



## EUROPEAN ASSESSMENT DOCUMENT

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# SOLID WOOD SLAB ELEMENT – ELEMENT OF TIMBER BOARDS JOINTED BY DOVETAIL CONNECTIONS TO BE USED AS A STRUCTURAL ELEMENT IN BUILDINGS

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

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## 1 SCOPE OF THE EAD

### 1.1 Description of the construction product

The solid wood slab element - element of timber boards jointed by dovetail connections is made of sawn solid wood boards. The boards are arranged in layers with parallel direction of grain. Within one layer the boards are assembled in key and slot. Two or more layers are connected via dovetail connections to archive a greater thickness, see Figure 1 a). A solid wood slab element can consist of minimum 2 and up to 6 layers. Additionally, joists may be added to achieve a higher bending resistance. In combination with joists at least one layer is connected, see Figure 1 b). The dovetail battens connecting the layers and the joists are perpendicular to the board direction.

The solid wood slab element is manufactured with a maximum thickness of approximately 360 mm (6 layers of thickness of 60 mm) and a length and width according to the needs.

The sawn solid wood boards may be finger jointed.

Wood species is European spruce (*Picea abies*), pine (*Pinus sylvestris*) or Larch (*Larix decidua*) for the sawn solid wood boards and European spruce (*Picea abies*) or ash (*Fraxinus excelsior*) for the dovetail battens.

Figure 1 shows the principle structure of the solid wood slab element used as walls and as floors. Figure 2 shows examples of the cross section, these examples are not exhaustive.

The surface preparations of the products (planed or grinded, etc.) shall be stated in the ETA.

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

No recycled wood has been used.

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

Figure 1: Principle structure of the solid wood slab element - element of timber boards jointed by dovetail connections a) used as walls and b) used as floors or roofs - Example

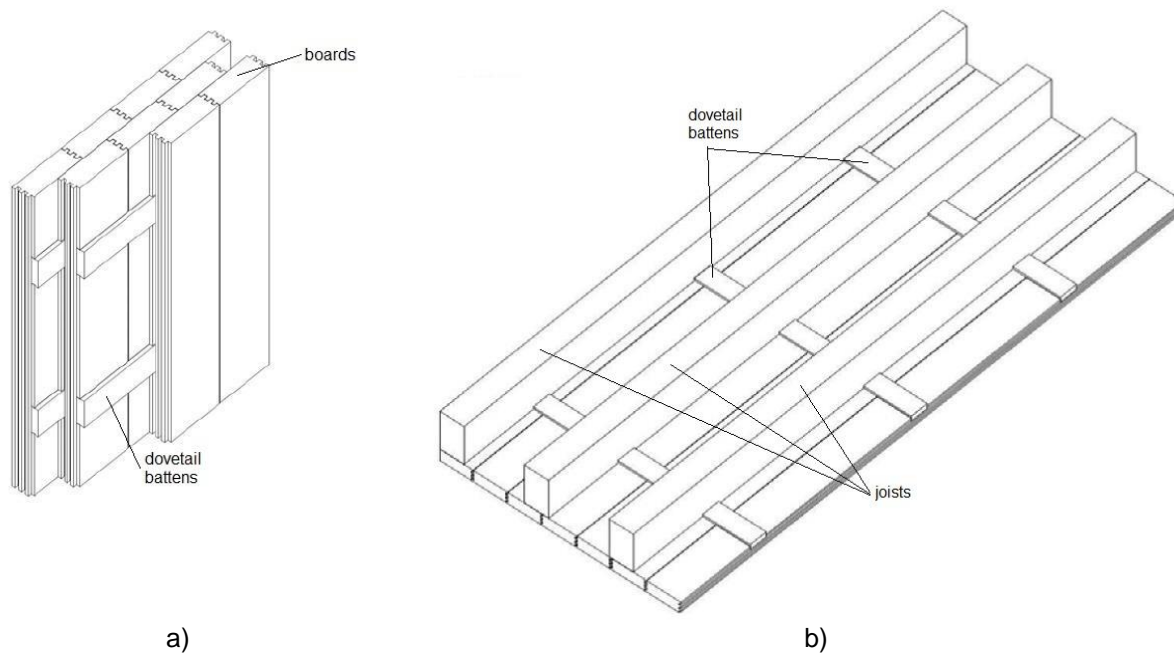
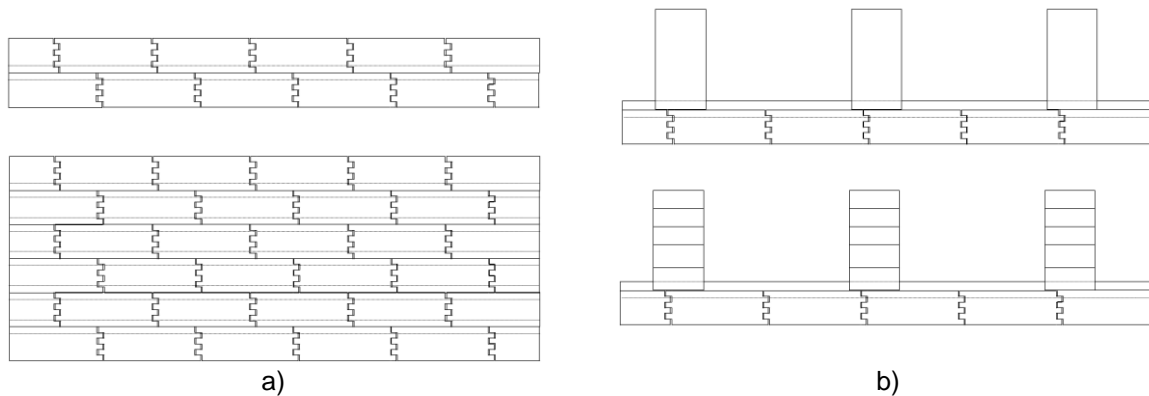


