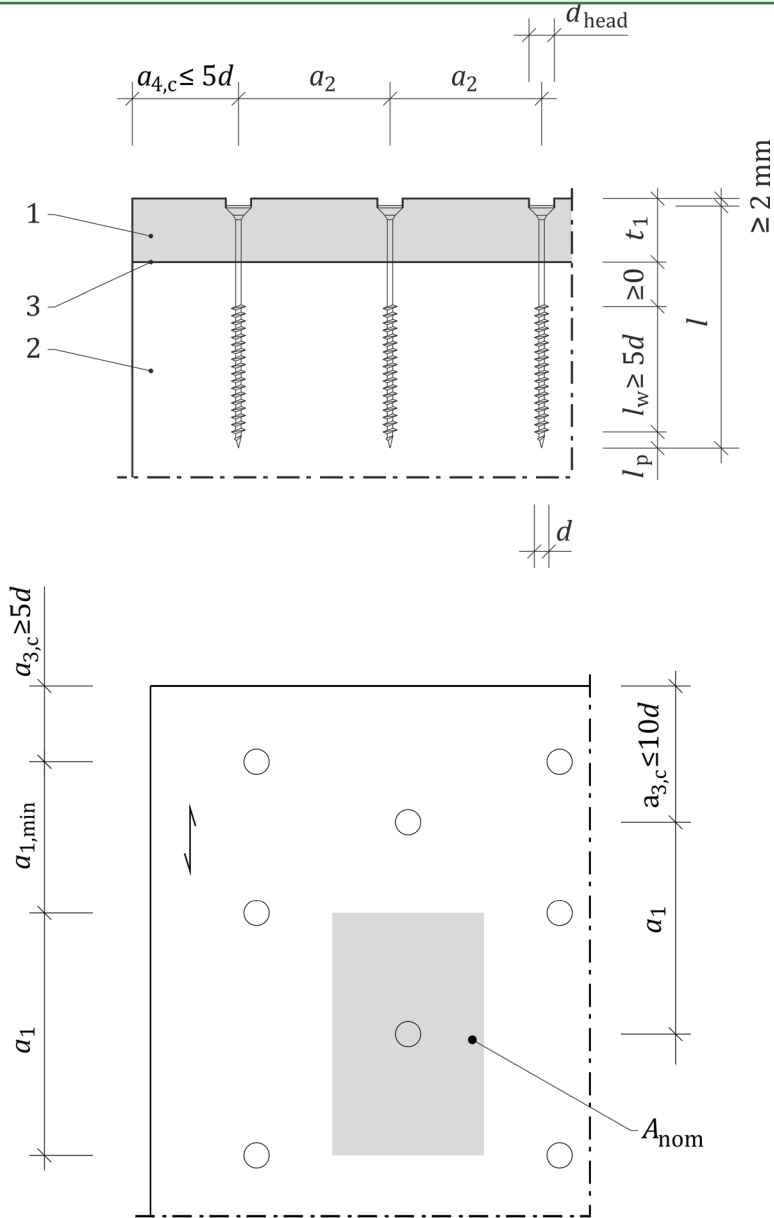
(2) Adequate pressure of the single screws shall be ensured. To achieve this, the head of a countersunk screw or washer head screw should penetrate the surface of the softwood part to be glued on at least by 2 mm, see Figure B.4.

(3) For reinforcements of holes in beams and notches there should be at least four screws within the area specified by b_r and h_{rp} in EN 1995-1-1:2025, Figure 8.19c) and d) or b_r and $l_{r,u}$ or $l_{r,l}$ in EN 1995-1-1:2025, Figure 8.14b), respectively, where h_{rp} is the height of plane reinforcement above or below a hole, b_r is the plane reinforcement width and $l_{r,l/u}$ is the reinforced length above/below the axis prone to splitting.

(4) If several layers are glued on, every layer shall be screwed on separately. In the intermediate layer, the screw head shall not protrude from the surface.

(5) Screws may be removed after curing of the bond line.

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Key

- | | | | |
|-------|--|------------|---|
| 1 | reinforcement | t_1 | thickness of members to be glued on |
| 2 | member to be reinforced | l_w | withdrawal length |
| 3 | bond line | d_{head} | head diameter |
| a_1 | minimum spacing of screws parallel to grain within one row | $a_{3,c}$ | minimum end distance of screws parallel to grain to end grain surface |

NOTE 2 mm shown in figure is approximate, to ensure that pressure is applied.

Figure B.4 — Boundary conditions of screw-press bonding with multiple layers

(6) The minimum screw end distance, edge distance and spacing shall comply with EN 1995-1-1 to avoid splitting during insertion unless different provisions are given in the respective European product specification. The maximum distance of screws within the glue line to the ends of the members should be $a_{3,c} \leq 10d$ and the distance to the edges should be $a_{4,c} \leq 5d$ (see Figure B.4).

NOTE See 11.4 in EN 1995-1-1:2025.

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(7) For reinforcement of notches, the distance of screws to the possible crack line (see EN 1995-1-1:2025, Figure 8.14b) should be at least $5d$.

