Deutsches Institut für Bautechnik

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment

ETA-06/0009 of 7 April 2016

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	Binderholz Brettsperrholz BBS
Product family to which the construction product belongs	Binderholz Brettsperrholz BBS Multilayered timber elements for walls, ceilings, roofs and special construction components
Manufacturer	Binderholz Bausysteme GmbH Zillertalstraße 39 6263 FÜGEN ÖSTERREICH
Manufacturing plant	W01, W02, W03, W04
This European Technical Assessment contains	19 pages including 5 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	European Assessment Document (EAD) 130005-00-0304
This version replaces	ETA-06/0009 issued on 19 June 2013

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Specific part

1 Technical description of the product

"*Binderholz Brettsperrholz BBS*" are plane timber building components which are made of at least three layers of softwood boards. Adjacent layers are glued together with an angle of 90°. The cross section of the elements is symmetric. The term symmetry only refers to the properties of the product which are relevant for the load-bearing capacity: geometry (grain direction of the longitudinal and cross layers) and strength of the applied timber (grading and classification).

The components and the system setup of the elements are given in Annex 1.

Two adjacent layers may be oriented with parallel grain direction if a symmetric and crosswise blocked structure is guaranteed.

Not load-bearing outer layers are permissible.

Building elements are plane.

The elements can be produced with a width up to 3.5 m and a length up to 22 m as *Großformat* and with a width up to 1.25 m und a length up to 5 m as *Systemformat.*

By cutting after the production more narrow elements can be fabricated.

The building components in *Systemformat* with a width up to 1.25 m may be connected in the plant in longitudinal direction by large finger jointing in accordance with EN 14080[1] to a length of up to 24 m.

The application of chemical substances (wood preservatives and flame-protective agents) is not subject of this European technical assessment.

Manufacturing

The cross laminated timber elements are manufactured in accordance with the provisions of this European technical assessment using the automated manufacturing process in accordance with the technical documentation.

The layers shall be bonded together to the required thickness of the cross laminated timber.

Specifications of the used boards are given in Annex 2. Boards are visually or machine strength graded. Only technically dried wood shall be used.

Only boards which are planed on both sides of the outer layer shall be used. The boards may be connected by finger joints in longitudinal direction according to EN 14080. There shall be no butt joints.

The boards of the longitudinal layers of the *Großformat* have grooves with a width of 4 mm in grain direction. The distances of the grooves from the edge and among each other must be in a range of 40 mm to 80 mm. The remaining thickness of the board under the groove must be 50 % of the thickness of the board at least.

The single boards of the layers in longitudinal direction may be glued at narrow side. The permissible width of the gap is given in Annex 2.

The solid wood slab elements correspond to the specifications given in Annexes 1 to 3 of this European technical assessment. The material characteristics, dimensions and tolerances of the solid wood slab elements not indicated in these Annexes are given in the technical documentation of the European technical assessment.

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[1] EN 14080:2013 Timber structures - Glued laminated timber and glued solid timber - Requirements

Design

The European Technical Assessment only applies to the manufacture and use of solid wood slab elements. Verification of stability of the building while using the solid wood slab elements is not subject of the European Technical Assessment.

The following conditions shall be observed:

- Design of the solid wood slab elements is carried out under the responsibility of an engineer experienced in such products.
- Design of the works shall account for the protection of the solid wood slab elements.
- The solid wood slab elements are installed correctly.

The design of the solid wood slab element can be performed according to EN 1995-1-1[2], taking into account Annexes 2 to 5 of the European Technical Assessment. Standards and regulations valid in the place of use shall be considered.

Packaging, transport, storage, maintenance and repair

The solid wood slab elements shall be protected during transport and storage against any damage and detrimental moisture effects. The manufacturer's instructions for packaging, transport and storage shall be observed.

The assessment of the fitness for use is based on the assumption that maintenance is not required during the assumed intended working life. In case of a severe damage of a solid wood slab element immediate actions regarding the mechanical resistance and stability of the works shall be initiated. Should this situation arise replacement of the elements can be necessary.

Installation

The manufacturer shall prepare assembling instructions in which the product-specific characteristics and important measures to be taken into consideration for assembling are described. The assembling instructions shall be available at every construction site.