Figure 2: Typical cross sections of the structure of the solid wood slab element - element of timber boards jointed by dovetail connections a) used as walls and b) used as floors or roofs



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 element is intended to be used as a structural element in buildings to construct walls, floors and roofs (simple buildings e.g. covering stands or covering bus stops are included as well) in service class 1 and 2 according to EN 1995-1-1.

The solid wood slab element is subjected to static and quasi static actions only.

Within a roof construction, the solid wood slab element will not contribute to the water tightness, but will receive a suitable waterproofing and roof covering. Waterproofing and roof covering are not subject of EAD and ETA.

### 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. 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 works<sup>1</sup>.

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

<sup>1</sup> 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.

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.

## 2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

### 2.1 Essential characteristics of the product

Table 1 and Table 2 show how the performance of the solid wood slab element is assessed in relation to the essential characteristics of the following product-types:

- solid wood slab elements made of finger jointed sawn solid wood boards
- solid wood slab element made of sawn solid wood boards without finger joints

**Table 1 Essential characteristics of the solid wood slab elements made of finger jointed sawn solid wood boards and methods and criteria for assessing the performance of the product in relation to those essential characteristics**

No	Essential characteristic	Assessment method	Type of expression of product performance
<b>Basic Works Requirement 1: Mechanical resistance and stability <sup>1)</sup></b>			
1	Bending <sup>2)</sup>	2.2.1	Description, level
2	Tension and compression <sup>2) 3)</sup>	2.2.2	Description, level
3	Shear capacity of dovetail connections	2.2.3	Description, level
4	Torsion	2.2.4	Description, level
5	Shear walls	2.2.5	Description, level
6	Buckling	2.2.6	Description, level
7	Embedment strength	2.2.7	Description, level
8	Creep and duration of the load	2.2.8	Description, level
9	Dimensional stability	2.2.9	Description, level
10	Durability	2.2.10	Description
11	Bond integrity of finger joints	2.2.11	Description
<b>Basic Works Requirement 2: Safety in case of fire</b>			
12	Reaction to fire	2.2.12	Class
13	Resistance to fire	2.2.13	Description, level
<b>Basic Works Requirement 3: Hygiene, health and the environment</b>			
14	Water vapour permeability – Water vapour transmission	2.2.14	Description, level

Basic Works Requirement 4: Safety and accessibility in use			
16	Same as BWR 1		
Basic Works Requirement 5: Protection against noise			
17	Airborne sound insulation	2.2.15	Description, level
18	Impact sound insulation	2.2.16	Description, level
19	Sound absorption	2.2.17	Description, level
Basic Works Requirement 6: Energy economy and heat retention			
20	Thermal conductivity	2.2.18	Description, level
21	Air permeability	2.2.19	Description, level
22	Thermal inertia	2.2.20	Description, level
1)	This characteristic also relates to BWR 4.		
2)	Load bearing capacity and stiffness regarding mechanical actions perpendicular to the solid wood slab element.		
3)	Load bearing capacity and stiffness regarding mechanical actions in plane of the solid wood slab element.		

