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-18/0955 of 27 March 2020

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	EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa
Product family to which the construction product belongs	Fibre-cement flat sheet according to EN 12467 with additional characteristics
Manufacturer	Eternit GmbH Deutschland Im Breitspiel 20 69126 Heidelberg DEUTSCHLAND
Manufacturing plant	Eternit GmbH Deutschland Dyckerhoffstr. 95-105 59269 Beckum DEUTSCHLAND
This European Technical Assessment contains	38 pages including 3 annexes with 27 pages 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 210025-00-0504

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Specific part

1 Technical description of the product

Fibre-cement flat sheets according to EN 12467 with additional characteristics "EQUITONE" is a fibre-cement flat sheet made of a mixture of man-made fibres, virgin cellulose fibres and/or recycled cellulose fibres, cement according to EN 197-1, additives and if necessary pigments as well as water. The reinforcing fibres are discrete elements randomly dispersed.

The fibre-cement flat sheets are type NT (Non-asbestos Technology).

The fibre-cement flat sheets are factory-made with the Hatschek process.

The exposed face of the sheets can be textured (by blasting, pressing, milling and other machining of the surfaces). The sheets can be coloured or left in their natural colour. The sheets can also receive opaque coloured or uncoloured coatings. The edges of the sheets may be impregnated.

Following sheet types were tested as part of the assessment:

- "EQUITONE [natura]" with a transparent acrylate layer with or without pigments
- "EQUITONE [natura] PRO" with a transparent acrylate coating with and without pigments as medium coating and a UV-cured functional layer
- "EQUITONE [textura]" with an opaque, optionally granular coating with acrylate-based binders with pigments
- "EQUITONE [pictura]" with an opaque acrylate coating as medium coating and a UV-cured functional layer
- "EQUITONE [materia]" with a mechanical surface treatment without coating
- "Elementa" with an opaque coating with acrylate-based binders
- "EQUITONE balcony sheets" each coating or treatment variant can be combined on both surfaces

The sheets are manufactured with a range of nominal thickness between 8 mm to 12 mm.

The sheets are usually available in nominal length up to 3100 mm and nominal width up to 1250 mm.

The class of reaction to fire performance for fibre-cement flat sheets "EQUITONE" is A2-s1,d0 or C-s2,d0 according to EN 13501-1.

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

The fibre-cement flat sheets "EQUITONE" are intended to be used for following non-structural applications:

- Ventilated cladding kit, ceiling kits and roofs cladding
- Parapets (balcony sheets)

The fibre-cement flat sheets "EQUITONE" are used with one of the following fixing elements:

- Universal Rivets 4,0 x L K15 aluminum, fixed point sleeve and moving point sleeve according to Annex A1
- Universal Rivets 4,0 x L K15 stainless steel, fixed point sleeve and moving point sleeve according to Annex A2

- Universal Screws 5,5 x L K15 stainless steel according to Annex A3
- Universal Screws with drillpoint 5,5 x L K15 stainless steel according to Annex A4
- Rivets 4,0 x L K15 aluminum, fixed point sleeve according to Annex A5
- Rivets 4,0 x L K15 stainless steel, fixed point sleeve according to Annex A6
- Balcony Screws M5 x L K15 according to Annex A7
- System-Roof Screw 5 x 70 according to Annex A8
- P+S Glass Clamp according to ETA-11/0380 according to Annex A9

The performances given in Section 3 are only valid if the fibre-cement flat sheets "EQUITONE" are used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the fibre-cement flat sheet “EQUITONE” 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)

The essential characteristics regarding mechanical resistance and stability are included under the Basic Works Requirement safety in use.

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	see Annex C, clause C.1
External fire performance of roofs	Satisfies the provisions of Commission Decision 96/ 603/EC

3.3 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Content, emission and/or release	
Substance(s) classified as Carc. 1A/1B.[a)]	The product does not contain these dangerous substances actively used.[b)]
Substance(s) classified as Muta. 1A/1B.[a)]	The product does not contain these dangerous substances actively used, except the coating for Textura F and Textura TC which contains a biocidal product with an active substance classified Muta. 1B.[b), c)]
Substance(s) classified as Acute Tox. 1, 2 and/or 3; Repr. 1A/1B; STOT SE 1 and/or STOT RE 1.[a)]	The product does not contain these dangerous substances actively used.[b)]
SVOC and VOC	No performance assessed.
Release scenarios regarding BWR 3 in accordance with EOTA TR 034: IA1, IA2	

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

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

c) The biocidal product may be made available on the market without authorization for the duration of authorization procedure of the active substances or of the final active substances to be authorized, in accordance with Regulation (EU) No. 528/2012 (Biocidal Products Regulation).