(8) Products, geometrical parameters and calculated minimum pressure for screw-press bonding should be taken from Table B.2.

Table B.2 — Products, geometrical parameters and calculated minimum pressure for screw-press bonding

Timber product to be glued on	Thickness of member to be glued on t [mm]	Screw diameter d [mm]	Minimum nominal head or washer diameter d_{head} [mm]	Maximum screw spacing		Withdrawal length l_w [mm]	Calculated minimum pressure $p_{\text{cal,min}}$ [N/mm ²]	
				parallel to grain $a_{1,\text{max}}$ [mm]	perpendicular to grain $a_{2,\text{max}}$ [mm]			
Softwood PW, SWP-C, OSB	$12 \leq t < 19$	≥ 5	9	100	65	$6d$	0,10	
Hardwood PW				100	100	$8d$		
ST, FST, GST, GL, SWP-P	$19 \leq t < 27$	≥ 6	10,8	140	65	$6d$		
Softwood PW, SWP-C, OSB			14,4	140	90	$8d$		
Hardwood PW			10,8	140	140	$8d$		
ST, FST, GST, GL, SWP-P, SWP-C, Softwood PW, OSB, LVL	$27 \leq t < 42$	≥ 8	19,2	175	100	$6d$		0,15
Hardwood PW				175	175	$15d$		
SWP-C, LVL	$42 \leq t < 60$	≥ 8	19,2	225	100	$6d$		
Hardwood PW				250	250	$15d$		

(9) Alternatively to Table B.2, the maximum screw distances $a_{i,\text{max}}$ parallel or perpendicular to grain should be determined by:

$$a_{i,\text{max}} = 3,35 \sqrt[4]{E_{i,\text{mean}} I_{i,b=1}} \quad (\text{B.1})$$

with $i = 1$ or 2

where

$a_{i,\text{max}}$ is the maximum spacing for direction i , in mm

$I_{i,b=1}$ is the moment of inertia for direction i for a width of $b = 1$ mm, in mm⁴ of the bonded-on material

$E_{i,\text{mean}}$ is the mean modulus of elasticity for direction i , in N/mm² of the bonded-on material

(10) For the calculation of the characteristic compression force due to a single fastener the head area A_{head} (see EN 1995-1-1:2025, 11.2.2(2)) should be multiplied with the characteristic compression strength for screw-press bonding $f_{c,k}$ as follows:

— for solid wood based (SWB) materials see Formula (B.2);

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- for plywood and laminated veneer lumber made of birch $f_{c,k} = 16 \text{ N/mm}^2$;
- for plywood and laminated veneer lumber made of beech $f_{c,k} = 25 \text{ N/mm}^2$.

$$f_{c,k} = 14d_{\text{head}}^{-0,14} \left(\frac{\rho_k}{350} \right)^{0,8} \quad (\text{B.2})$$

where

- $f_{c,k}$ is the characteristic compression strength for screw-press bonding, in N/mm^2 ;
- d_{head} is the head diameter, in mm;
- ρ_k is the characteristic density, in kg/m^3 .

(11) Additionally, the calculated minimum pressure per screw shall satisfy:

$$\frac{F_{\text{ax,t,d}}}{A_{\text{nom}}} \geq p_{\text{cal,min}} \quad (\text{B.3})$$

where

- $F_{\text{ax,t,d}}$ is the design axial resistance of the screw, in N;
- A_{nom} is the influence area of a screw, in mm^2 ;
- $p_{\text{cal,min}}$ is the calculated minimum pressure according Table B.2, in N/mm^2 .

(12) The decrease of pressure during the curing of the adhesive may be taken into account by $k_{\text{mod}} = 1$ and $\gamma_M = 1,3$.

B.9 Measures to ensure contact pressure between two members

- (1) Adhesives shall be used up to the maximum depth specified by the adhesive manufacturer.
- (2) It shall be ensured that the gap is completely filled with adhesive and that no adhesive escapes during the curing process.

B.10 Quality control

B.10.1 General

(1) The execution specification shall include quality control requirements depending on the type of bonding operation, installation instructions of the adhesive manufacturer and the national regulations.

B.10.2 Documentation

(1) Any deviation from the process given in the execution specification or from the adhesive manufacturer's instructions shall be documented.

NOTE For further actions to be taken, see 4.6.

(2) National regulations or the execution specification may require documentation to be prepared for the following works carried out.

(3) For bonding work, documentation should include, if applicable and relevant:

- a) general information (e.g. project description, owner, order number);

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- b) the date the bonding was undertaken;
- c) the name of the person in charge of the bonding with qualifications;
- d) the ambient temperature and relative humidity of the air;
- e) the adhesive type and batch number, and shelf life;
- f) the adhesive temperature if low temperatures are likely to occur;
- g) the members to be bonded and their identification;
- h) the moisture content and temperature of the wooden members to be bonded if low temperatures are likely to occur;
- i) for bonded-in rods, the specification (strength class or property class, and specification) and temperature of the rod if low temperatures are likely to occur;
- j) the time between planning of surfaces or drilling of holes, and applying or filling with adhesive;
- k) the mixing ratio of the adhesive if applicable;
- l) the adhesive application volume (or mass per square metre) and any difference from the calculated quantity required if adhesive leakage is likely to occur;
- m) the pot life and assembly time, if applicable;
- n) the applied pressure and pressing time, if applicable;
- o) the curing time until handling and loading;
- p) the curing conditions if different from d);
- q) relevant information about the setup and the results of glue line testing.