The assembling of the solid wood slab elements according to this European technical assessment shall be carried out by appropriately qualified personnel.

Elements which are directly exposed to the weather shall be provided with an effective protection for the cross laminated timber element during assembling and service.

The safety-at-work and health protection regulations have to be observed.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The elements are intended to be used as load-bearing and/or stiffening or not load-bearing wall, ceiling/floor, roof and special construction components for timber structures. For the taking up and transmitting of loads they may be stressed both perpendicular to the element plane and in the element plane.

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

The solid wood slab element 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.

The performances given in Section 3 are only valid if the solid wood slab elements are used in compliance with the specifications and conditions given in Annex 1 to 5.

[2] EN 1995-1-1:2004+A1:2008+A2:2014 Eurocode 5: Design of timber structures – Part 1-1: General - Common rules and rules for buildings

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The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the solid wood slab element of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability [1)] (BWR 1)

Essential characteristic	Performance
Bending [2)]	Annex 3
Tension and compression [2)]	Annex 3
Shear [2)]	Annex 3
Embedment strength	Annex 3
Creep and duration of the load	Annex 3
Dimensional stability	Annex 3
In-service environment	Annex 3
Bond integrity	Annex 3

[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.

For gluing the board layers, for the finger joint connection of the individual boards and for the large finger joint connection an adhesive which meet the requirements of EN 301[3] shall be used. Alternatively a one component polyurethane adhesive which meets the requirements of EN 15425[4] and EN 14080[5], annex B.2 considering annex B.1, may be used.

Regarding the applicable type of adhesive national regulations apply.[6]

Details on the adhesives and the bonding process are deposited with Deutsches Institut für Bautechnik.

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Annex 3
Resistance to fire	Annex 3

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3 EN 301:2013 Adhesives, phenolic and aminoplastic, for load-bearing timber structures

4 EN 15425:2008 Adhesives – One component polyurethane for load bearing timber structures – Classification and performance requirements

5 EN 14080:2013 Timber structures – Glued laminated timber and glued solid timber - Requirements

6 In Germany adhesives of the type I are to be used.

3.3 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Content of dangerous substances	The manufacturer has submitted a written declaration to the Technical Assessment Body (DIBt) that no dangerous substances > 0.1 wt. % are used in the product assessed by the present ETA. Only wood based panels which can be assigned to formaldehyde class E1 according to EN 13986 shall be used. The use of wood preservatives and flame retardants is excluded. The chemical composition of the adhesives for gluing the board layers, the finger joint connection of the individual boards and the universal finger joint connection has to be in compliance with the chemical composition deposited at the Technical Assessment Body (DIBt).
Release scenarios regarding BWR 3	IA 1, IA 2
Water vapour permeability – Water vapour transmission	Annex 3

3.4 Safety and accessibility in use (BWR 4)

Essential characteristic	Performance
Impact resistance	Annex 3

3.5 Protection against noise (BWR 5)

Essential characteristic	Performance
Airborne sound insulation	Annex 3
Impact sound insulation	Annex 3
Sound absorption	Annex 3

3.6 Energy economy and heat retention (BWR 6)

Essential characteristic	Performance
Thermal conductivity	Annex 3
Air permeability	Annex 3
Thermal inertia	Annex 3

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3.7 Sustainable use of natural resources (BWR 7)

The performance of this product in terms of sustainable use of natural resources has not been investigated.

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with EAD No. 130005-00-0304 the applicable European legal act is: 1997/176/EC amended by 2001/596/EC

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 7 April 2016 by Deutsches Institut für Bautechnik