3.4 Safety and accessibility in use (BWR 4)

Essential characteristic	Performance
Part A: For all intended uses	
Thickness	<u>For non-textured surfaces:</u> e_{nom} = 8,0 mm ± 0,8 mm e_{nom} = 12,0 mm ± 1,2 mm <u>For textured surfaces:</u> e_{nom} = 8,0 mm -0,8 mm and +1,2 mm e_{nom} = 12,0 mm -1,2 mm and +1,8 mm
Dimension (length and width)	Maximum nominal length: l = 2500 mm ± 5 mm l = 3100 mm ± 5 mm Maximum nominal width: w = 1250 mm ± 3,75 mm
Straightness of edges	<u>Trimmed sheets:</u> 0,1 % = Level I acc. to EN 12467 <u>Untrimmed sheets:</u> 0,3 % = Level II acc. to EN 12467

Essential characteristic	**Performance**
Squareness of edges	Trimmed sheets: 2 mm/m = Level I acc. to EN 12467 Untrimmed sheets: 4 mm/m = Level II acc. to EN 12467
Density	ρ_m = 1.750 kg/m³ ± 100 kg/m³ ρ_k = 23,5 kN/m³
Moisture content	e_{nom} ≥ 8 mm and ≤ 12 mm: $H_{20/65}$ = 5,2 % by mass H_{wet} = 17,2 % by mass
Water impermeability	WI = Passed
Dimensional stability	$\delta l_{30,95}$ = 1,18 mm/m
Characteristic value of bending strength and mean bending modulus of elasticity perpendicular to the plane of the sheet	e_{nom} ≥ 8 mm and ≤ 12 mm: $f_{m,0,k}$ = 21,5 N/mm² $f_{m,90,k}$ = 16,5 N/mm² $E_{m,0,mean}$ = 12.000 N/mm² $E_{m,90,mean}$ = 12.000 N/mm² Diagrams load versus deflection, see Annex C, clause C.2
Thermal expansion coefficient	α_{mean} = 9,4·10^{-6} K^{-1}
Freeze-thaw resistance for category A	Passed = $R_{L,FT}$ ≥ 0,75 acc. to EN 12467
Warm water resistance for category A	Passed = $R_{L,WW}$ ≥ 0,75 acc. to EN 12467
Soak-dry resistance for category A	Passed = $R_{L,SD}$ ≥ 0,75 acc. to EN 12467
Modification factor	k_{mod} : Annex C, clause C.3 $k_{mod,f}$: Annex C, clause C.3
Deformation factor	k_{def} : Annex C, clause C.4
Brinell hardness	HBW = 75 N/mm²

Essential characteristic	Performance
Part E: Ventilated cladding kits, ceiling kits and roof claddings	
Application quantity and solid content of the surface coating	Annex C, clause C.5
Parameter of pull-through resistance: Universal Rivets 4,0 x L K15 aluminum according to Annex A1 Universal Rivets 4,0 x L K15 stainless steel according to Annex A2 Universal Screws 5,5 x L K15 stainless steel according to Annex A3 Universal Screws with drillpoint 5,5 x L K15 stainless steel according to Annex A4 Rivets 4,0 x L K15 aluminium according to Annex A5 Rivets 4,0 x L K15 stainless steel according to Annex A6 System-Roof screw 5,0 x 70 according to Annex A8	 $f_{head,k}$ = 24,0 N/mm² $f_{head,k}$ = 25,6 N/mm² $f_{head,k}$ = 15,2 N/mm² $f_{head,k}$ = 15,2 N/mm² $f_{head,k}$ = 18,5 N/mm² $f_{head,k}$ = 19,7 N/mm² $f_{head,k}$ = 8,1 N/mm²
Influence of the edge distance of the fasteners on the embedment strength: Fastener with max. diameter of the borehole ∅ = 7 mm Fastener with max. diameter of the borehole ∅ = 11 mm	 $a_{4,t}$ = 70 mm $a_{4,c}$ = 20 mm $a_{4,t}$ = 70 mm $a_{4,c}$ = 25 mm
Characteristic value of the tensile strength / mean value of tensile modulus of elasticity in the plane of the sheet	No performance assessed.
Characteristic value of the tensile strength perpendicular to the plane of the sheet	No performance assessed.
Embedment strength Universal Rivets 4,0 x L K15 according to Annex A1, diameter of the borehole ∅ = 11,0 mm and Universal Rivets 4,0 x L K15 according to Annex A2, diameter of the borehole ∅ = 11,0 mm	 e_{nom} = 8,0 mm $f_{h,k}$ = 93,5 N/mm² $f_{h,sl,k}$ = 46,3 N/mm² e_{nom} = 12,0 mm $f_{h,k}$ = 110,0 N/mm² $f_{h,sl,k}$ = 54,5 N/mm²