(4) For works to ensure pressure contact between surfaces (3) should be applied analogously.

B.10.3 Type and frequency of quality control for bonding operations

(1) The type and frequency of quality control shall be specified.

NOTE 1 With regard to bonded-in rods, a bonding operation is considered as the continuous process of bonding in single or multiple rods in one connection, member or structure without major interruptions.

NOTE 2 Type and frequency of qualified control specification can be according to Table B.3 (NDP) unless stricter requirements for type and frequency of quality control are given in the National Annex.

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Table B.3 (NDP) — Type and frequency of quality control for bonding operations

Type of bonding	Requirement for	Type of quality control operation	Frequency of quality control operation
Bonded-in rods	Mixing ratio ^a	Weighing of the components	- for manual mixing: per mixing operation ^a - for machine mixing: per shift
	Complete filling of space between pre-drilled hole and rod	Visual check of the specified filling of the pre-drilled hole and by checking, that at least the nominal quantity has been applied considering possible adhesive leakage	for any bonded-in rod
	Relative humidity of air and temperature at bonding	Measuring the temperature and the relative humidity of the air	per bonding operation
		Measuring the moisture content of the timber and the temperatures of all members at time of manufacture	per bonding operation
	Curing	Checking the curing according to the adhesive manufacturer's instructions	per bonding operation
	Bond line strength	Testing the constancy of performance of bond line e.g. by a pull-out test with constant configuration or checking the curing	per bonding operation
Bonded-on panels and laminations	Mixing ratio ^a	Weighing of the components	for manual mixing: per mixing operation
	Relative humidity of air and temperature at bonding	Measuring air temperature and the relative humidity	per bonding operation
		Measuring the moisture content of the timber members and the temperatures of all components at manufacture	per bonding operation
	Curing	Checking the curing according to the adhesive manufacturer's instructions	per bonding operation
	Glue line thickness	Checking the glue line thickness according to the adhesive manufacturer's instructions ^b	per bonding operation
	Bond line strength	Testing the constancy of performance of the bond line e.g. by a shear or delamination test with constant configuration	per shift
^a Deemed to be satisfied if cartridges in conjunction with specific mixing devices are used. ^b The glue line thickness is usually measured at drill cores taken from the hardened connection.			

B.10.4 Applications of bonded-in rods

(1) Together with the principles in B.10.1, the requirements for execution of bonded-in rods should take into account the complexity of the application and may consider the degree of utilization.

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(2) Requirements on quality control for the bonding operation should be given.

NOTE Requirements on applicability and content of quality control for bonding operations can be given in the National Annex. Table B.4 (NDP) can be used unless the National Annex sets different requirements.

Table B.4 (NDP) — Guidance on the specification of requirements for the execution of connections and reinforcements with bonded-in rods

Requirements for execution	Usual applications
Higher	Small groups ($n \leq 4$) of rods bonded-in parallel to the grain connecting members loaded with normal forces and systematic bending or large groups of rods ($n > 4$), e.g. for an assembly hall: <ul style="list-style-type: none"> — portal frame corners — moment rigid connections of beams and columns — trusses
Normal	Small groups ($n \leq 4$) of rods parallel to the grain under pure axial loading and reduced fastener spacing ($a_2 < 5d$), e.g. for an office building: <ul style="list-style-type: none"> — wall anchorage — tension ties Rods at an angle to the grain with higher complexity: <ul style="list-style-type: none"> — timber concrete composite — shear reinforcement Rods with exclusive lateral load: <ul style="list-style-type: none"> — mounting
Lower	Perpendicular to the grain reinforcements, e.g. for an agricultural building: <ul style="list-style-type: none"> — compression at supports and load introductions — tension in connections and in curved members — notches and holes in beams Connections with single rods and small groups ($n \leq 4$) of bonded-in rods parallel and perpendicular to the grain with large fastener spacing ($a_2 > 5d$): <ul style="list-style-type: none"> — purlin support on column
NOTE 1 The choice of different requirements within one project can focus the available resources on the most important applications of bonded-in rods.	
NOTE 2 The descriptions in EN 1990 about the consequence class can serve as additional guidelines.	
NOTE 3 The consequence of the failure of a bonded-in rod, e.g. the design for ULS or SLS, can be taken onto account.	
NOTE 4 The level of ductility assumed in the design can be taken into account.	

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Annex C (informative)

Timber foundation piles

C.1 Use of this annex

(1) This informative annex provides guidance for the execution of timber foundation piles.