Andreas Kummerow
p.p. Head of Department

beglaubigt:
Deniz

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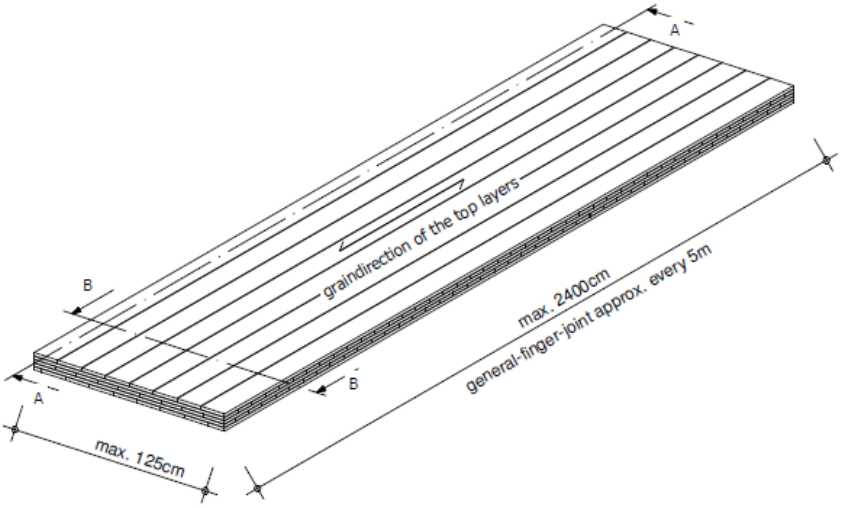

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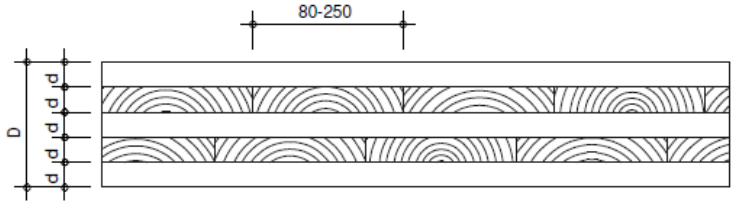

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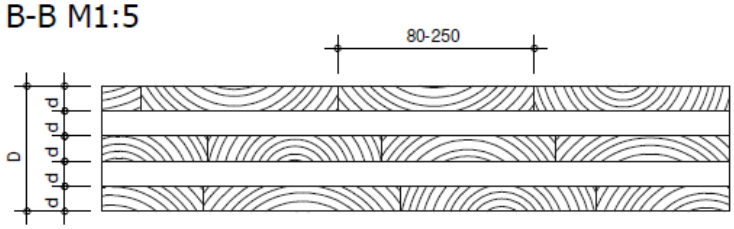

d= board thickness (18mm - 45mm)
D= element thickness (54mm - 350mm)

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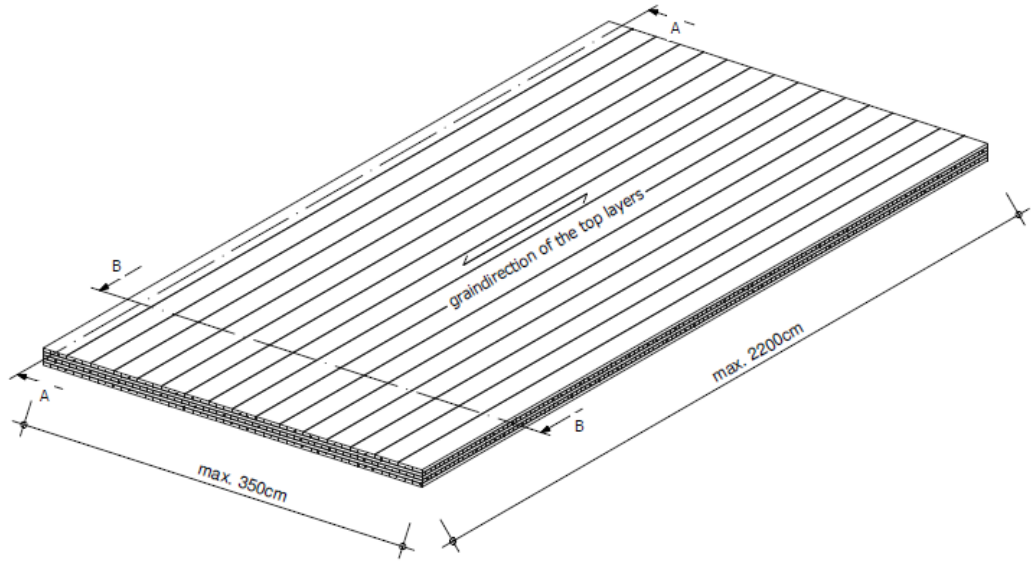
Binderholz Brettsperrholz BBS	Annex 1
Construction of a multilayered timber element of Systemformat	



