

EUROPEAN ASSESSMENT DOCUMENT

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**SOLID WOOD SLAB ELEMENT TO BE
USED AS A STRUCTURAL ELEMENT IN
BUILDINGS**

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1 SCOPE OF THE EAD

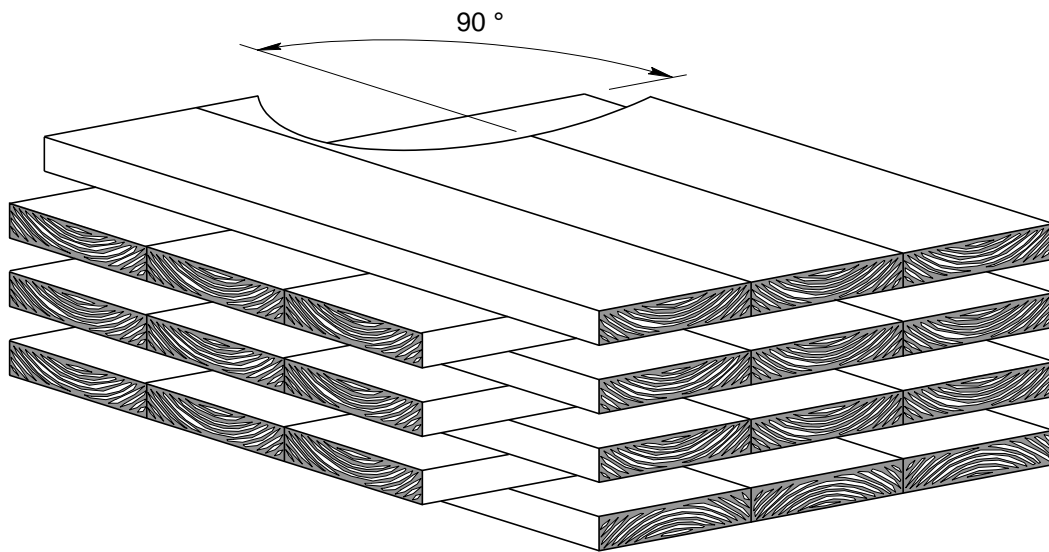
1.1 Description of the construction product

The solid wood slab elements are made of softwood boards, which may be finger jointed, bonded together in order to form cross laminated timber. Generally adjacent layers of the softwood boards are arranged perpendicular (angle of 90 °) to each other, see Figure 1. Wood species is European spruce or equivalent softwood.

The individual boards of the layers may be side-glued.

Due to the inclined orientation of the boards, the slab is able to transfer loads in all directions according to its condition of support.

Figure 1: Principle structure of the solid wood slab



The solid wood slab element consists of at least three adjacent layers and is manufactured with a maximum thickness of approximately 35 cm. Length and width according to the needs. With regard to the thickness of the solid wood slab element, thicknesses and orientations of individual layers are symmetrically assembled. In case of serious deviations from symmetry potential effects should be investigated.

The surfaces preparations of the product (planed or grinded, etc.) shall be declared in the ETA.

The application of wood preservatives and flame retardants is not subject of the European Assessment Document.

The product is not covered by a harmonised European standard (hEN).

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

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

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

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

1.2.1 Intended use(s)

The solid wood slab is intended to be used as a structural or non-structural element in buildings and timber structures.

The solid wood slab shall be subjected to static and quasi static actions only.

The solid wood slab is intended to be used in service classes 1 and 2 according to EN 1995 1 1. Members which are directly exposed to the weather shall be provided with an effective protection for the solid wood slab element in service.

1.2.2 Working life/Durability

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

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

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

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

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 1 shows how the performance of the solid wood slab element is assessed in relation to the essential characteristics.

