Deutsches Institut für Bautechnik

Approval body for construction products and types of construction

Bautechnisches Prüfamt

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European Technical Assessment

ETA-13/0609 of 12 June 2018

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	"FERMACELL Powerpanel HD"
Product family to which the construction product belongs	Cement-Bonded Board
Manufacturer	Fermacell GmbH Düsseldorfer Landstraße 395 47259 Duisburg DEUTSCHLAND
Manufacturing plant	Werk 10
This European Technical Assessment contains	14 pages including 4 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	EAD 210024-00-0504
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Specific Part

1 Technical description of the product

The cement bonded board "FERMACELL Powerpanel HD" is a special board made of cement according to EN 197-1[1], mineral lightweight aggregates, additions, admixtures and glass fibres with a high resistance against alkali (in the form of glass fibre meshes and chopped glass fibres).

The surfaces of the cement bonded board are not coated.

The boards are manufactured with a thickness of 15 mm and by a size of 1250 mm x 3000 mm.

The boards can be used with the following fasteners, which provide sufficient corrosion protection:

- Nails according to EN 14592[2] with a diameter of 2,0 mm ≤ d ≤ 3,0 mm and a head diameter d_k ≥ 4,6 mm
- Screws according to EN 14592[2] or with a European Technical Assessment with a diameter of 3,8 mm ≤ d ≤ 4,0 mm and a head diameter d_k ≥ 7,0 mm
- Staples according to EN 14592[2] or with a European Technical Assessment with a wire diameter of 1,5 mm ≤ d ≤ 1,8 mm and a staples crown width b_r ≥ 11,0 mm

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

The cement bonded board "Fermacell Powerpanel HD" may be used for non-structural applications e.g. as lining in interior area and also for structural applications for the planking and lining of walls, for stiffening timber framed walls.

The performances given in Section 3 are only valid if the cement bonded board "FERMACELL Powerpanel HD" is used in compliance with the specifications and conditions given in Annex A1 to A3.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the cement bonded board "FERMACELL Powerpanel HD" 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 (BWR 1)

Essential characteristic	Performance
Thickness	e = 15 mm ± 1,5 mm
Dimension (length and width)	a = 1000 mm ± 3 mm x 1250 mm ± 3,75 mm a = 2600 mm ± 5 mm x 1250 mm ± 3,75 mm a = 3000 mm ± 5 mm x 1250 mm ± 3,75 mm
Straightness of edges	0,1 % = Level I acc. to EN 12467[3]
Squareness of edges	2 mm/m = Level I acc. to EN 12467[3]
Density	ρ_{mean} = 930 kg/m³

[1] EN 197-1 Cement - Part 1: Composition, specifications and conformity criteria for common cements
[2] EN 14592 Timber structures - Dowel-type fasteners - Requirements
[3] EN 12467 Fibre-cement flat sheets - Product specification and test methods