Essential characteristic	**Performance**
Universal Screws 5,5 x L K15 according to Annex A3, diameter of the borehole ∅ = 7,0 mm and Universal Screws 5,5 x L K15 according to Annex A4, diameter of the borehole ∅ = 7,0 mm Rivets 4,0 x L K15 according to Annex A5, diameter of the borehole ∅ = 9,5 mm and Rivets 4,0 x L K15 according to Annex A6, diameter of the borehole ∅ = 9,5 mm System-Roof Screw 5,0 x 70 mm according to Annex A8, diameter of the borehole ∅ = 7,0 mm	e_{nom} = 8,0 mm $f_{h,k}$ = 90,4 N/mm² e_{nom} = 12,0 mm $f_{h,k}$ = 106,0 N/mm² e_{nom} = 8,0 mm $f_{h,k}$ = 93,5 N/mm² $f_{h,sl,k}$ = 49,8 N/mm² e_{nom} = 12,0 mm $f_{h,k}$ = 110,0 N/mm² $f_{h,sl,k}$ = 58,6 N/mm² e_{nom} = 8,0 mm $f_{h,k}$ = 95,2 N/mm²
Durability of metallic fasteners	Annex B, Page 2
Characteristic value of the tensile strength of glued kits at different temperatures	No performance assessed.
Characteristic value of the shear strength of glued kits at different temperatures	No performance assessed.
Characteristic value of the tensile strength at 23°C - Use only of foam tape	No performance assessed.
Characteristic value of the shear strength at 23 °C - Use only of foam tape	No performance assessed.
Creep and elastic recovery under long term tensile or shear loading of glued kits	No performance assessed.
Shatter properties	SP: Group A, Annex C, clause C.8
Resistance to structural damage from soft body impact load	Annex C, clause C.6
Resistance to structural damage from hard body impact load	Annex C, clause C.7
Heat-rain resistance	HRR = Passed
Hygrothermal behaviour - Only for jointless render coating or tiles	No performance assessed.
Freeze-thaw behaviour – Only for jointless render coating or tiles	No performance assessed.
Bond strength between base coat and "sheet" – Only for jointless render coating or tiles	No performance assessed.
Tensile properties after hygrothermal cycles for glued kits	No performance assessed.
Tensile properties after immersion in water for glued kits	No performance assessed.
Tensile properties after humidity and NaCl for glued kits	No performance assessed.

Essential characteristic	**Performance**
Tensile properties after humidity and SO_2 for glued kits	No performance assessed.
Tensile properties after exposure to cleaning products for glued kits	No performance assessed.
Resistance to horizontal point loads	No performance assessed.
Pulsating load on fasteners	F_{mean} = 2018 N $F_{1,mean}$ = 2186 N $F_{1,mean} \geq 0{,}8\ F_{mean}$
Pulsating load on rear fasteners and for glued kits	No performance assessed.
Axial tension resistance of rear fasteners	No performance assessed.
Shear resistance of rear fasteners	No performance assessed.
Combined tension and shear resistance of rear fasteners	No performance assessed.
Sustained loading of rear fasteners	No performance assessed.
Freeze-thaw resistance of rear fasteners	No performance assessed.
Resistance to earthquake impacts	No performance assessed.
Part F: Parapets (Balcony sheets)	
Application quantity and solid content of the surface coating	Annex C, clause C.5
Parameter of pull-through resistance:	
Universal Rivets 4,0 x L K15 aluminum according to Annex A1	$f_{head,k}$ = 24,0 N/mm²
Universal Rivets 4,0 x L K15 stainless steel according to Annex A2	$f_{head,k}$ = 25,6 N/mm²
Universal Screws 5,5 x L K15 stainless steel according to Annex A3	$f_{head,k}$ = 15,2 N/mm²
Universal Screws with drillpoint 5,5 x L K15 stainless steel according to Annex A4	$f_{head,k}$ = 15,2 N/mm²
Rivets 4,0 x L K15 aluminium according to Annex A5	$f_{head,k}$ = 18,5 N/mm²
Rivets 4,0 x L K15 stainless steel according to Annex A6	$f_{head,k}$ = 19,7 N/mm²
Balcony Screws M5 x L K15 according to Annex A7	$f_{head,k}$ = 15,2 N/mm²