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

| No | Essential characteristic | Method of assessment | Type of expression of product performance |
|---|--|----------------------|---|
| Basic Works Requirement 1: Mechanical resistance and stability | | | |
| 1 | Bending ²⁾ | 2.2.1.1 | Description, level |
| 2 | Tension and compression ²⁾ | 2.2.1.2 | Description, level |
| 3 | Shear ²⁾ | 2.2.1.3 | Description, level |
| 4 | Embedment strength | 2.2.1.4 | Description, level |
| 5 | Creep and duration of the load | 2.2.1.5 | Description, level |
| 6 | Dimensional stability | 2.2.1.6 | Description, level |
| 7 | In-service environment | 2.2.1.7 | Description |
| 8 | Bond integrity | 2.2.1.8 | Description |
| Basic Works Requirement 2: Safety in case of fire | | | |
| 9 | Reaction to fire | 2.2.2.1 | Class |
| 10 | Resistance to fire | 2.2.2.2 | Description, level |
| Basic Works Requirement 3: Hygiene, health and the environment | | | |
| 11 | Content, emission and/or release of dangerous substances | 2.2.3.1 | Description |
| 12 | Water vapour permeability – Water vapour transmission | 2.2.3.2 | Description, level |
| Basic Works Requirement 4: Safety and accessibility in use | | | |
| 13 | Impact resistance | 2.2.4.1 | Description |
| Basic Works Requirement 5: Protection against noise | | | |
| 14 | Airborne sound insulation | 2.2.5.1 | Description, level |
| 15 | Impact sound insulation | 2.2.5.2 | Description, level |
| 16 | Sound absorption | 2.2.5.3 | Description, level |

| Basic Works Requirement 6: Energy economy and heat retention | | | |
|--|--|---------|--------------------|
| 17 | Thermal conductivity | 2.2.6.1 | Description, level |
| 18 | Air permeability | 2.2.6.2 | Description, level |
| 19 | Thermal inertia | 2.2.6.3 | Description, level |
| 1) | This characteristic also relates to BWR 4. | | |
| 2) | Load bearing capacity and stiffness regarding mechanical actions perpendicular to and in plane of the solid wood slab element. | | |

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

Characterisation of products to be assessed shall be done in accordance with available specifications, notably

- Dimensions of the solid timber material
- Grading of the solid timber material
- Adhesive

2.2.1 Mechanical resistance and stability

2.2.1.1 Bending

Bending tests shall be performed following EN 408. In addition the principles for slab-like specimens, for bending perpendicular to the plane, as given in EN 789 have to be observed.

Measurement of local and global deformations according to EN 408 and deformation at support, if relevant.

Table 2: Number and dimensions of bending tests samples

| | Number of tests | Width w | Span l _A | Length L | Height H |
|---|----------------------------------|--|---------------------|------------------------------|--|
| | | m | m | m | mm |
| Bending perpendicular to the plane of the CLT | | | | | |
| - cover layers parallel to the span | 20 per relevant number of layers | ~ 1.5 | ~ 5.5 | overlap at supports ≥ 100 mm | according to relevant number of layers |
| - cover layers perpendicular to the span | 10 for one number of layers | ~ 0.8 | ~ 2.3 | overlap at supports ≥ 100 mm | according to relevant number of layers |
| Bending in plane of the CLT | 20 per relevant number of layers | according to relevant number of layers | ~ 5.5 | overlap at supports ≥ 100 mm | 400 |

The bending stiffness is specified in relation to the effective moment of inertia I_{ef}.

Calculation of the effective moment of inertia and therewith of the effective bending stiffness and modulus of elasticity according to EN 1995-1-1, Annex B, Equation (B.1). However, the term s_i/K_i appearing in EN 1995-1-1, Annex B, Equation (B.5) shall be substituted by $d_i/G \cdot b$.

| | | |
|----------|-----|--|
| I_{ef} | ... | effective moment of inertia |
| s_i | ... | spacing according to EN 1995-1-1 (not relevant for solid wood slab) |
| K_i | ... | slip modulus according to EN 1995-1-1 (not relevant for solid wood slab) |
| d_i | ... | thickness of the perpendicular board |
| G | ... | shear modulus of the board perpendicular to the grain; $G = 50$ MPa |
| b | ... | width of the glue joint; for calculation normally $b = 100$ cm |

Alternatively, the shear analogy method may be used for a larger number of layers.