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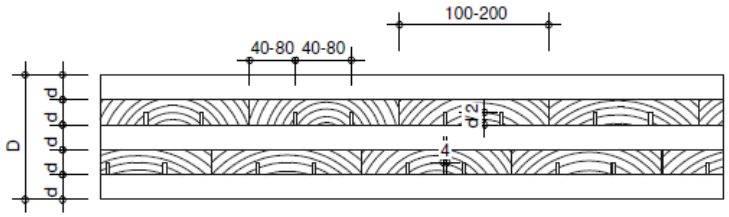

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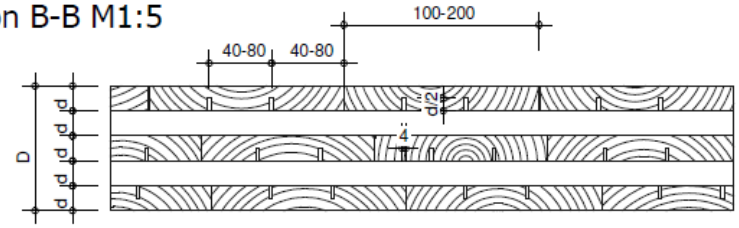

d= board thickness (17mm - 43mm)
D= element thickness (51mm - 215mm)

Binderholz Brettsperrholz BBS	Annex 1
Construction of a multilayered timber element of Großformat	

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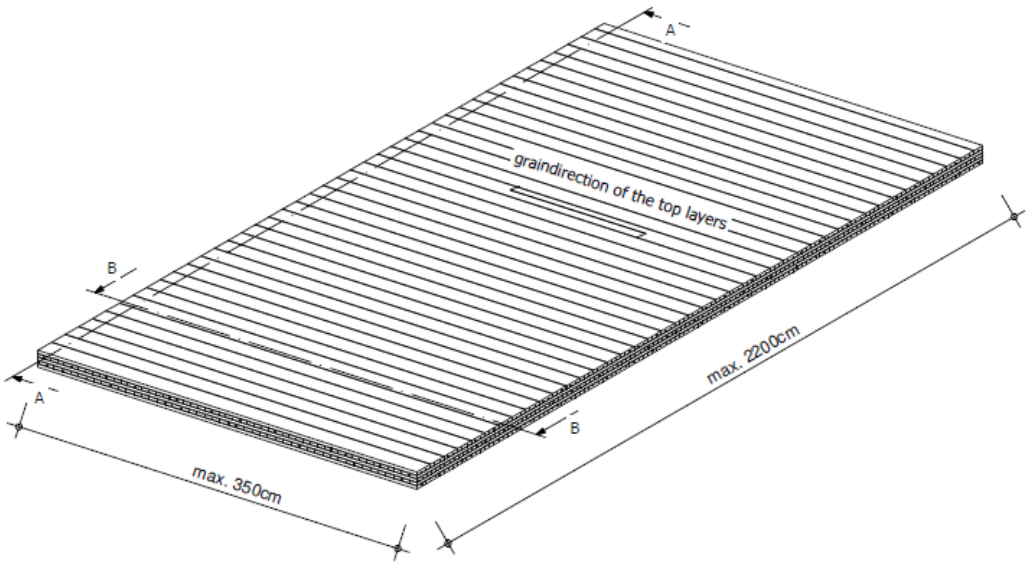

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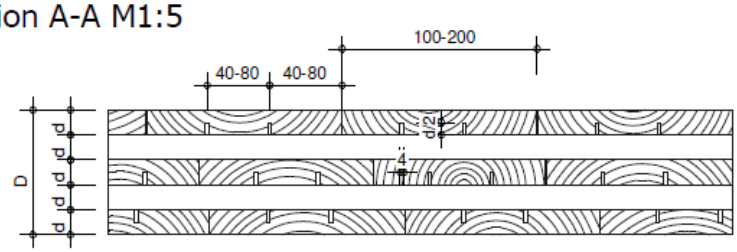