NOTE National choice on the application of this informative annex is given in the National Annex. If the National Annex contains no information on the application of this informative annex, it can be used.

C.2 Scope and field of application

(1) This informative annex contains execution rules for timber foundation piles.

C.3 Data recording

(1) During the execution of foundations with timber foundation piles, the following data should be recorded for each pile:

- wood species;
- criteria applied and respective measured values in the grading process;
- nominal length and diameter class at the pile toe;
- geometrical properties and materials of the pile extension, if applied.

C.4 Execution rules

(1) The execution of foundations with timber foundation piles should follow the specifications given in EN 1997-3, EN 12699 and Annex C.

(2) Where a pile tip is necessary due to the soil conditions, the tapered end of the pile should be cut symmetrically with respect to the axis of the pile, and the length of the pile tip should be 1,2 to 2,0 times larger than the pile diameter adjacent to the tip.

NOTE No pile tip or only a short pile tip is needed when driving piles into weak soils and a large pile tip is needed when driving piles into compact soils.

(3) Piles shall be kept fully saturated and shall be driven into the soil as soon as possible.

NOTE Timber logs are in a fully saturated condition right after felling and this condition can be maintained, for example by wrapping the logs or parts of the logs in air tight plastic, or by submerging them under water, or by installing the piles quickly after felling.

(4) The driving energy should be adapted to the soil conditions, the pile length, and the wood species.

(5) To prevent pile damage during driving, the characteristic compressive stresses parallel to the grain should not exceed $0,8 f_{c,0,k,sat}$, where $f_{c,0,k,sat}$ is the characteristic compressive strength parallel to the grain in water saturated timber.

(6) If necessary, the pile heads should be reinforced with steel rings to prevent damage during driving.

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- (7) If necessary, the pile tips should be protected with steel shoes to prevent damage during driving.
- (8) If the pile head has been destroyed due to heavy driving in, a new pile head should be formed by cutting out the damaged material.
- (9) Piles split during heavy driving should not be assigned any resistance.
- (10) After driving, if necessary, the heads of the piles should be cut off leaving only sound wood.

Annex D (normative)

Carpentry joints – deviation limits

D.1 Use of this annex

(1) This normative annex provides deviation limits for carpentry joints.

D.2 Scope and field of application

(1) This normative annex gives deviations limits for carpentry joints.

D.3 Dovetail connections

(1) The connection should fit accurately with a deviation limit for clearance Δ_{\max} of 1,5 mm between the notch in the primary member and the end face of the secondary member, see EN 1995-1-1:2025, Figures 11.43 and 11.45.

(2) The deviations limits Δ_{\max} for the dovetail connection should be as follows:

- inner dovetail width at the top in the secondary member $b_{2,1}$: ± 1 mm;
- dovetail length t : $\pm 1,5$ mm;
- depth of the dovetail in the secondary member $h_{2,1}$: ± 2 mm.

D.4 Single step connections

(1) The connection should fit accurately with a deviation limit for clearance Δ_{\max} of 2 mm between members.

(2) If a suitable contact medium (e.g. wedges, gap filling adhesives) is used, the deviation limit for clearance Δ_{\max} before filling should be 8,0 mm.

D.5 Mortise and tenon joints

(1) The connection should fit accurately with a deviation limit for clearance Δ_{\max} of 1 mm between members.

(2) The tenon shall be fully supported in the mortise over the full length l_{ten} .

NOTE For l_{ten} , see Figure 11.42 in EN 1995-1-1:2025.

(3) The mortise l_m should be 5 mm to 10 mm deeper than the tenon length l_{ten} , EN 1995-1-1:2025, Figure 11.42.

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Annex E (informative)

Execution rules for tie-down connections for structures in seismic areas

E.1 Use of this annex

(1) This informative annex provides guidance for structures in seismic areas.

NOTE National choice on the application of this informative annex is given in the National Annex. If the National Annex contains no information on the application of this informative annex, it can be used.

E.2 Scope and field of application

(1) This informative annex covers execution rules for tie-down connections for structures in seismic areas.

E.3 Number of fasteners at connections

(1) It should be checked that the number of fasteners (e.g. nails or screws) connecting connector plates and metal 3D-connectors with the timber member does not exceed the number specified in the detail drawings.

NOTE This provision aims to ensure the attainment of the required ductile failure mechanism and fulfil the capacity-based design rules at connection level. This provision can lead in some cases to the use of less fasteners than the number of holes present in the connector plates and metal 3D-connectors, see Figure E.1.