Essential characteristic	Performance
Influence of the edge distance of the fasteners on the embedment strength: Fastener with max. diameter of the borehole: ∅ = 7 mm Fastener with max. diameter of the borehole: ∅ = 11 mm	 $a_{4,t}$ = 70 mm $a_{4,c}$ = 20 mm $a_{4,t}$ = 70 mm $a_{4,c}$ = 25 mm
Embedment strength: Universal Rivets 4,0 x L K15 according to Annex A1, diameter of the borehole: ∅ = 11,0 mm and Universal Rivets 4,0 x L K15 according to Annex A2, diameter of the borehole: ∅ = 11,0 mm Universal Screws 5,5 x L K15 according to Annex A3, diameter of the borehole: ∅ = 7,0 mm and Universal Screws 5,5 x L K15 according to Annex A4, diameter of the borehole: ∅ = 7,0 mm Rivets 4,0 x L K15 according to Annex A5, diameter of the borehole: ∅ = 9,5 mm and Rivets 4,0 x L K15 according to Annex A6, diameter of the borehole: ∅ = 9,5 mm Balcony Screws M5 x L K15 according to Annex A7, diameter of the borehole: ∅ = 7,0 mm	 e_{nom} = 12,0 mm $f_{h,k}$ = 110,0 N/mm² $f_{h,sl,k}$ = 54,5 N/mm² e_{nom} = 12,0 mm $f_{h,k}$ = 106,0 N/mm² e_{nom} = 12,0 mm $f_{h,k}$ = 110,0 N/mm² $f_{h,sl,k}$ = 58,6 N/mm² e_{nom} = 12,0 mm $f_{h,k}$ = 94,1 N/mm²
Durability of metallic fasteners	Annex B, Page 2
Heat-rain resistance	HRR = Passed
Resistance to earthquake impacts	No performance assessed.
Resistance to soft body impact	Annex C, clause C.6
Resistance to hard body impact	Annex C, clause C.7

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

In accordance with EAD No. 21-0025-00-0504, the applicable European legal act is: 2003/640/EC(EU) for ventilated cladding kits, ceiling kits and roof claddings and 97/176/EC(EU) for parapets (balcony sheets).

The system to be applied is: 2+

In addition, with regard to reaction to fire for products covered by this EAD the applicable European legal act is: Decision 2003/640/EC.

The systems are: 1, 3 or 4 (depending on the class of reaction to fire according to Regulation (EU) No. 2016/364 and EN 13501-1)

In addition, with regard to e.g. reaction 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.

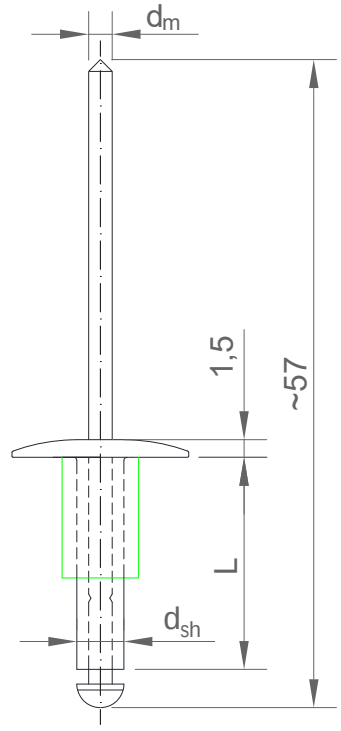
Issued in Berlin on 27 March 2020 by Deutsches Institut für Bautechnik

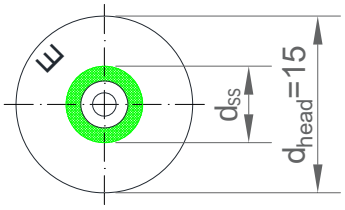
BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Schröder

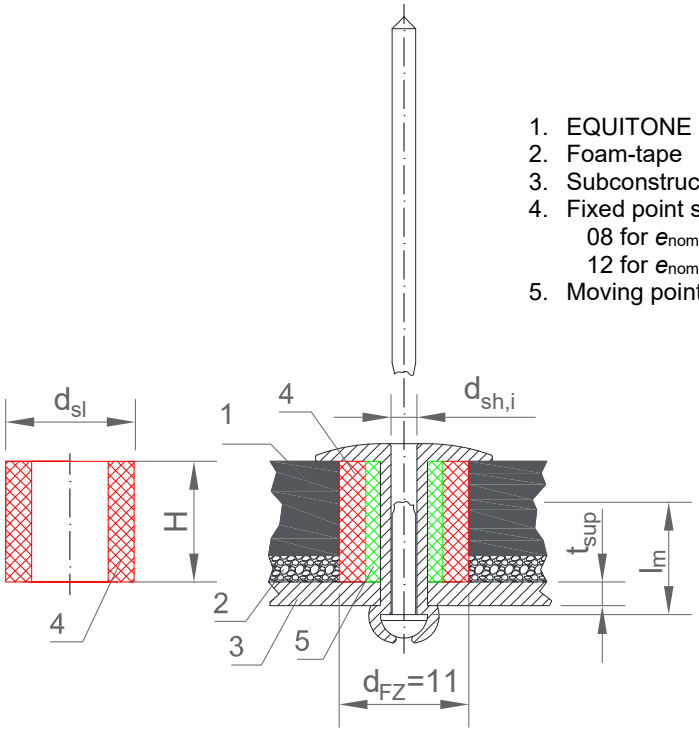
Deutsches Institut für Bautechnik DIBt

rivet unmounted
with spacer sleeve





rivet mounted as fixpoint



1. EQUITONE
2. Foam-tape
3. Subconstruction
4. Fixed point sleeve:
   08 for e_{nom} = *8 mm*
   12 for e_{nom} = *12 mm*
5. Moving point spacer sleeve

all dimensions in mm;
without scale

Materials:

Sleeve / head:	AlMg5 (Material no.: 3.3555 acc. to EN AW-5019)
Rivet mandrel:	X6CrNiTi18-10 (Material no.: 1.4541 acc. to EN 10088-1)
Moving point sleeve:	Polyamide green coloured
Fixed point sleeve:	Polyamide red coloured
Corrosivity	
Rivet system:	with coloured coating rivet head EN ISO 12944-2 "C4 medium" with additional corrosion protection coating EN ISO 12944-2 "C5-M long" [when applied in chloride containing environments e.g. the coast (<25 km)]

4xL K15	d_{ss}	$f_{u,sh}$	$f_{u,m}$	d_{sh}	$d_{sh,i}$	d_m	d_{sl}	H [mm]		l_m	H_{eff}	t_{sub} [mm]		$F_{tens,k}$	A_{sh}	A_m
-	mm	N/mm²	N/mm²	mm	mm	mm	mm	e_{nom}=8	e_{nom}=12	mm	mm	e_{nom}=8	e_{nom}=12	N	mm²	mm²
4x18 K15	6,5	275	1.000	4	2,1	2,05	10,9	10,25	-	8,3	e_{nom}	1,7-3,0	-	2.400	9,1	3,3
4x25 K15	6,5	275	1.000	4	2,1	2,05	10,9	10,25	14,25	8,3	e_{nom}	3,7-10	1,7-6,0	2.400	9,1	3,3

Key figures*	t_{sub}	$f_{u,sub}$	$f_{head,k}$	e_{nom}	$F_{head,k}$	$F_{ax,k,sub}$**	$F_{b,Rk}$	$F_{vr,Rk}$	$F_{v,Rk}$	k_{mod}	$k_{mod,f}$	$F_{ax,Rd}$	$F_{v,Rd}$
-	mm	N/mm²	N/mm²	mm	N	N	N	N	N	-	-	N	N
4x18 K15	2	245	24,0	8	1.960	1.842	4.900	3.482	2.538	0,6	0,8	905	1.562
4x25 K15	2	245	24,0	12	1.960	1.842	4.900	3.482	2.733	0,6	0,8	905	1.682

* calculation according to EN 1995-1-1:2004/A2:2014 and ETA-18/0955

** this value is only valid for the minimal indicated tensile strength $f_{u,sub}$ and the minimum thickness of t_{sub}

EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony boards, Elementa

Universal Rivets 4,0 x L K15 aluminum, fixed point sleeve and moving point sleeve

Annex A1

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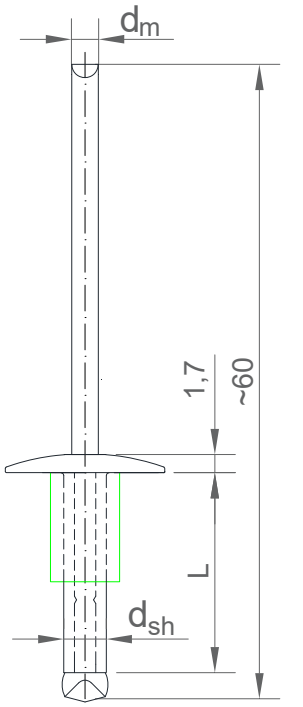
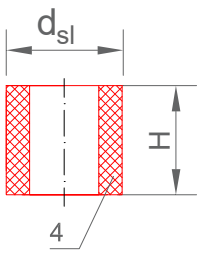
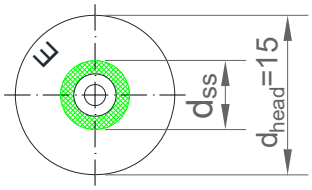
rivet unmounted
with spacer sleeve

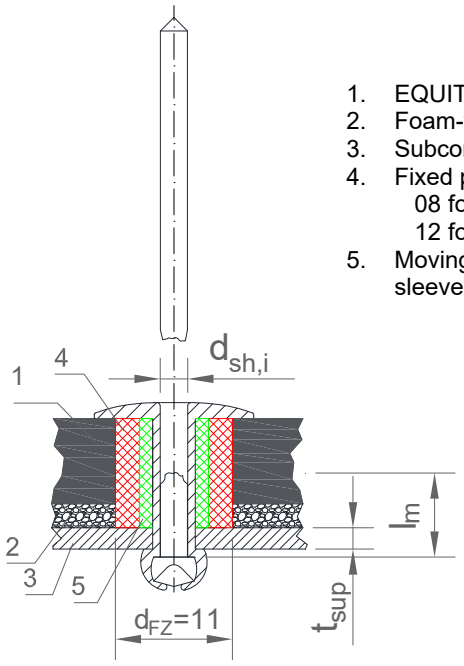






all dimensions in mm;
without scale

rivet mounted as fixpoint



1. EQUITONE
2. Foam-tape
3. Subconstruction
4. Fixed point sleeve:
   08 for e_{nom} = *8 mm*
   12 for e_{nom} = *12 mm*
5. Moving point spacer sleeve