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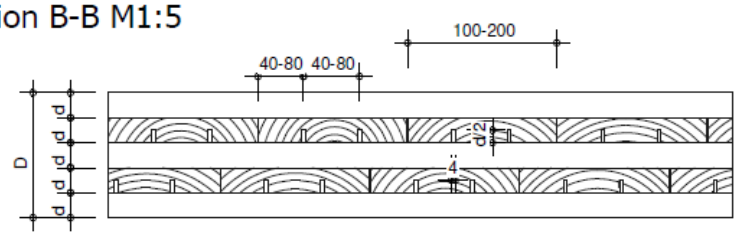

d= board thickness (17mm - 43mm)
D= element thickness (51mm - 215mm)

Binderholz Brettsperrholz BBS	Annex 1
Construction of a multilayered timber element of Großformat DQ	

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Table 1: Dimensions and specifications of the multilayered timber elements

Binderholz Brettsperrholz BBS "Systemformat"	
Characteristic	**Specification**
Thickness	54 to 350 mm
Tolerance in thickness	± 1 mm
Width	≤ 1.25 m
Tolerance in width	± 2 mm
Length	≤ 5 m
Tolerance in length (relating to a max. length up to 5 m)	± 2 mm
Length of the element with large finger joint	≤ 24 m
Number of layers	3 ≤ n ≤ 9
maximum number of consecutive layers having the same grain direction	≤ 2
maximum width of gap between the boards of a layer	4 mm
Large finger joints	according to EN 14080
Boards	
Material	softwood
Strength class according to EN 338[1] Cover layers / longitudinal layers (having the same grain direction as cover layers) Cross layer (having the a grain direction perpendicular to the cover layer)	 ≥ 90 % C24; < 10 % C16* ≥ 30 % C24; < 70 % C16**
Thickness	18 to 45 mm
Width	80 to 250 mm
Ratio width to thickness of the cross-layers	≥ 4:1
Moisture of wood according to EN 13183-2[2]	12 ± 2 %
Finger joints	according to EN 14080
* The proportion of wood of grade C16 may be disregarded by way of calculation. ** The proportion of wood of grade C24 shall be disregarded by way of calculation.	

[1] EN 338:2009 Structural timber - Strength classes
[2] EN 13183-2:2002 Moisture content of a piece of sawn timber – Part 2: Estimation by electrical resistance method

Binderholz Brettsperrholz BBS	Annex 2
Dimensions and specifications of the multilayered timber elements	

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Table 1 (continued)

***Binderholz Brettsperrholz BBS* "*Großformat*" and "*Großformat DQ*"**	
Characteristic	**Specification**
Thickness	51 to 215 mm
Tolerance in thickness	± 1 mm
Width	≤ 3.5 m
Tolerance in width	± 2 mm
Length	≤ 22 m
Tolerance in length (relating to a max. length up to 22 m)	± 2 mm
Number of layers	3 ≤ n ≤ 5
maximum number of consecutive layers having the same grain direction	≤ 2
maximum width of gaps between the boards of a layer	4 mm
Boards	
Material	softwood
Strength class according to EN 338 Cover layers / longitudinal layers (having the same grain direction as cover layers) Cross layers (having the grain direction perpendicular to the cover layers)	≥ 90 % C24; < 10 % C16*
Thickness	17 to 43 mm
Width	100 to 200 mm
Ratio width to thickness of the cross-layers	≥ 4:1
Moisture of wood according to EN 13183-2	12 ± 2 %
Finger joints	according EN 14080 mechanical resistance
* The proportion of wood of grade C16 may be disregarded by way of calculation.	

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Binderholz Brettsperrholz BBS	Annex 2
Dimensions and specifications of the multilayered timber elements	

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Table 2: Characteristic strength values and values of stiffness for "*Binderholz Brettsperrholz BBS*" in MN/m²

Kind of stress		Strength class of boards	
		C16	C24
Characteristic strength values			
Bending	$f_{m,k}$	16	24
Tension	$f_{t,0,k}$	10	14
	$f_{t,90,k}$	0.4	0.4
Compression	$f_{c,0,k}$	17	21
	$f_{c,90,k}$	2.2	2.5
Shearing	$f_{v,k}$	1.8	2.5
Rolling shear "Systemformat"	$f_{R,k}$	1.0	
Rolling shear "Großformat" and "Großformat DQ"	$f_{R,k}$	0.7	
Values of stiffness			
Elasticity modulus of bending	$E_{0,mean}$	8000	11000
	$E_{90,mean}$	270	370
Shear modulus	G_{mean}	500	690
Rolling shear modulus	$G_{R,mean}$	50	