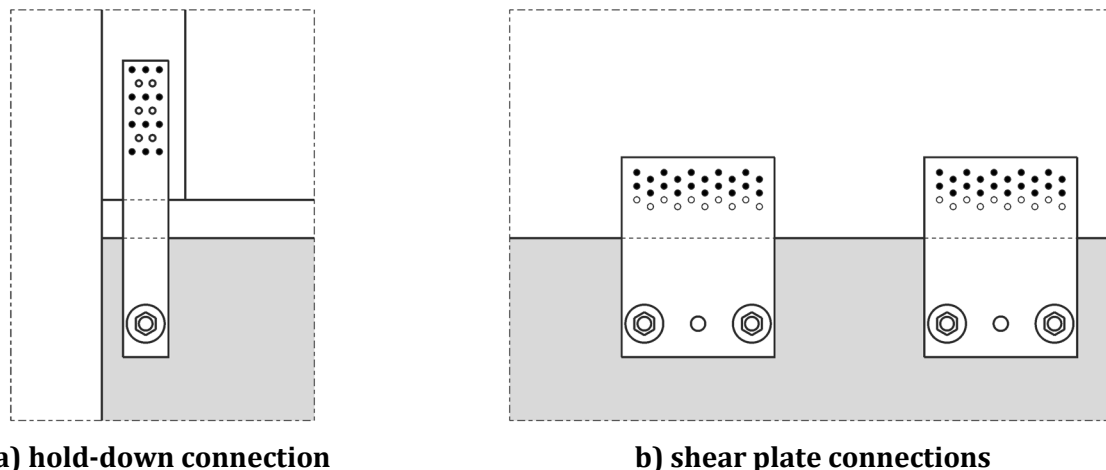


Figure E.1 — Connections with number of fasteners intentionally lower than the total number of holes

E.4 Deviation limits of tie-down to foundations

(1) In case of an offset of a timber wall with respect to the concrete foundation base beam due to small differences in deviations between the concrete work and the timber structure, the maximum inclination

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a/b of the connector plates and metal 3D-connectors connecting the wall to the foundation should not exceed $1/25$, (see Figure E.2).

(2) If the inclination a/b exceeds $1/25$, a wood-based interlayer may be placed between the metal plate and the timber wall, or a metal washer may be added in the bolted connection to reduce the inclination. In these cases, the design resistance of the connection shall be verified accordingly.

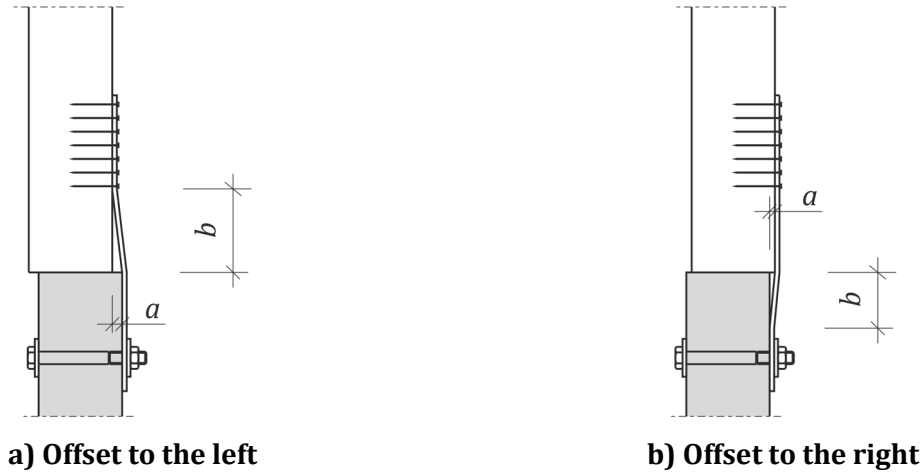


Figure E.2 — Example of deviation due to offset of a timber wall with respect to the concrete base beam

E.5 Tie-down connection at inter-storey

(1) In platform construction, buckling of the metal plate connections caused by squashing of the floor panel between the supporting and the upper wall panels during installation should be prevented.

NOTE Buckling of tie-down connections can be avoided for example by fastening either the upper or the lower part of the metal plate at inter-storeys after the complete erection of the building, see Figure E.3. In this case additional measures to ensure stability during erection can be necessary.

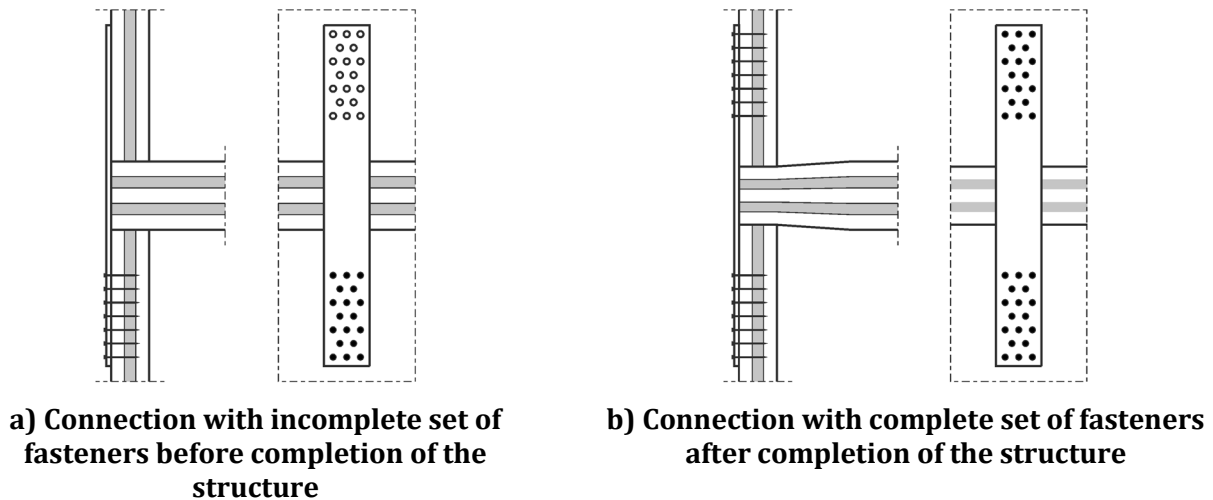


Figure E.3 — Example of tie-down connection at inter-storey level in a platform construction