**Table 2 Essential characteristics of the solid wood slab element made of sawn solid wood boards without finger joints and methods and criteria for assessing the performance of the product in relation to those essential characteristics**

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability <sup>1)</sup>			
1	Bending <sup>2)</sup>	2.2.1	Description, level
2	Tension and compression <sup>2) 3)</sup>	2.2.2	Description, level
3	Shear capacity of dovetail connections	2.2.3	Description, level
4	Torsion	2.2.4	Description, level
5	Shear walls	2.2.5	Description, level
6	Buckling	2.2.6	Description, level
7	Embedment strength	2.2.7	Description, level
8	Creep and duration of the load	2.2.8	Description, level
9	Dimensional stability	2.2.9	Description, level
10	Durability	2.2.10	Description
Basic Works Requirement 2: Safety in case of fire			
11	Reaction to fire	2.2.12	Class
12	Resistance to fire	2.2.13	Description, level

Basic Works Requirement 3: Hygiene, health and the environment			
13	Water vapour permeability – Water vapour transmission	2.2.14	Description, level
Basic Works Requirement 4: Safety and accessibility in use			
14	Same as BWR 1		
Basic Works Requirement 5: Protection against noise			
15	Airborne sound insulation	2.2.15	Description, level
16	Impact sound insulation	2.2.16	Description, level
17	Sound absorption	2.2.17	Description, level
Basic Works Requirement 6: Energy economy and heat retention			
18	Thermal conductivity	2.2.18	Description, level
19	Air permeability	2.2.19	Description, level
20	Thermal inertia	2.2.20	Description, level
1)	This characteristic also relates to BWR 4.		
2)	Load bearing capacity and stiffness regarding mechanical actions perpendicular to the solid wood slab element.		
3)	Load bearing capacity and stiffness regarding mechanical actions 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

### Mechanical resistance and stability

Mechanical resistance and stability can be verified by combinations of calculations and tests (also referred to as design assisted by testing). Design assisted by testing can be used to apply test results obtained from one type of structure to another type (e.g. varying thickness or lay-up) or to another use condition (e.g. humidity or eccentricity of the load). Stress distribution within the solid wood slab shall be calculated taking into account the shear deformation of the dovetail batten and the deformation between the dovetail batten and the boards within the dovetail connection.

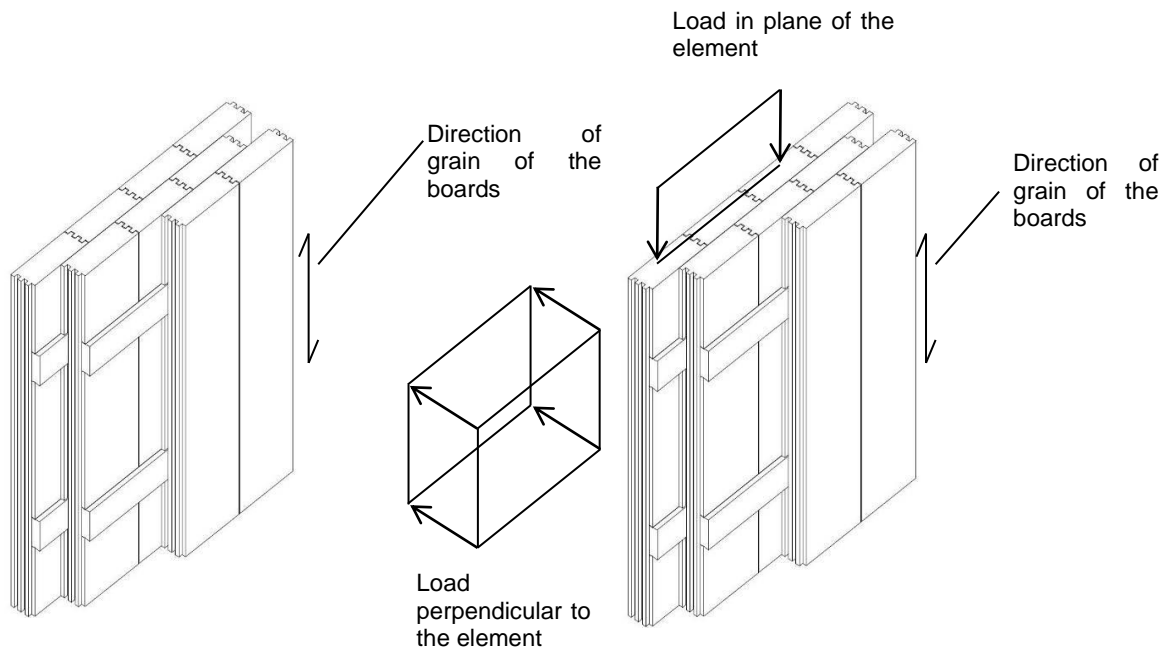
Design assisted by testing shall be carried out according to EN 1990. Accompanying calculations shall be based on EN 1995-1-1.