The characteristic values shall be determined in accordance with EN 14358, Clause 4, taking into account the factor k_s according to Table 1 for the relevant number of samples.

The characteristic bending strength in MPa and the mean value of the modulus of elasticity in MPa shall be declared in the ETA.

2.2.1.2 Tension and compression

Load bearing capacity and stiffness in tension and compression shall be calculated according to EN 1995-1-1, Clause 6.1.2, 6.1.4 and 6.1.5. Hereby, values corresponding to the relevant strength classes according to EN 338 shall be used.

Tension perpendicular to the solid wood slab shall be avoided. Fasteners shall be applied to cover tension forces perpendicular to the solid wood slab.

Alternatively, testing and calculation according to EN 408. The characteristic values shall be determined in accordance with EN 14358, Clause 4, taking into account the factor k_s according to Table 1 for the relevant number of samples.

2.2.1.3 Shear

Testing in 4-point-test according to EN 408 with 45 cm distance of load application to the supports. In addition the principles for slab-like specimens, for shear perpendicular to the plane, as given in EN 789 have to be observed.

Measurement of local deformations according to EN 408.

Table 3: Number and dimensions of shear tests samples

| | Number of tests | Width w | Span l_A | Length L | Height H |
|--|----------------------------------|--|------------|-----------------------------------|--|
| | | m | m | m | mm |
| Shear perpendicular to the plane of the CLT (cover layers parallel to the span) | 20 per relevant number of layers | ~ 0.8 | ~ 3.0 | overlap at supports \geq 100 mm | according to relevant number of layers |
| Shear in plane of the CLT* (cover layers parallel to the span) | 15 per relevant number of layers | according to relevant number of layers | ~ 3.5 | overlap at supports \geq 100 mm | 400 |

* For every specimen the layers parallel to the span shall be provided with an approx. 3 mm wide open joint in the middle of the height.

For shear perpendicular to the plane of the CLT calculation of the effective moment of inertia and therewith of the effective shear stiffness and shear modulus according to EN 1995-1-1, Annex B, Equation (B.1). However, the term s_i/K_i appearing in EN 1995-1-1, Annex B, Equation (B.5) shall be substituted by $d_i/G \cdot b$.

| | | |
|-------|-----|---|
| s_i | ... | spacing according to EN 1995-1-1 (not relevant for solid wood slab) |
|-------|-----|---|

| | | |
|-------|-----|--|
| K_i | ... | slip modulus according to EN 1995-1-1 (not relevant for solid wood slab) |
| d_i | ... | thickness of the perpendicular board |
| G | ... | shear modulus of the board perpendicular to the grain; $G = 50$ MPa |
| b | ... | width of the glue joint; for calculation normally $b = 100$ cm |

Alternatively, the shear analogy method may be used for a larger number of layers.

For shear in plane of the CLT the net cross-section shall be used to calculate the shear strength and the shear modulus.

The characteristic values shall be determined in accordance with EN 14358, Clause 4, taking into account the factor k_s according to Table 1 for the relevant number of samples.

The characteristic shear strength in MPa and the mean value of the shear modulus in MPa shall be declared in the ETA.

2.2.1.4 Embedment strength

Normally the limitation of the embedding depth is sufficient to characterise the embedment strength. If necessary, testing of embedment strength shall be performed according to EN 383.

2.2.1.5 Creep and duration of load

Factors k_{mod} and k_{def} as specified in EN 1995-1-1, Table 3.1 and Table 3.2, shall be used.

2.2.1.6 Dimensional stability

Tolerances of dimensions

The solid wood slab shall have manufacturing tolerances within such limits, that its performance and stability will be maintained. Dimensions and deviations of solid wood slab elements shall be measured and determined according to EN 1309-1.

The manufacturing tolerances of the solid wood slab shall be declared by the manufacturer. These dimensions shall follow the applicable specifications of EN 336.

Stability of dimensions

The dimensional changes of the solid wood slab due to varying moisture content shall not have inadmissible effects on its performance and stability.

The moisture content at time of shipping shall be declared by the manufacturer.