Annex F (informative)

Expanded tube connections

F.1 Use of this annex

(1) This informative annex provides guidance for reinforced connections with expanded tube fasteners.

NOTE National choice on the application of this Informative Annex is given in the National Annex. If the National Annex contains no information on the application of this informative annex, it can be used.

F.2 Scope and field of application

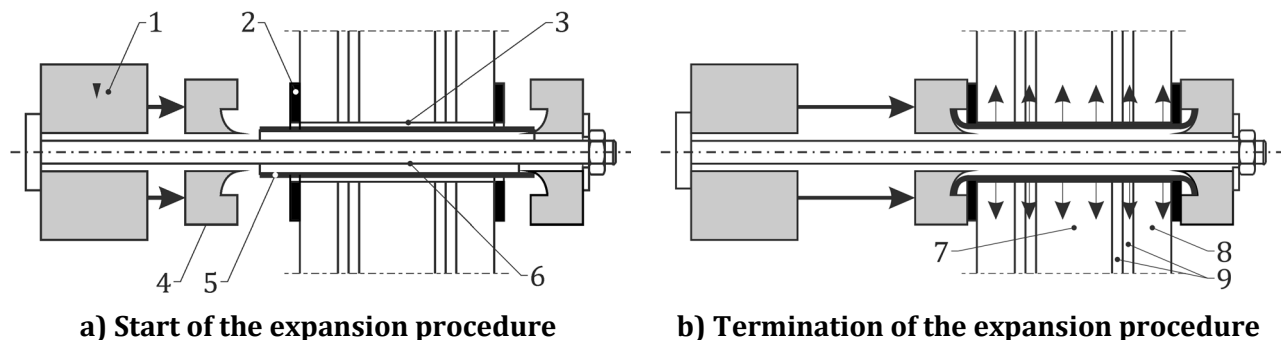
(1) This informative annex covers execution rules for connections with expanded tube fasteners.

(2) During execution and erection of the structure the densified laminated wood (DLW) shall be always kept dry or protected against direct water take up.

NOTE The influence of water is detrimental to the properties of the DLW caused by rapid swelling.

F.3 Introduction

(1) The expanded tube connection uses steel tubes that fit into oversized holes. During the assembly stage of the connection the steel tubes are expanded in diameter until all clearance vanished. To prevent splitting caused by the expansion procedure and for transfer of high lateral forces, the connection area is reinforced by DLW at the shear plane, see Figure F.1. The DLW is bonded to each connection member separately.



Key

- | | |
|----------------------|-------------------|
| 1 hydraulic actuator | 4 dies |
| 2 washer | 5 overlength tube |
| 3 pre-drilled hole | 6 tensile rod |

Figure F.1 — Expansion procedure

F.4 General

(1) The deviation of the wood moisture content of a connection at time of assembly from the target equilibrium moisture content in service should not exceed $\pm 3\%$.

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F.5 Adhesive

(1) Two-component epoxy and two-component polyurethane adhesives according to EN 17418 can be used for surface bonding of DLW.

F.6 Bonding

(1) For the bonding of DLW to SWB, the requirements of bonded-on panels in EN 1995-1-1 shall apply.

NOTE See Table 3.1 in EN 1995-1-1:2025.

(2) The subclauses for surface preparation and the bonding process according to B.8.2 and B.8.3, respectively, shall apply. In addition to B.8.2(4) DLW should be sanded on both sides.

(3) In addition to B.8.4.2, the pre-drilled holes for the screws in DLW should be no more than 0,2 mm larger than the screw diameter.

(4) The screw dimensions and maximum screw distances given in Table F.1 shall be used.

(5) The rules of Clause B.9 and Clause B.10 apply.

(6) To prevent cupping deformation due to excessive moisture content changes for members with DLW on one side, a surface bonded PLY material, may be bonded on the other side.

Table F.1 — Screw dimensions and maximum screw distances per screw for bonding of DLW

Thickness of DLW to be glued on <i>t</i> [mm]	Recommended screw diameter <i>d</i> [mm]	Minimum head diameter ^a <i>d</i> _{head,min} [mm]	Maximum screw spacing parallel / perpendicular to grain		Effective thread length <i>l</i> _{ef} [mm]	Calculated minimum pressure <i>p</i> _{cal} [N/mm ²]
			<i>a</i> _{1,max} [mm]	<i>a</i> _{2,max} [mm]		
12	5	9	200	200	42	0,05
18	6	9	200	200	42	0,05

^a The ratio of screw head or washer diameter and screw diameter shall be greater than or equal to 1,8.