Essential characteristic	**Performance**
Moisture content	H = 2,33 % by mass
Water impermeability	Passed
Dimensional stability - Length	$\delta l_{65,30}$ = -0,40 mm/m $\delta l_{65,85}$ = 0,16 mm/m
Dimensional stability - Thickness	$\delta l_{65,30}$ = -0,1 % $\delta l_{65,85}$ = 0,0 %
Modification factor	Annex B, table B1
Deformation factor	Annex B, table B2
Bending strength Bending modulus of elasticity	$f_{m,90,k}$ = 2,1 N/mm² * $f_{m,0,k}$ = 2,1 N/mm² * $E_{m,90,mean}$ = 4200 N/mm² * $E_{m,0,mean}$ = 4100 N/mm² *
Tensile strength Tensile modulus of elasticity	$f_{t,0,k}$ = 0,7 N/mm² $E_{t,0,mean}$ = 4200 N/mm²
Compressive strength Compressive modulus of elasticity	$f_{c,90,k}$ = 10,2 N/mm² $f_{c,0,k}$ = 9,7 N/mm² $E_{c,90,mean}$ = 3900 N/mm² $E_{c,0,mean}$ = 6740 N/mm²
Shear strength Shear modulus in the plane of the board	$f_{r,k}$ = 1,3 N/mm² $G_{r,mean}$ = 2520 N/mm²
Shear strength Shear modulus perpendicular to the plane of the board	$f_{v,k}$ = 3,0 N/mm² $G_{v,mean}$ = 2480 N/mm²
Embedment strength for nails with - d = 2,0 mm - d = 2,5 mm - d = 3,0 mm d = pin diameter	 $f_{h,k}$ = 26,7 N/mm² $f_{h,k}$ = 26,2 N/mm² $f_{h,k}$ = 21,8 N/mm²
Pull through resistance - Nail acc. to EN 14592² with d_k = 4,6 mm - Nail acc. to EN 14592² with d_k = 5,7 mm - Nail acc. to EN 14592² with d_k = 6,7 mm - Screw acc. to EN 14592² with d = 3,9 mm and d_k = 7,0 mm - Staple acc. to EN 14592² with d = 1,53 mm and b_R = 11,2 mm - Staple acc. to EN 14592² with d = 1,8 mm and b_R = 11,0 mm	 $F_{ax,head,k}$ = 611 N $F_{ax,head,k}$ = 783 N $F_{ax,head,k}$ = 678 N $F_{ax,head,k}$ = 818 N $F_{ax,head,k}$ = 548 N $F_{ax,head,k}$ = 626 N
Influence of the edge distance of the fasteners on the embedment strength and slip modulus of the fasteners	Annex B, table B3
Racking resistance and stiffness - Screws acc. to EN 14592² with d = 3,9 mm - Screws acc. to EN 14592² with d = 3,9 mm - Screws acc. to EN 14592² with d = 3,9 mm - Staple acc. to EN 14592² with d = 1,53 mm - Staple acc. to EN 14592² with d = 1,53 mm	 $F_{v,Rd}$ = 17,5 kN with a_v = 38 mm $F_{v,Rd}$ = 9,4 kN with a_v = 150 mm $F_{v,Rd}$ = 7,0 kN with a_v = 200 mm $F_{v,Rd}$ = 20,3 kN with a_v = 38 mm $F_{v,Rd}$ = 7,9 kN with a_v = 150 mm
Impact resistance	IR_{mean} = 12,5 mm/mm
Water adsorption	w_a = 22,8 M.-%

Essential characteristic	Performance
Freeze-thaw resistance for category A	$R_{L,FTC}$ = 1,00
Heat-rain resistance for category A	Passed
Warm water resistance for category A	$R_{L,WW}$ = 0,93
Soak-dry resistance for category A	$R_{L,SD}$ = 1,00
Durability of metallic parts	Annex A1
* In deviation from EAD 210024-00-0504, the bending strength and the bending modulus of elasticity were determined perpendicular to the board plane and in board plane according to EN 310[4] on test specimens with a width w of 300 mm and a length l of 400 mm with a span LA of 350 mm.	

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1 according to EN 13501-1[5]

3.3 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Vapour Permeability	μ = 0,32 (wet cup) μ = 0,37 (dry cup)
Content, emission and/or release of dangerous substances	
Substance(s) classified as EU-cat. Carc. 1A/1B [a)]	The product does not contain these dangerous substances actively used. [b)]
Substance(s) classified as EU-cat. Muta. 1A/1B [a)]	
Substance(s) classified as EU-cat. Acute Tox. 1, 2 and/or 3; substance(s) classified as EU-cat. Repr. 1A/1B; substance(s) classified as EU-cat. STOT SE 1 and/or STOT RE 1 [a)]	
SVOC and VOC	No performance assessed.
Release scenarios regarding BWR 3 according to EOTA TR 034: IA1, IA2	

a) In accordance with Regulation (EC) No 1272/2008.

b) Assessment based on a detailed manufacturer's statement on dangerous substances.

3.4 Safety and accessibility in use (BWR 4)

Thickness	e = 15 mm ± 1,5 mm
Dimension (length and width)	a = 1000 mm ± 3 mm x 1250 mm ± 3,75 mm a = 2600 mm ± 5 mm x 1250 mm ± 3,75 mm a = 3000 mm ± 5 mm x 1250 mm ± 3,75 mm
Straightness of edges	0,1 % = Level I acc. to EN 12467[3]
Squareness of edges	2 mm/m = Level I acc. to EN 12467[3]
Density	ρ_{mean} = 930 kg/m³
Moisture content	H = 2,33 % by mass
Water impermeability	Passed
Dimensional stability - Length	$\delta l_{65,30}$ = -0,40 mm/m $\delta l_{65,85}$ = 0,16 mm/m