Thermal expansion

Thermal expansion is governed by the thermal expansion coefficient. For timber structures in buildings, thermal expansion is normally not relevant, as it interferes with much larger moisture effects.

If not proven otherwise, the thermal expansion coefficient parallel to the grain as given in EN 1991-1-5 shall be used. Normally, thermal expansion is not relevant for timber structures.

2.2.1.7 In-service environment

Durability of timber shall be assessed according to EN 335, Table 1, EN 350-2, Table 2, and EN 460.

The service classes according to EN 1995-1-1, Clause 2.3.1.3 shall be given.

2.2.1.8 Bond integrity

Only structural adhesives with suitable behaviour in fire and suitable long term behaviour shall be used. These conditions are deemed to be satisfied for the following adhesives:

- Adhesives according to EN 301
- Adhesives according to EN 15425

The adhesives used in the product shall be described in the ETA. For the adhesives used for the surface bonding between layers, for the bonding of adjacent boards and for the finger joints the type of adhesive as well as specific provisions for their use according to EN 301 or EN 15425 shall be stated.

Testing of bond line integrity by delamination tests according to EN 14080, Method B. After the delamination treatment the glue lines shall be opened and the percentage of wood failure shall be determined.

Total delamination ≥ 75 % amount of wood fibre fracture.

Single glue line ≥ 50 % amount of wood fibre fracture.

2.2.2 Safety in case of fire

2.2.2.1 Reaction to fire

The solid wood slab is considered to satisfy the requirements for performance class D-s2,d0 of the characteristic reaction to fire in accordance with the EC Decision 2005/610/EC without the need for testing on the basis of it fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

Therefore the performance of the product is D-s2,d0.

When the product does not meet the provisions of EC Decision 2005/610/EC or when a higher classification is sought, the solid wood slab shall be tested, using the test method(s) relevant for the corresponding reaction to fire class, in order to be classified according to EN 13501 1.

2.2.2.2 Resistance to fire

The resistance to fire performance shall be tested and classified according to EN 13501-2.

Alternatively resistance to fire can be calculated on the basis of EN 1995-1-2 and the assumption as given in 2.2.1. The charring rates from tests performed shall be given. The direction of the grain of the layers of the solid wood slab shall be carefully observed.

2.2.3 Hygiene, health and environment

2.2.3.1 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer using the following methods and criteria: EOTA TR034

2.2.3.2 Water vapour permeability – water vapour transmission

Declaration of design values according to EN ISO 10456.

2.2.4 Safety and accessibility in use

2.2.4.1 Impact resistance

Soft body resistance is assumed to be fulfilled for walls with a minimum of 3 layers and minimum thickness of 60 mm.

If relevant, testing according to EOTA TR001.

2.2.5 Protection against noise

2.2.5.1 Airborne sound insulation

Testing according to EN ISO 10140-2 considering EN ISO 10140-1 and EN ISO 10140-5 and declaration of results according to EN ISO 717-1.

2.2.5.2 Impact sound insulation

Testing according to EN ISO 10140-3 considering EN ISO 10140-1 and EN ISO 10140-5 and declaration of results according to EN ISO 717-2.

2.2.5.3 Sound absorption

Testing according to EN ISO 354 and declaration of results according to EN ISO 11654.

2.2.6 Energy economy and heat retention

2.2.6.1 Thermal conductivity

Declaration of design values according to EN ISO 10456.

2.2.6.2 Air permeability

Testing and declaration of results according to EN 12114.

2.2.6.3 Thermal inertia

Declaration of design values according to EN ISO 10456.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance

For the product covered by this EAD the applicable European legal act is: 1997/176/EC of the European Commission² as amended by 2001/596/EC³

The system to be applied is: 1

3.2 Tasks of the manufacturer

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

Table 4 Control plan for the manufacturer; cornerstones

| No | Subject/type of control | Test or control method | Criteria, if any | Minimum number of samples | Minimum frequency of control |
|---|-----------------------------------|---|------------------------------------|---------------------------|---|
| Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]* | | | | | |
| 1 | Finger joints | Bending test according to EN 14080 and EN 408 | EN 14080 | 3 | Per working shift |
| 2 | Bonding of cross laminated timber | 2.2.1.8 ¹⁾ | 2.2.1.8 | 1 | Per clamping operation |
| 3 | Dimensions | — | According to customers declaration | 1 | Per day and per changeover of working shift |

¹⁾ The position of the specimen within the solid wood slab element shall be changed for each sampling.