When characteristic values shall be determined, the number of tests for each configuration shall be at least 10, but depending on coefficient of variation. Tests which aim to confirm or to compare assumptions and models require smaller numbers of tests. At least 6 tests shall be performed for each configuration or 3 tests for simple items.

Tests, and the analysis of tests, shall be based on reference standards of EN 1995-1-1 and on harmonised product standards, so that the resulting properties are compatible with the Eurocode system.



Figure 3: Action perpendicular to the solid wood slab element and action in plane of the solid wood slab element



### 2.2.1 Bending

For load bearing capacity and stiffness regarding mechanical actions perpendicular to the solid wood slab element, bending tests shall be performed following EN 408, Clause 19 as well as Clause 9 and 10, observing principles as given in EN 789.

Vector of momentum shall be in plane of the solid wood slab element and perpendicular to the grain of the boards. Tests shall be performed with different configurations of solid wood slab elements jointed by dovetail connections, e.g. number and thicknesses of boards, spacing of dovetail connections.

For the bending tests load deflections plots, both local and global, shall be recorded. Some of these tests shall include at least three loading and unloading cycles, preferably at serviceability load level with at least 30 % unloading of the applied load.

The bending stiffness  $(EI)_{ef}$  of the slab elements shall be determined at different load levels, e.g. at serviceability load and close to ultimate load.

The load bearing capacity is defined as the ultimate moment  $M_u$  of the test.

Calculation shall follow EN 1995-1-1. For two or three layers EN 1995-1-1, Annex B may be applied. More than three of such layers will require the advanced procedures of these methods (advanced  $\gamma$ -method) or numerical methods. An example of a suitable method is described in EOTA Technical Report EOTA TR 019, section C.1. Further guidance on other numerical methods is given further down in EOTA TR 019.

The contribution of the dovetail connections will be considered by shear stiffness. This shear stiffness shall be determined in shear tests, evaluated with the above mentioned calculations.

The mechanical characteristics of the single layers shall be taken from EN 338 according to the strength class of the boards. The factor  $k_{sys}$  from EN 1995-1-1 shall not be applied.

The characteristic values shall be determined in accordance with EN 14358, Clause 4.

In the course of bending tests, the finger joints in the sawn solid wood boards shall be tested according to EN 14080, Annex E, on 30 samples per wood board thickness.

Bending strength of finger joints shall conform to  $f_{m,j,k} \geq (8 + 1,4 \cdot f_{t,0,l,k}) \cdot k_{mod}$ , where  $f_{t,0,l,k}$  is the tension strength of the respective solid wood board.

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

### 2.2.2 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. The technical strength classes specified in EN 338 shall be considered.

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

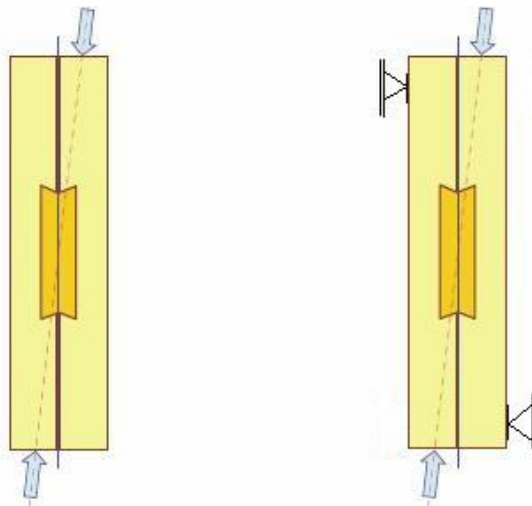
### 2.2.3 Shear capacity of dovetail connections

Determination of load-bearing capacity and stiffness of dovetail connections loaded in shear parallel to the longitudinal direction of the connection (rolling shear). Consideration of free and restrained clamping effect on load-bearing capacity of dovetail connection subjected to pressure and shear.

Shear tests shall be performed following the principle of EN 408, Clause 18.

Figure 4 shows the test method to determine the shear capacity of the dovetail connection.