F.7 Holes in DLW

(1) The holes pre-drilled in the DLW and washer shall comply with Table F.2.

(2) The misalignment of the pre-drilled holes in the DLW and the connecting members before the expansion procedure should be less than 0,03*d*.

(3) For expanded tube fasteners, the deviation limits from the spacings, end and edge distances should be 0,1 times the minimum spacings, end and edge distances given in EN 1995-1-1:2025, G.4.4.

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Table F.2 — Requirements related to the execution of the tube connection

Tube diameter	Minimum DLW panel thickness	Wall thickness tube	Washer		Hole diameter	DLW pre-drilled hole diameter ^a	Central threaded rod
			Minimum diameter	thickness			
[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
17,2	12	2,35	54	3	19	18,0	M10 ^b
21,3	14	2,65	76	3	24	22,0	M14
26,9	16	2,65	85	4	31	28,0	M18
33,7	18	3,2	72	4	37	35,0	M24
^a Deviation $\pm 0,1$ mm ^b At least 8.8 steel according to EN 1993-1-1 is required							

F.8 Expansion procedure

(1) The total over-length of the tube before expansion shall be 1,1 times the total distance between both washers plus the thickness of the washers plus an additional 10 mm for the flare. To prevent expansion of the tube outside the connection the part that sticks out on each side should be smaller or equal to the tube diameter.

(2) Connection members are assembled and the tube with overlength is inserted and centred with the washers on the outside, see Figure F.1a. The central tensile rod is inserted and the dies are mounted and securely fastened at both tube ends to enable the expansion. This rod can be fully threaded or smooth with only threaded ends.

(3) The dies make contact with the ends of the tube making certain the tube and dies are in line. The actuator forces the dies to slide inwards over the central rod. This will first create a flare at the end of the tube after which the tube diameter starts to increase.

(4) The actuator continues to move the dies together until the connection members are tightly pushed together. When the washers make contact with the connection surfaces the sound of cracks caused by compression perpendicular to grain failure terminates the expansion procedure, see Figure F.1b.

(5) The use of a central rod ensures constant alignment of the tube ends. The steel quality of the central rod expanding the smallest diameter tube should be at least 10.9 according to EN 1993-1-1. Compression of the tube ends by other means result in failure of the expansion process.

F.9 Requirements for the dies

(1) Dimensions of the dies required to flare the tube ends and to expand the tube given in Figure F.2 and Table F.3 should be used.

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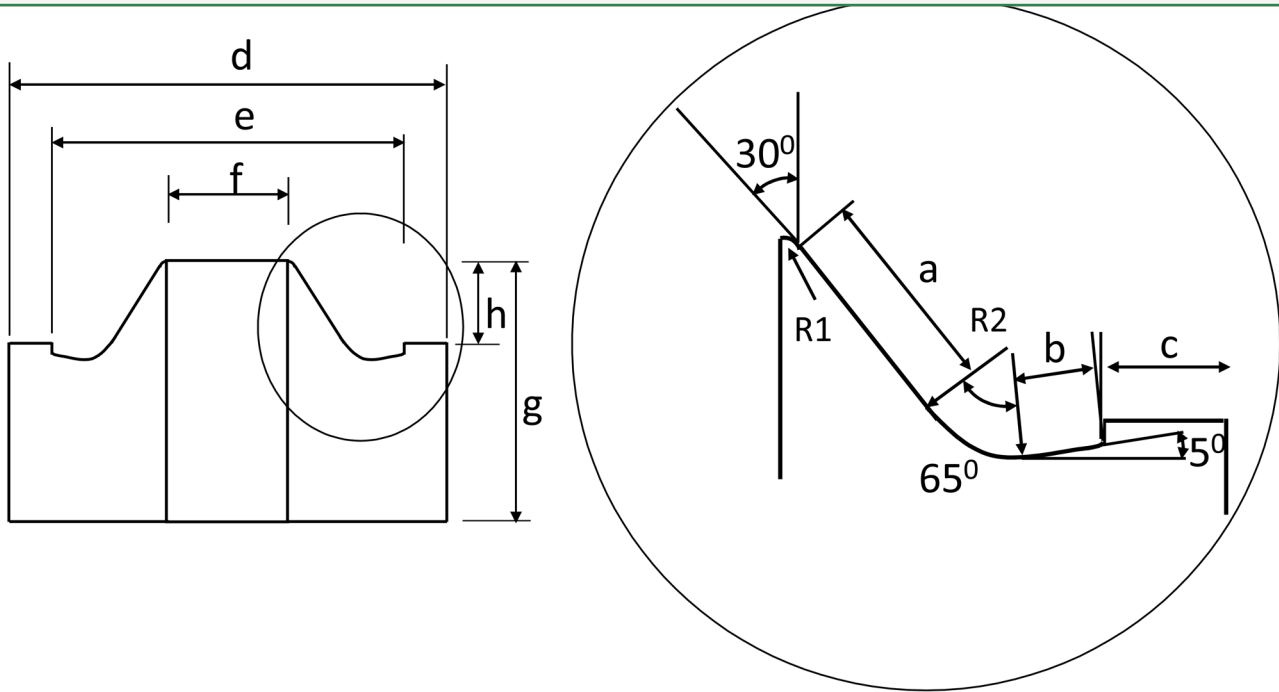