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for solid wood slab elements are laid down in Table 5.

² OJEU L 73 of 14 March 1997

³ OJEU L 209/33 of 2 August 2011

Table 5 Control plan for the notified body; cornerstones

| No | Subject/type of control | Test or control method | Criteria, if any | Minimum number of samples | Minimum frequency of control |
|---|--|------------------------|------------------|---------------------------|------------------------------|
| Initial inspection of the manufacturing plant and of factory production control | | | | | |
| 1 | The notified body shall ascertain that, in accordance with the control plan, the manufacturing plant of the single product manufacturer, in particular personnel and equipment, and the factory production control are suitable to ensure a continuous and orderly manufacturing of the solid wood slab element according the European Technical Assessment. | | | | — |
| Continuous surveillance, assessment and evaluation of factory production control | | | | | |
| 2 | It shall be verified that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan. | | | | 2/year |

4 REFERENCE DOCUMENTS

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

EOTA TR001 (2003-02): EOTA Technical Report for Determination of impact resistance of panels and panel assemblies

EOTA TR034 (2012-03): EOTA Technical Report for General ER 3 Checklist for ETAGs/CUPAs/ETAs-Content and/or release of dangerous substances in products/kits

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

EN 335: Durability of wood and wood-based products — Use classes: definitions, application to solid wood and wood-based products

EN 336: Structural timber — Sizes, permitted deviations

EN 338: Structural timber — Strength classes

EN 350-2: Durability of wood and wood-based products — Natural durability of solid wood — Part 2: Guide to natural durability and treatability of selected wood species of importance in Europe

EN 383: Timber structures — Test methods — Determination of embedment strength and foundation values for dowel type fasteners

EN 408: Timber structures — Structural timber and glued laminated timber — Determination of some physical and mechanical properties

EN 460: Durability of wood and wood-based products — Natural durability of solid wood — Guide to the durability requirements for wood to be used in hazard classes

EN 789: Timber structures — Test methods — Determination of mechanical properties of wood based panels

EN 1309-1: Round and sawn timber — Method of measurement of dimensions — Part 1: Sawn timber

EN 1991-1-5: Eurocode 1: Actions on structures — Part 1-5: General actions — Thermal actions

EN 1995-1-1: Eurocode 5 — Design of timber structures — Part 1 1: General – Common rules and rules for buildings

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

EN 12114: Thermal performance of buildings — Air permeability of building components and building elements — Laboratory test method

EN 13238: Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates

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

EN 13501-2: Fire classification of construction products and building elements — Part 2: Classification using data from fire resistance tests, excluding ventilation services

EN 14080: Timber structures — Glued laminated timber and glued solid timber — Requirements

EN 14358: Timber structures — Calculation of characteristic 5-percentile values and acceptance criteria for a sample

EN 15425: Adhesives — One component polyurethane for load bearing timber structures — Classification and performance requirements

EN ISO 354: Acoustics — Measurement of sound absorption in a reverberation room

EN ISO 717-1: Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation

EN ISO 717-2: Acoustics — Rating of sound insulation in buildings and of building elements — Part 2: Impact sound insulation

EN ISO 10140-1: Acoustics — Laboratory measurement of sound insulation of building elements — Part 1: Application rules for specific products

EN ISO 10140-2: Acoustics — Laboratory measurement of sound insulation of building elements — Part 2: Measurement of airborne sound insulation

EN ISO 10140-3: Acoustics — Laboratory measurement of sound insulation of building elements — Part 3: Measurement of impact sound insulation

EN ISO 10140-5: Acoustics — Laboratory measurement of sound insulation of building elements — Part 5: Requirements for test facilities and equipment

EN ISO 10456: Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values

EN ISO 11654: Acoustics — Sound absorbers for use in buildings — Rating of sound absorption