4 Wood-based panels; determination of modulus of elasticity in bending and of bending strength

5 Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests

Essential characteristic	Performance
Dimensional stability - Thickness	$\delta l_{65,30}$ = -0,1 % $\delta l_{65,85}$ = 0,0 %
Bending strength Bending modulus of elasticity	$f_{m,90,k}$ = 2,1 N/mm² * $f_{m,0,k}$ = 2,1 N/mm² * $E_{m,90,mean}$ = 4200 N/mm² * $E_{m,0,mean}$ = 4100 N/mm² *
Pull through resistance - Nail acc. to EN 14592[2] with d_k = 4,6 mm - Nail acc. to EN 14592[2] with d_k = 5,7 mm - Nail acc. to EN 14592[2] with d_k = 6,7 mm - Screw acc. to EN 14592[2] with d = 3,9 mm and d_k = 7,0 mm - Staple acc. to EN 14592[2] with d = 1,53 mm and b_R = 11,2 mm - Staple acc. to EN 14592[2] with d = 1,8 mm and b_R = 11,0 mm	 $F_{ax,head,k}$ = 611 N $F_{ax,head,k}$ = 783 N $F_{ax,head,k}$ = 678 N $F_{ax,head,k}$ = 818 N $F_{ax,head,k}$ = 548 N $F_{ax,head,k}$ = 626 N
Impact resistance	IR_{mean} = 12,5 mm/mm
Freeze-thaw resistance for category A	$R_{L,FTC}$ = 1,00
Heat-rain resistance for category A	Passed
Warm water resistance for category A	$R_{L,WW}$ = 0,93
Soak-dry resistance for category A	$R_{L,SD}$ = 1,00
Durability of metallic parts	Annex A1

* In deviation from EAD 210024-00-0504, the bending strength and the bending modulus of elasticity were determined perpendicular to the board plane and in board plane according to EN 310[4] on test specimens with a width w of 300 mm and a length l of 400 mm with a span LA of 350 mm.

3.5 Energy economy and heat retention (BWR 6)

Essential characteristic	Performance
Thermal conductivity	$\lambda_{10,tr}$ = 0,29 W/(m x K)
Air permeability	The cement bonded board "FERMACELL Powerpanel HD" is not permeable to air.

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

In accordance with EAD No. 21-0024-05.04, the applicable European legal act is: 1998/437/EC (EU).

The system to be applied is: 4

In addition, with regard to reaction to fire for products covered by this EAD the applicable European legal act is: 1989/106/EC (EU)

The system to be applied is: 3

In addition, with regard to dangerous substances for products covered by this EAD the applicable European legal act is: 98/437/EC (EU)

The system to be applied is: 3

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 12 June 2018 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Schröder

Deutsches Institut für Bautechnik DIBt

Specification of the intended use

Cement bonded board "Fermacell Powerpanel HD" subject to <u>structural applications</u>

- load-bearing and stiffening planking of timber frame walls according to EN 1995-1-1
- planking and lining of walls

Cement bonded board "Fermacell Powerpanel HD" subject to <u>non-structural applications</u>

- non load-bearing internal partitions
- lining of building components in indoor and outdoor areas

Use conditions

<u>Cement bonded board "Fermacell Powerpanel HD"</u>

Category **A** acc. to EN 12467:	Boards which are for applications where they may be subjected to heat, high moisture and severe frost.
Category **B** acc. to EN 12467:	Boards which are intended for applications where they may be subjected to heat, moisture and occasional frost, e.g. where they are either protected from or not subjected to severe weathering conditions.
Category **C** acc. to EN 12467:	Boards which are intended for internal applications, where they may be subjected to heat and moisture, but not to frost.
Category **D** acc. to EN 12467:	Boards for rigid underlayer applications.
Service class **1** acc. to EN 1995-1-1:	Is characterised by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air only exceeding 65 % for a few weeks per year.
Service class **2** acc. to EN 1995-1-1:	Is characterised by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air only exceeding 85 % for a few weeks per year.
Service class **3** acc. to EN 1995-1-1:	Is characterised by climatic conditions leading to higher moisture contents than in service class 2*

* In this case it is recommended to use the board only in areas that are not directly exposed to the weather.