Materials:

Sleeve / head:	X3CrNiCu18-9-4 (Material no.: 1.4567 acc. to EN 10088-1)
Rivet mandrel:	X6CrNiTi18-10 (Material no.: 1.4541 acc. to EN 10088-1)
Moving point sleeve:	Polyamide green coloured
Fixed point sleeve:	Polyamide red coloured
Corrosivity Rivet system:	with coloured coating rivet head EN ISO 12944-2 "C4 medium" with additional corrosion protection coating EN ISO 12944-2 "C5-M long" [when applied in chloride containing environments e.g. the coast (<25 km)]

4xL K15	d_{ss}	$f_{u,sh}$	$f_{u,m}$	d_{sh}	$d_{sh,i}$	d_m	d_{sl}	H [mm]		l_m	H_{eff}	t_{sub} [mm]		$F_{tens,k}$	A_{sh}	A_m
-	mm	N/mm²	N/mm²	mm	mm	mm	mm	e_{nom}=8	e_{nom}=12	mm	mm	e_{nom}=8	e_{nom}=12	N	mm²	mm²
4x18 K15	6,5	497	1.000	4	2,6	2,55	10,9	10,25	-	8,3	e_{nom}	1,7-3,5	-	3.600	7,3	5,1
4x20 K15	6,5	497	1.000	4	2,6	2,55	10,9	10,25	-	8,3	e_{nom}	3,5-5,5	-	3.600	7,3	5,1
4x22 K15	6,5	497	1.000	4	2,6	2,55	10,9	10,25	14,25	8,3	e_{nom}	5,5-7,5	1,7-3,5	3.600	7,3	5,1
4x24 K15	6,5	497	1.000	4	2,6	2,55	10,9	10,25	14,25	8,3	e_{nom}	7,5-9,5	3,5-5,5	3.600	7,3	5,1

Key figures*	t_{sub}	$f_{u,sub}$	$f_{head,k}$	e_{nom}	$F_{head,k}$	$F_{ax,k,sub}$**	$F_{b,Rk}$	$F_{vr,Rk}$	$F_{v,Rk}$	k_{mod}	$k_{mod,f}$	$F_{ax,Rd}$	$F_{v,Rd}$
-	mm	N/mm²	N/mm²	mm	N	N	N	N	N	-	-	N	N
4x18 K15 4x20 K15	2	245	25,6	8	2.091	2.149	4.900	5.228	2.662	0,6	0,8	965	1.638
4x22 K15 4x24 K15	2	245	25,6	12	2.091	2.149	4.900	5.228	3.353	0,6	0,8	965	2.063

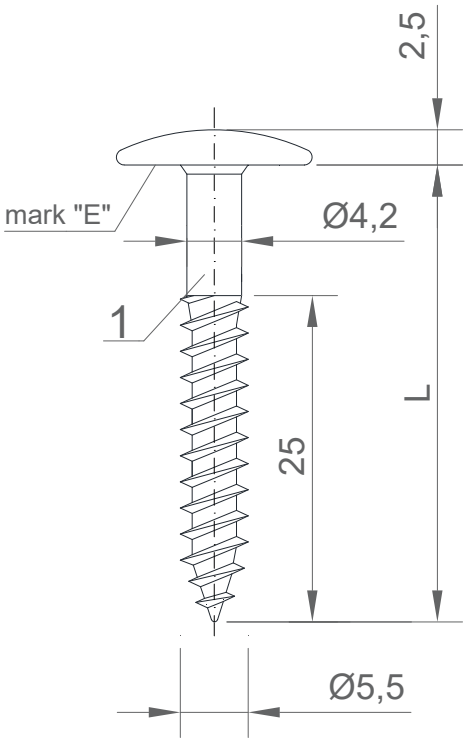
* calculation according to EN 1995-1-1:2004/A2:2014 and ETA-18/0955
** this value is only valid for the minimal indicated tensile strength $f_{u,sub}$ and the minimum thickness of t_{sub}

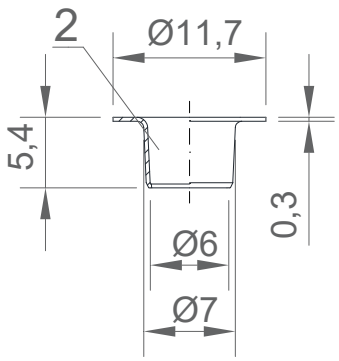
EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa

Universal Rivets 4,0 x L K15 stainless steel, fixed point sleeve and moving point sleeve