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Binderholz Brettsperrholz BBS	Annex 2
Strength and stiffness values	

Table 3: Essential requirements of the multilayered timber elements

<table>
<tr><th>BWR</th><th>Requirement</th><th colspan="2">Verification method</th><th>Class / Use category / Value</th></tr>
<tr><td rowspan="8">1</td><td colspan="4">Mechanical resistance and stability</td></tr>
<tr><td>Panel shear strength

Bending strength</td><td colspan="3">For the calculation of the single layers the characteristic strength and stiffness values of softwood of the corresponding strength classes according to EN 338 shall be used taking into consideration the definitions in Annex 2. In addition the following values apply:
<table>
<tr><td>Rolling shear strength "Systemformat" (5%-fractile)</td><td>$f_{R,k}$</td><td>1.0 N/mm²</td></tr>
<tr><td>Rolling shear strength "Großformat" and "Großformat DQ" (5%-fractile)</td><td>$f_{R,k}$</td><td>0.70 N/mm²</td></tr>
<tr><td>Rolling shear modulus (mean value)</td><td>$G_{R,mean}$</td><td>50 N/mm²</td></tr>
</table>
In case of connecting the elements by large finger joints the characteristic bending strength is to reduce by 25 %. In case of tensile stresses in the panel plane the characteristic tensile strength is to reduce by 30 %.
For references regarding the calculation see annexes 4 to 5.
National regulations might have to be followed.</td></tr>
<tr><td>Use of fasteners</td><td colspan="3">according to EN 1995-1-1, for further details see Annex 4</td></tr>
<tr><td>Creep and duration of load</td><td colspan="3">according to EN 1995-1-1</td></tr>
<tr><td>Dimensional stability</td><td colspan="3">Moisture content during use shall not change to such extent that adverse deformations can occur.</td></tr>
<tr><td>In-service environment</td><td colspan="2">EN 1995-1-1</td><td>1 and 2</td></tr>
<tr><td>Bond integrity</td><td colspan="2">EAD 130005-00-0304</td><td>Passed</td></tr>
<tr><td rowspan="5">2</td><td colspan="4">Safety in case of fire</td></tr>
<tr><td colspan="4">Reaction to fire</td></tr>
<tr><td>Timber elements except for floorings</td><td colspan="2" rowspan="2">Commission Decision 2005/610/EC</td><td>Euroclass D-s2, d0</td></tr>
<tr><td>Floorings</td><td>Euroclass D_{fl}-s1</td></tr>
<tr><td colspan="4">Resistance to fire</td></tr>
<tr><td>Charring rate</td><td colspan="2">EN 1995-1-2[3]</td><td>0.7 mm/min</td></tr>
<tr><td rowspan="3">3</td><td colspan="4">Hygiene, health and the environment</td></tr>
<tr><td>Water vapour permeability μ</td><td colspan="2">EN ISO 10456[4]</td><td>20 to 50</td></tr>
<tr><td>Content of dangerous substances</td><td colspan="2">EAD 130005-00-0304</td><td>See clause 3</td></tr>
</table>

[3] EN 1995-1-2:2004 + AC:2009 Eurocode 5: Design of timber structures – Part 1-2: General – Structural fire design
[4] EN ISO 10456:2007 * AC:2009 Building materials and products – Tabulated design values and procedures for determining declared and design thermal values

Binderholz Brettsperrholz BBS	Annex 3
Essential requirements of the multilayered timber elements	

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Table 3 (continued)

4	**Safety in use**		
	Impact resistance	Soft body resistance is assumed to be fulfilled for walls with a minimum of 3 layers and minimum thickness of 60 mm.	
5	**Protection against noise**		
	Airbourne sound insulation	No performance assessed	
	Impact sound insulation	No performance assessed	
	Sound absorption	No performance assessed	
6	**Energy economy and heat retention**		
	Thermal conductivity λ	EN ISO 10456	0,13 W/(m^2 · K)
	Air tightness	No performance assessed	
	Thermal inertia c_p	EN ISO 10456	1.600 J/(kg · K)

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1 Recommendations for the design of the elements

1.1 General

Design, calculation and realization can be done according to EN 1995-1-1 taking into account the following provisions. For the calculation according to EN 1995-1-1 national regulations may have to be followed.