<u>Fasteners</u>

- Structures subject to dry internal conditions (zinc coated steel or stainless steel)
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (stainless steel)

Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plant or road tunnels where de-icing materials are used

"FERMACELL Powerpanel HD"	**Annex A1**
Specification of the intended use: Use conditions	

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Design

1. The design, calculation and execution of building components which are manufactured using the cement bonded board "FERMACELL Powerpanel HD" can be carried out according to EN 1995-1-1 considering the characteristics given below.
2. Characteristic strength and stiffness values as well as the density value of the cement bonded board "FERMACELL Powerpanel HD", which are to be used during design and calculation:

Type of stress		Nominal thickness 15 mm
Characteristic values of strength [N/mm²]		
Stress perpendicular to the plane of the board		
Bending	$f_{m,90,k}$	2,1[1)]
Compression	$f_{c,90,k}$	10,0
Shear	$f_{r,k}$	1,3
Stress in plane of the board		
Bending	$f_{m,k}$	2,1[1)]
Tension	$f_{t,k}$	0,7
Compression	$f_{c,k}$	9,7
Shear	$f_{v,k}$	3,0
Stiffness values [N/mm²]		
Stress perpendicular to the plane of the board		
Bending modulus of elasticity	$E_{m,90,mean}$	4200[1)]
Compressive modulus of elasticity	$E_{c,mean}$	3900
Shear modulus	$G_{r,mean}$	2400
Stress in plane of the board		
Bending modulus of elasticity	$E_{m,mean}$	4100[1)]
Tension modulus of elasticity	$E_{t,mean}$	4200
Compressive modulus of elasticity	$E_{c,mean}$	6700
Shear modulus	G_{mean}	2500
Density [kg/m³]		
Density	ρ_{mean}	950

1) In deviation from EAD 210024-00-0504, the bending strength and the bending modulus of elasticity were determined perpendicular to the board plane and in board plane according to EN 310 on test specimens with a width w of 300 mm and a length l of 400 mm with a span LA of 350 mm.

As partial safety factor of the cement bonded board “FERMACELL Powerpanel HD” $\gamma_M = 1,7$ is recommended.

3. As design data of the modification factor k_{mod} the following values are valid:

Load-duration class	Service class 1	Service class 2	Service class 3*
Permanent action	0,60	0,60	0,50
Long-term action	0,70	0,70	0,55
Medium-term action	0,80	0,80	0,65
Short-term action	0,90	0,90	0,70
Instantaneous action	1,10	1,10	0,90

* Applies only without direct weathering of the boards.

As design data of the deformation parameter k_{def} the following values are valid:

Load-duration class	Service class 1	Service class 2	Service class 3*
Permanent action	6,0	5,0	4,0

* Applies only without direct weathering of the boards.

4. The characteristic embedment strength can be determined using the equation:

$f_{h,1,k} = 37 \cdot d^{-0,5}$ (N/mm²)

where:

d: is the nominal diameter of the fastener in mm.

The characteristic value of the pull-through resistance, determined according to EN 1383, is for

- nails with diameter 2,0 mm ≤ d ≤ 3,0 mm and a head diameter $d_k \geq 4,6$ mm $F_{ax,head,Rk} = 600$ N
- screws with diameter 3,8 mm ≤ d ≤ 4,0 mm and a head diameter $d_k \geq 7,0$ mm $F_{ax,head,Rk} = 800$ N
- staples with diameter 1,5 mm ≤ d ≤ 1,8 mm and a width of the staple crown width $b_R \geq 11,0$ mm $F_{ax,head,Rk} = 500$ N

5. As design data of the slip modulus K_{ser} per shear plane per fastener under service load for fasteners in panel-timber connections the following values are valid:

Fastener Type	K_{ser} in N/mm
Nails (without pre-drilling)	$0,6 \cdot \rho_m^{1,5} \cdot d^{0,8} / 30$
Screws	$0,4 \cdot \rho_m^{1,5} \cdot d / 23$
Staples	$1,4 \cdot \rho_m^{1,5} \cdot d^{0,8} / 80$

where:

d: nominal diameter of the fastener in mm;

ρ_m: mean density of the timber in kg/m³.