Figure F.2 — Dimension parameters for dies

Table F.3 — Dimensions for dies

Tube diameter	17,2 mm	21,3 mm	26,9 mm	33,7 mm
dimension	[mm]	[mm]	[mm]	[mm]
R1	0,2	0,2	0,2	0,2
R2	2,5	3,0	3,5	4,0
a	3,5	4,5	5,5	6,5
b	2,1	2,7	3,2	3,2
c	13	13	13	13
d	45	51	60	68
e	25	31	40	48
f	12	15	20	26
g	35	35	35	35
h	4,2	5	6,3	7,5
Hardness	62/63HRC (Rockwell Hardness C)			

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Annex G (informative)

Moisture control plan

G.1 Use of this annex

(1) This informative annex provides supplementary guidance on the content of a moisture control plan as mentioned in 5.3.

NOTE National choice on the application of this informative annex is given in the National Annex. If the National Annex contains no information on the application of this informative annex, it can be used.

G.2 Scope and field of application

(1) This informative annex covers structures in service classes 1 and 2. For service class 3 different considerations can be necessary.

G.3 Content of the Moisture Control Plan

(1) Depending on the type of structure and the service class, the moisture control plan should include the following in addition to the requirements of Clause 5.3:

- a) the target equilibrium moisture content or range during fabrication and storage on site, the expected moisture content in service, the permitted moisture content range during execution and in service for different wood-based materials and/or for different parts of the structure;

NOTE 1 It is not intended that the moisture content in service is measured. Adequate information on the expected level and variation of moisture content in service enable the correct conditions during execution to be established.

- b) measures to ensure that detrimental swelling, shrinkage or decay of the timber members and their connections are avoided;

NOTE 2 A damp proof membrane can be used to avoid moisture transfer from fresh concrete, masonry, or screed.

NOTE 3 At the end of the manufacturing process wood-based panels can have very low moisture contents and might need conditioning to bring moisture contents up to an appropriate level; guidance is given in CEN/TR 12872.

NOTE 4 High moisture content can have detrimental effects on wood-based panels through significant swelling along their edges.

NOTE 5 Redrying can generally be ensured by sufficient ventilation.

- c) storage methods on site;
- d) any protection needed during transport, storage and erection;
- e) measures to prevent the risk of wetting and water traps during transport, storage and erection;

NOTE 6 Measures to protect timber members during erection against sudden heavy rainfall are relevant especially in the case of large buildings.

NOTE 7 For large components, for which protection against weathering is not possible, a coating can provide effective protection during execution.

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Bibliography

References given in recommendations (i.e. “should” clauses)

The following documents are referred to in the text in such a way that some or all of their content constitutes highly recommended choices or course of action of this document. Subject to national regulation and/or any relevant contractual provisions, alternative documents could be used/adopted where technically justified. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1990:2023,¹ *Eurocode - Basis of structural and geotechnical design*

EN 1997-3, *Eurocode 7 — Geotechnical design — Part 3: Geotechnical structures*

EN 12699, *Execution of special geotechnical works - Displacement piles*

EN 14080, *Timber structures - Glued laminated timber and glued solid timber - Requirements*

EN 14374, *Timber structures - Structural laminated veneer lumber - Requirements*

EN 14592, *Timber structures - Dowel-type fasteners - Requirements*

References given in permissions (i.e. “may” clauses)

The following documents are referred to in the text in such a way that some or all of their content expresses a course of action permissible within the limits of the Eurocodes. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 300, *Oriented Strand Boards (OSB) - Definitions, classification and specifications*

EN 636, *Plywood — Specifications*

EN 13353, *Solid wood panels (SWP) - Requirements*

EN 13986, *Wood-based panels for use in construction — Characteristics, evaluation of conformity and marking*

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

EN 15497, *Structural finger jointed solid timber - Performance requirements and minimum production requirements*

EN 61061-3-1:1998, *Non-impregnated densified laminated wood for electrical purposes - Part 3: Specifications for individual materials - Sheet 1: Sheets produced from beech veneer*

¹ As impacted by EN 1990:2023/prA1:2024.

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References given in possibilities (i.e. “can” clauses) and notes

The following documents are cited informatively in the document, for example in “can” clauses and in notes.

EN 14250, *Timber structures - Product requirements for prefabricated structural members assembled with punched metal plate fasteners*

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

CEN/TR 12872, *Wood-based panels - Guidance on the use of load-bearing boards in floors, walls and roofs*

EAD 130118-01-0603, *Screws and threaded rods for use in timber constructions*