The determination of the distribution of stresses and internal forces must consider the influence of shear deformations of the cross layers. In Annex 5 advice is given on how to perform the calculation of the elements.

If using panels as cover, the deformation of the covers might have to be taken into account. These cover layers may not be used for calculation of the bearing capacity of the cross laminated timber elements.

1.2 Characteristic values

The characteristic strength and stiffness values can be taken from Annex 2 and 3. In addition the following applies:

While calculating the part of the deformation due to shear forces, the elements thickness D regardless of the configuration and a shear modulus of G = 60 N/mm² may be used.

1.3 Mechanical actions perpendicular to the element`s plane

1.3.1 Bending and shear

For the calculation of the characteristic values of the element according to Annex 5, only the boards, which are oriented parallel to the span direction, may be considered.

For the verification of the bending strength of a layer the design value of the bending strength may be multiplied with a system factor k_ℓ:

$$k_\ell = \min \begin{cases} 1 + 0{,}025 \cdot n \\ 1{,}1 \end{cases}$$

with n = number of boards lying side by side.

1.3.2 Tension and compression

The behaviour in bearing and deformation against compression perpendicular to the element's plane can be calculated according to EN 1995-1-1 using the strength and stiffness values given in chapter 1.2.

Tension loads perpendicular to plane of the element should be avoided.

1.4 Mechanical actions in plane of the element

For loads in plane of the element only layers can be taken into account, where the direction of the grain is parallel to the stresses occurring from external loads.

1.4.1 Shear

If forces between adjacent boards of a layer are transmitted only by means of using the next layer glued crosswise, the shear stresses in the crossing surfaces have to be calculated as follows:

$$\tau_{T,d} = \frac{F_d \cdot h}{\sum I_p} \cdot \frac{a}{2} \le f_{v,d}$$

with F_d = external load on a wall element (N)
h = height of the wall (mm)
a = largest side length of the crossing area (mm)

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I_p = polar moment of inertia of a certain crossing area i (mm^4)

$\sum I_p$ = sum of all polar moments of inertia of the crossing areas in the element

$f_{v,d}$ = design value of the torsional shear strength; the characteristic value shall be set to $f_{v,k}$ = 2.5 N/mm² for this calculation

$\tau_{T,d}$ = design value of the torsional stresses occurring if boards of one layer are not glued on their narrow sides

In addition it has to be verified that the layers can bear the stresses falling upon them.

1.4.2 Tension and compression

The behaviour in bearing and deformation in the elements plane can be calculated according to EN 1995-1-1 using the strength and stiffness values given in chapter 1.2.

2 Recommendations for the design of the fasteners

2.1 General

The determination of characteristic values of the load-bearing capacity of fasteners in the element shall be carried out according to EN 1995-1-1 or a European technical assessment which has been granted for the relevant fastener as for softwood or for glued laminated timber. For the calculation according to European regulations national provisions may apply.

Side surfaces are the surfaces of the element parallel to the plane of the element consisting of the surface of the outer layers.

Narrow surfaces are the surfaces perpendicular to the plane of the element, consisting of the lateral surfaces and the cross grain of the boards.

As fasteners nails, wood screws, bolts, dowels and dowels type fasteners according to EN 1995-1-1 or a European technical assessment may be used.

Fasteners in narrow sides may not take into account as load-bearing. Decisive for the minimum spacings of the fasteners and the embedding strength is the grain direction of the cover layers.

Other fasteners resp. their dimensions and application stated in this assessment may be used and calculated with special and with *Deutsches Institut für Bautechnik* coordinated verifications.

2.2 Connections with dowels and bolts

The characteristic value of connections with dowels and bolts in the side surfaces can be calculated according to EN 1995-1-1.