Figure 4: Test configuration to determine the shear stiffness of the dovetail connection - consideration of free and restrained clamping effect



The characteristic values shall be determined in accordance with EN 14358, Clause 4.

The characteristic shear strength and deformation stiffness  $k_s$  shall be stated in the ETA.

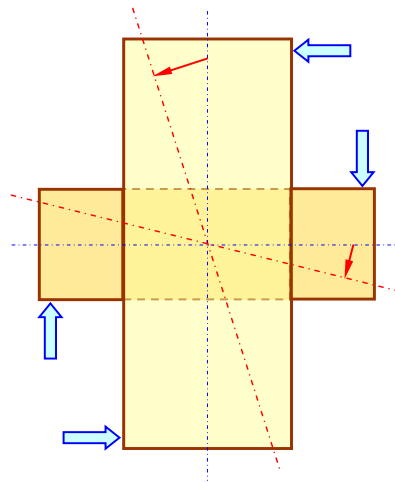
### 2.2.4 Torsion

Determination of load-bearing capacity in torsion between solid wood board and dovetail connection.

Two solid wood boards of width approx. 160 mm and length 500 mm are connected via dovetail battens and mounted into an articulated frame of square shape. The load introduction into the solid wood boards as well as into the dovetail battens is performed by pulling on the articulated frame. Rotation is measured by inductive displacement transducers at the lateral side of the solid wood boards.

Figure 5 shows the test method to determine the momentum load bearing capacity and torsion stiffness of the dovetail connection.

Figure 5: Test configuration to determine the momentum load bearing capacity and torsion stiffness of the dovetail connection.



The characteristic values shall be determined by calculation assisted by testing and in accordance with EN 14358, Clause 4.

The momentum load bearing capacity per node  $m_{\phi,k,1}$  and torsional stiffness  $C_{\phi}$  shall be stated in the ETA.

### 2.2.5 Shear walls

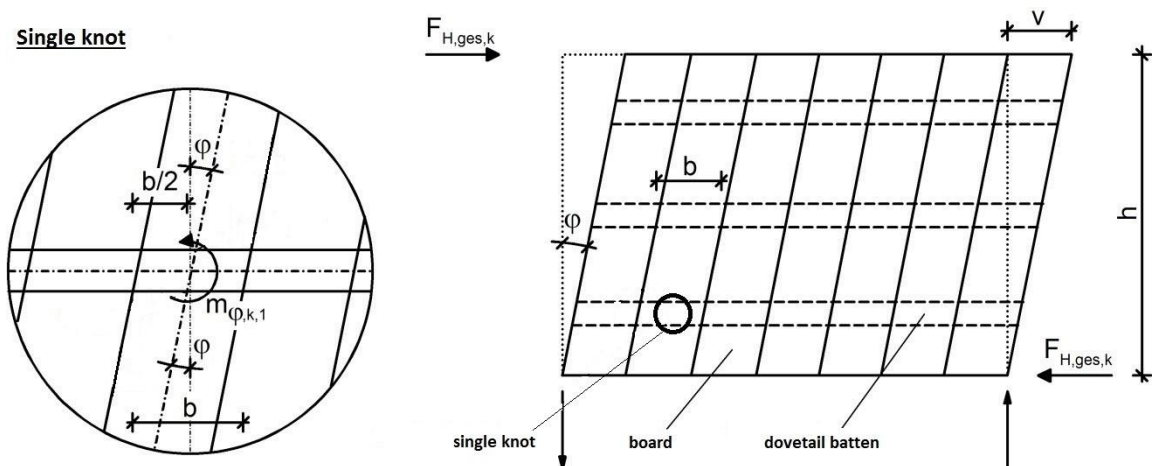
Shear tests shall be performed following EN 594. Testing of shear walls shall be applied with all configurations intended for load configurations.

For the tests, load deflections plots shall be recorded. Stiffness of the slab elements shall be determined at different load levels, e.g. at serviceability load and close to ultimate load. Some of these tests shall include at least three loading and unloading cycles, preferably at serviceability load level with at least 30 % unloading of the applied load.

The load bearing capacity is defined as the ultimate shear force of the test.