6. If the pointside penetration is at least 12·d the characteristic value of the lateral load-carrying capacity of panel-timber connections with nails or staples for each shear joint $F_{v,Rk}$ can be determined simplifying as follows:

$$F_{v,Rk} = K \cdot \sqrt{2 \cdot M_{y\,k} \cdot f_{h,1,k} \cdot d} + \frac{F_{ax,k}}{4} \qquad (N)$$

where:

K = $1{,}2 \cdot d^{-0,5}$ with d in mm

d = nominal diameter of the fastener in mm

$M_{y,k}$ = characteristic fastener yield moment in Nmm

$f_{h,1,k}$ = characteristic embedment strength of the panel in N/mm²

$F_{ax,k}$ = characteristic axial withdrawal capacity of the fastener in N

The second term in the equation for $F_{v,Rk}$ is the contribution from the rope effect which can only be considered for nails and screws with predominantly actions on structures parallel to the edge of the special boards "Fermacell Powerpanel HD". For staple connections the contribution from the rope effect should be taken as zero.

The design value for staple connections with load perpendicular to the edge of the board the characteristic value of the lateral load-carrying capacity $F_{v,Rk}$ is to be reduced by a factor of 0,75.

7. The design value of the length-based shear strength $f_{v,0,d}$ for diaphragms assembled from "FERMACELL Powerpanel HD" special boards should be taken under consideration of the load-carrying capacity of the connection and the panels and the shear buckling of the sheet as the minimum value calculated from the following expressions:

$$f_{v,0,d} = \min \begin{cases} k_{v1} \cdot F_{V,Rd}/s \\ k_{v1} \cdot k_{v2} \cdot f_{t,d} \cdot t_i \\ k_{v1} \cdot k_{v2} \cdot f_{v,d} \cdot 35 \cdot t_i^2/b_{net} \end{cases} \qquad (N/mm)$$

where:

$F_{v,Rd}$ = design value of lateral load-carrying capacity of panel-timber connection

s = fastener spacing

k_{v1} = factor considering the panel arrangement and the connection of the sheathing edges with k_{v1} = 1,0 for constant connection of sheathing and frame members along the perimeter of every sheet and with k_{v2} = 0,66 for constructions with free, unconnected sheathing edges perpendicular to the frame members

k_{v2} = factor taking into account additional stresses on the sheet with k_{v2} = 0,33 for sheathing only on one side and k_{v2} = 0,5 for sheathing on both sides

$f_{t,d}$ = value of tension strength of the sheet

t_i = thickness of the sheet

$f_{v,d}$ = design value of shear strength in plane of the sheet

b_{net} = clear distance between studs

8. In deviation from EN 1995-1-1 for fasteners along the edges of an individual sheet, the design lateral load-carrying capacity $F_{v,Rd}$ may not be increased by a factor of 1,2.

The design racking resistance of each wall panel should be calculated from

$$F_{i,v,0,d} = f_{v,0,d} \cdot b_i \cdot c_i \quad (N)$$

where:

$f_{v,0,d}$ = design value oft the length-based shear strength for diaphragms

b_i = wall panel width

and

$$c_i = \begin{cases} 1 & \text{for} \quad b_i \geq b_0 \\ \dfrac{b_i}{b_0} & \text{for} \quad b_i < b_0 \end{cases}$$

where:

b_0 = h/2

h = height of the wall

The stress caused by geometrical and structural imperfections may be disregarded at the verification of wall diaphragms, provided that:

- the length of the wall is at least h/3
- the width of each sheet is at least h/4
- the wall is directly supported in a stiff supporting structure

and

the ratio $q_{z,k}/q_{x,k}$ is less or equal 15

where:

$q_{x,k}$ = horizontal short-term wind load perpendicular to the wall that has to be stiffened in kN/m

$q_{z,k}$ = permanent vertical load on the head binder of the wall that has to be stiffened in kN/m

Sufficient stiffening of compression- or bending-loaded ribs in the plane of the board, roof or ceiling in-plane by using the cement bonded board "Fermacell Powerpanel HD" may be assumed under the following conditions:

- for wall diaphragms with boards on both sides the frame members are continuously connected to the stiffening panels and the distance of the vertical frame members is less than 50-times the thickness of the sheathing
- for wall diaphragms with boards only on one side additionally the vertical frame members must be designed with rectangular cross-section and an aspect ratio of h/b ≤ 4

Loads perpendicular in-plane of the board must be verified.

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Installation

During transport and storage the cement bonded board "FERMACELL Powerpanel HD" and the components manufactured by using these boards shall be protected against damaging and inadequate moisture, e.g. from precipitation or high building moisture (e.g. covering the boards or the components on all sides with foil to avoid standing water).