The minimum distance and spacing for dowels and bolts must be 5 ·d from the loaded edge and between each other and 3 ·d from the unloaded edge. This applies regardless of the angle between the direction of force and the direction of the grain.

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2.3 Nails

The characteristic value of the load-bearing capacity of axially loaded nails in the side surfaces can be calculated according to EN 1995-1-1.

The diameter of nails must be at least 4 mm. Only grooved nails with a characteristic value of the point side withdrawal strength $f_{ax,k} \geq 50 \cdot 10^{-6} \cdot \rho_k^2$ and a characteristic value of the head side pull-through strength $f_{head,k} \geq 100 \cdot 10^{-6} \cdot \rho_k^2$ may be employed for axial loading (ρ_k = characteristic density in kg/m³; max. 500 kg/m³).

2.4 Screws

The characteristic value of the load-bearing capacity of screws in the side surfaces of the board can be calculated according to EN 1995-1-1.

Screws must have a diameter of at least 4 mm.

2.5 Split ring connectors and toothed-plate connectors

The characteristic value of the load-bearing capacity of split ring connectors and toothed-plate connectors in the side surfaces of the board can be calculated according to EN 1995-1-1.

Toothed-plate connectors in the narrow surfaces may not be taken into consideration as load-bearing.

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Recommendations for the design of the elements and the fasteners	

Design according to the theory of flexible bonded beams

The calculation of elements with up to five layers can be performed using the theory of flexible bonded beams as described in EN 1995-1-1.

To consider deformations due to shear the factor s_i/K_i according to the standard is substituted by the factor $\overline{h_i}/(G_R \cdot b)$.

The effective moment of inertia is calculated by:

$$I_{ef} = \sum_{i=1}^{3} (I_i \cdot + \gamma_i \cdot A_i \cdot a_i^2) \qquad \text{with} \qquad A_i = b_i \cdot h_i ; \qquad I_i = \frac{b_i \cdot h_i^3}{12}$$

$$\gamma_1 = \frac{1}{1 + \frac{\pi^2 \cdot E_0 \cdot A_1 \cdot \overline{h_1}}{G_R \cdot b \cdot l^2}} ; \qquad \gamma_2 = 1; \qquad \gamma_3 = \frac{1}{1 + \frac{\pi^2 \cdot E_0 \cdot A_3 \cdot \overline{h_2}}{G_R \cdot b \cdot l^2}}$$

$$a_1 = \left(\frac{h_1}{2} + \overline{h_1} + \frac{h_2}{2} \right) - a_2 ; \qquad a_3 = \left(\frac{h_2}{2} + \overline{h_2} + \frac{h_3}{2} \right) + a_2$$

$$a_2 = \frac{\gamma_1 \cdot A_1 \cdot \left(\frac{h_1}{2} + \overline{h_1} + \frac{h_2}{2} \right) - \gamma_3 \cdot A_3 \cdot \left(\frac{h_2}{2} + \overline{h_2} + \frac{h_3}{2} \right)}{\sum_{i=1}^{3} (\gamma_i \cdot A_i)}$$

The verification of the bending performance is done by determination of the bending stress at the boundary of the boards. The bending stress in the middle of the boards may remain unconsidered.

$$\sigma_{m,r,i,d} = \pm \frac{M_d}{I_{ef}} \cdot \left(\gamma_i \cdot a_i + \frac{h_i}{2} \right) \le f_{m,d}$$

The verification of the shear performance is done by determination of the shear stress in the decisive plane:

$$\tau_{v,d} = \frac{V_d \cdot \gamma_i \cdot S_i}{I_{ef} \cdot b} \le f_{R,d}$$

Legend:

h_{tot}	=	thickness of the whole element [mm]
h_i	=	thickness of the layer i parallel to the direction of load transfer [mm]
$\overline{h_i}$	=	thickness of the layer i perpendicular to the direction of load transfer [mm]
b	=	width of the element [mm]
n	=	number of layers
l	=	span width [mm]
I_{ef}	=	effective moment of inertia [Nmm²]
G_R	=	rolling shear modulus [N/mm²]
E_0	=	modulus of elasticity parallel to the grain of the boards [N/mm²]

Binderholz Brettsperrholz BBS	Annex 5
Recommendations for the design according to the theory of flexible bonded beams	

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