Calculation of stiffness and shear capacity of shear walls shall be performed by the following method:

Figure 6: Calculation of stiffness and shear capacity of shear walls



#### Verification of the dovetail connection:

- total momentum per element (SLS)

$$M_{\phi,k} = F_{H,ges,k} \times h \text{ [Nm]}$$

- number of nodes of two-layer elements

$$n_{No} = n_{Bo} \times n_{DoB} - n_{No,op}$$

$n_{No}$  = number of nodes

$n_{Bo}$  = number of boards per layer

$n_{DoB}$  = number of dovetail batten

$n_{No,op}$  = number of nodes, omitted by openings

- number of effective nodes of multi-layer elements

$n_{No,eff} = n_{No} \times (0.8n_{Lay} - 0.6)$  with  $n_{Lay} \geq 2$

- momentum loading per node (SLS)

$m_{\varphi,k,1} = M_{\varphi,k} / n_{No,eff}$  [Nm]

- rotation of single node (corresponds with deformation of the wall)

$\varphi_{k,1} = m_{\varphi,k,1} / C_{\varphi}$  [°]

The torsion stiffness  $C_{\varphi}$  [Nm/°] respectively the relation between momentum and rotation shall be determined according to 2.2.4.

The load bearing capacity of shear walls shall be calculated by

$R_{H,tot,k} = R_{m\varphi,k,1} \times n_{No,eff}$

The momentum load bearing capacity per node (SLS)  $m_{\varphi,k,1}$  [Nm] may be determined according to 2.2.4.

The load bearing capacity of shear walls  $R_{H,tot,k}$  and the shear wall stiffness shall be stated in the ETA. In case of tested walls, the values are valid for the tested configuration only.

## 2.2.6 Buckling

Calculation according to EN 1995-1-1, Clause 6.3. The strength classes specified in EN 338 shall be considered.

## 2.2.7 Embedment strength

Determination according to EN 1995-1-1, Clause 8.

## 2.2.8 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.

## 2.2.9 Dimensional stability

### Tolerances of dimensions

The manufacturing tolerances of the solid wood slab shall be declared by the manufacturer.

### Stability of dimensions

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, Table C.1 shall be used. Normally, thermal expansion is not relevant for timber structures.

## 2.2.10 Durability

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.

### **2.2.11 Bond integrity of finger joints**

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 type I according to EN 301
- Adhesives type I according to EN 15425 and EN 14080, Annex B.2.

### **2.2.12 Reaction to fire**

The solid wood slab is considered to satisfy the requirements for performance class D-s2,d0 (excluding floorings) and class D<sub>FL</sub>-s1 for floorings of the characteristic reaction to fire in accordance with the EC Decision 2003/43/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 (excluding floorings) and class D<sub>FL</sub>-s1 for floorings.

If the above mentioned EC decision is not applicable, the solid wood slab element 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.

### **2.2.13 Resistance to fire**

The part of the works or assembled system in which the solid wood slab element is intended to be incorporated, installed or applied shall be tested, using the test method relevant for the corresponding fire resistance class, in order to be classified according to EN 13501-2.

### **2.2.14 Water vapour permeability – water vapour transmission**

Declaration of design values according to EN ISO 10456.

### **2.2.15 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.

### **2.2.16 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.

### **2.2.17 Sound absorption**

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

### **2.2.18 Thermal conductivity**

Declaration of design values according to EN ISO 10456.

### **2.2.19 Air permeability**

Testing and declaration of results according to EN 12114.

### 2.2.20 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 to be applied

For the products covered by this EAD the applicable European legal act is: Decision 1997/176/EC, amended by Decision 2001/596/EC

The system is: **1** for solid wood slab elements made of finger jointed sawn solid wood boards

The system is: **2+** for solid wood slab element made of sawn solid wood boards without finger joints

### 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 3.

**Table 3 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
<b>Factory production control (FPC)</b> [including testing of samples taken at the factory in accordance with a prescribed test plan]*					
1	Visual inspection of mechanically jointed solid wood slab elements	(1)	(1)	3	100 %
2	Visual inspection of boards and dovetail battens	(1)	(1)	1	5 %
3	Testing of boards and dovetail battens for dimensions, moisture content, density	(1)	(1)	1	1 %, at least 5
4	Finger joints (if relevant)	EN 14080	EN 14080	EN 14080	EN 14080

<sup>(1)</sup> According to the specification and configuration of the mechanically jointed solid wood slab elements and their components.

### 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 4.

**Table 4 Test 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
<b>Initial inspection of the manufacturing plant and of factory production control</b>					
1	The notified body shall ascertain that, in accordance with the test 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.				—
<b>Continuous surveillance, assessment and evaluation of factory production control</b>					
2	It shall be verified that the system of factory production control and the specified manufacturing process are maintained taking account of the test 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 TR 019 (2005-02): Calculation models for prefabricated wood-based loadbearing stressed skin panels for use in roofs

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 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 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 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 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