Damaged cement bonded boards "FERMACELL Powerpanel HD" or components manufactured by using these boards may neither be used nor installed.

If cement bonded board "FERMACELL Powerpanel HD" is processed on site (on-site fabrication), the moisture of the timber substructure may not detrimentally increase until installing the boards (protection from precipitation or high building moisture).

As connecting devices of the cement bonded board "FERMACELL Powerpanel HD" to the substructure appropriate nails, screws or samples with adequate corrosion protection shall be used, see Annex A1.

The distances of the connecting devices from the unstressed edge $a_{4,c}$ of the cement bonded board "FERMACELL Powerpanel HD" shall be at least 5 x d for nails, 4 x d for screws and 10 x d for staples.

The distances of the connecting devices from the stressed edge $a_{4,t}$ of the cement bonded board "Fermacell Powerpanel HD" the distances shall be at least 7 x d for nails and screws and 10 x d for staples.

The spacing between the fasteners a_1 shall be at least 20 x d for nails and screws and 40 x d for staples.

The maximum spacing along the edges of the planking shall be complied with EN 1995-1-1.

"FERMACELL Powerpanel HD"	**Annex A3**
Specification of the intended use: Installation	

Table B1: Modification factor k_{mod} of the cement bonded board "Fermacell Powerpanel HD"

Load-duration class	Service class 1	Service class 2	Service class 3*
Permanent action	0,60	0,60	0,50
Long-term action	0,70	0,70	0,55
Medium-term action	0,80	0,80	0,65
Short-term action	0,90	0,90	0,70
Instantaneous action	1,10	1,10	0,90

* Applies only without direct weathering of the boards.

Table B2: Deformation factor k_{def} of the cement bonded board "Fermacell Powerpanel HD"

Load-duration class	Service class 1	Service class 2	Service class 3*
Permanent action	6,0	5,0	4,0

* Applies only without direct weathering of the boards.

Table B3: Fasteners tests with nails, screws and staples at a displacement of 1 mm - determined maximum load ($F_{exp, 1mm}$) and calculated value of K_{ser} according to EN 1995-1-1, table 7.1

Fasteners	Edge distance / Force direction to the edge	m ($F_{exp, 1mm}$)	v ($F_{exp, 1mm}$)	K_{ser}
Nails acc. to EN 14592[2] t = 15 mm, d = 2,2 mm	7 d ⊥ to the edge of the board	313 N	16,1 %	539 N/mm²
Nails acc. to EN 14592[2] t = 15 mm, d = 2,2 mm	5 d ⊥ to the edge of the board	342 N	13,9 %	539 N/mm²
Nails acc. to EN 14592[2] t = 15 mm, d = 2,5 mm	7 d ⊥ to the edge of the board	459 N	11,8 %	597 N/mm²
Nails acc. to EN 14592[2] t = 15 mm, d = 2,5 mm	5 d ⊥ to the edge of the board	382 N	4,6 %	597 N/mm²
Nails acc. to EN 14592[2] t = 15 mm, d = 2,8 mm	7 d ⊥ to the edge of the board	504 N	18,6 %	654 N/mm²
Nails acc. to EN 14592[2] t = 15 mm, d = 2,8 mm	5 d ⊥ to the edge of the board	549 N	11,6 %	654 N/mm²
Screws acc. to EN 14592[2] t = 15 mm, d = 3,9 mm	7 d ⊥ to the edge of the board	612 N	4,7 %	1460 N/mm²
Screws acc. to EN 14592[2] t = 15 mm, d = 3,9 mm	4 d ⊥ to the edge of the board	603 N	12,0 %	1460 N/mm²
Staples acc. to EN 14592[2] t = 15 mm, d = 1,53 mm	10 d ⊥ to the edge of the board	442 N	9,7 %	302 N/mm²
Staples acc. to EN 14592[2] t = 15 mm, d = 1,53 mm	7 d ⊥ to the edge of the board	449 N	11,6 %	302 N/mm²
Staples acc. to EN 14592[2] t = 15 mm, d = 1,8 mm	10 d ⊥ to the edge of the board	559 N	13,3 %	344 N/mm²
Staples acc. to EN 14592[2] t = 15 mm, d = 1,8 mm	7 d ⊥ to the edge of the board	468 N	9,7 %	344 N/mm²
t = thickness of the board d = pin diameter				