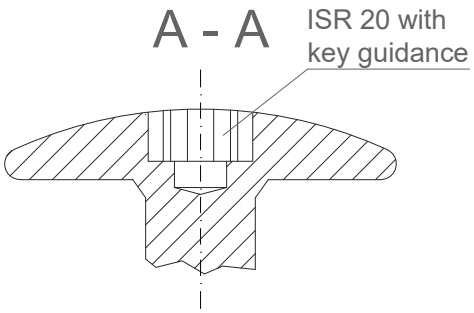
Annex A2

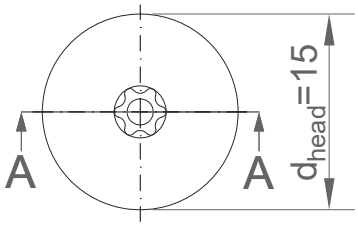
Deutsches Institut für Bautechnik DIBt





1. Universal Screw
2. Screw collar for EQUITONE [natura] PRO, [pictura]





all dimensions in mm;
without scale

Materials:

Universal Screw:	X3CrNiCu18-9-1 (Material-no.: 1.4567 acc. to EN 10088-1)
Screw collar:	X5CrNi18-10 (Material-no.: 1.4301 acc. to EN 10088-1)
Corrosivity Screw system:	with coloured coating screw head and additional corrosion protection coating EN ISO 12944-2 "C5-M long" [when applied in chloride containing environments e.g. the coast (<25 km)]

5,5xL K15	L	e_{nom}	$M_{y,k}$	d_{FZ}	$f_{ax,k}$	ρ_a	$f_{tor,k}$	$R_{tor,k}$	$f_{tor,k}$ / $R_{tor,k}$	$F_{tens,k}$
-	mm	mm	Nm	mm	N/mm²	kg/m³	Nm	Nm	-	N
5,5x35 K15	35	8	6,75	7	17,4	450	6,8	3,6	1,89	6.475
5,5x45 K15	45	12	6,75	7	17,4	450	6,8	3,6	1,89	6.475

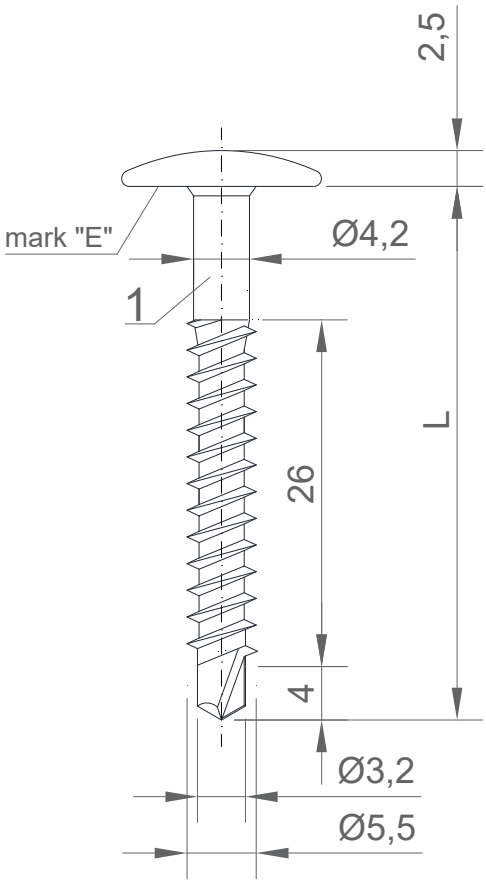
Key figures*	t_{sub}	ρ_k	e_{nom}	$f_{head,k}$	$F_{head,k}$	$F_{ax,k,sub}$	Test Johansen yield theory failure mode and ratio of axial tension resistance (rope effect)	$F_{v,Rk}$	k_{mod}	$k_{mod,f}$	$F_{ax,Rd}$	$F_{v,Rd}$
-	mm	kg/m³	mm	N/mm²	N	N	-	N	-	-	N	N
5,5x35 K15	40	350	8	15,2	2.101	1.957	(e) / 1,41	2.248	0,6	0,8	970	1.198
5,5x45 K15	40	350	12	15,2	2.101	1.957	(e) / 1,41	2.523	0,6	0,8	970	1.344

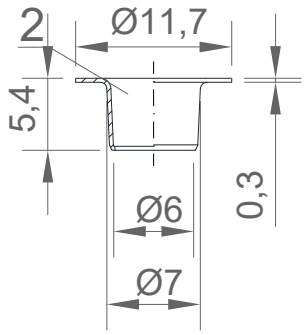
* calculation according to EN 1995-1-1:2004/A2:2014 and ETA-18/0955

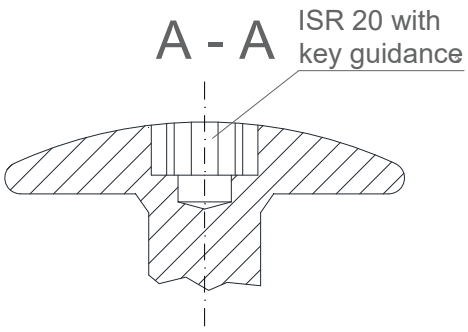
EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura],
EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa

Universal Screws 5,5 x L K15 stainless steel

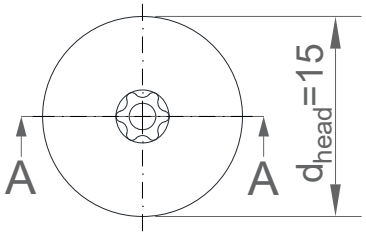
Annex A3







1. Universal Screw with drillpoint
2. Screw collar for EQUITONE [natura] PRO, [pictura]



all dimensions
in mm; without scale

Materials:

Universal Screw:	X3CrNiCu18-9-1 (Material-no.: 1.4567 acc. to EN 10088-1)
Screw collar:	X5CrNi18-10 (Material-no.: 1.4301 acc. to EN 10088-1)
Corrosivity Screw system:	with coloured coating screw head and additional corrosion protection coating EN ISO 12944-2 "C5-M long" [when applied in chloride containing environments e.g. the coast (<25 km)]

5,5xL K15	L	e_{nom}	$M_{y,k}$	d_{FZ}	$f_{ax,k}$	ρ_a	$f_{tor,k}$	$R_{tor,k}$	$f_{tor,k}$ / $R_{tor,k}$	$F_{tens,k}$
-	mm	mm	Nm	mm	N/mm²	kg/m³	Nm	Nm	-	N
5,5x40 K15	40	8	6,75	7	17,4	450	6,8	3,6	1,89	6.475
5,5x50 K15	50	12	6,75	7	17,4	450	6,8	3,6	1,89	6.475

Key figures*	t_{sub}	ρ_k	e_{nom}	$f_{head,k}$	$F_{head,k}$	$F_{ax,k,sub}$	Test Johansen yield theory failure mode and ratio of axial tension resistance (rope effect)	$F_{v,Rk}$	k_{mod}	$k_{mod,f}$	$F_{ax,Rd}$	$F_{v,Rd}$
-	mm	kg/m³	mm	N/mm²	N	N	-	N	-	-	N	N
5,5x40 K15	40	350	8	15,2	2.101	2.035	(e) / 1,41	2.457	0,6	0,8	970	1.309
5,5x50 K15	40	350	12	15,2	2.101	2.035	(e) / 1,41	2.757	0,6	0,8	970	1.470

* calculation according to EN 1995-1-1:2004/A2:2014 and ETA-18/0955

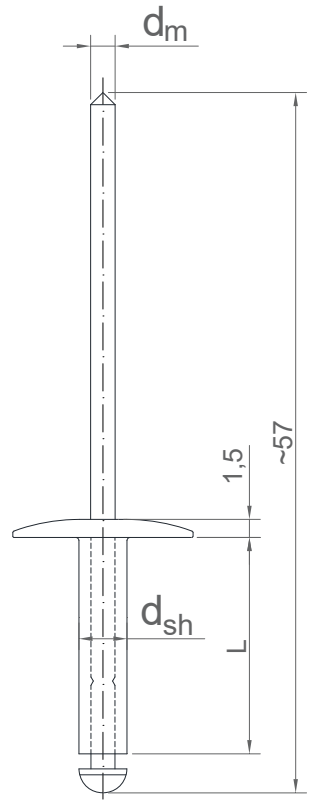
EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa

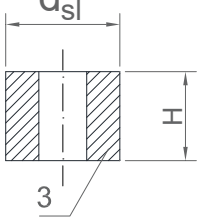
Universal Screws with drillpoint 5,5 x L K15 stainless steel

Annex A4

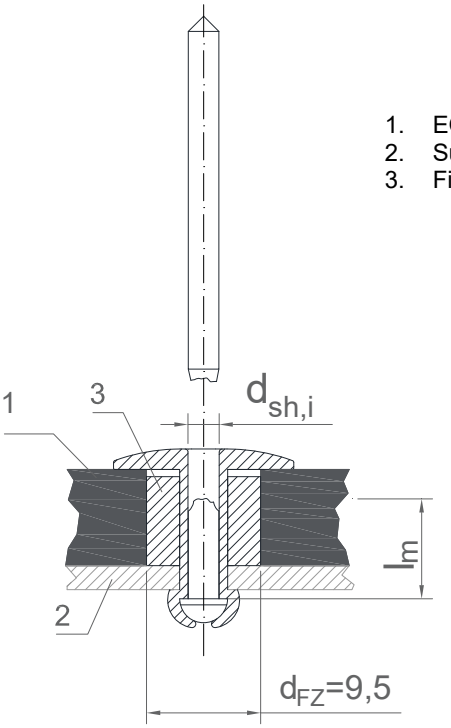
Deutsches Institut für Bautechnik DIBt

rivet unmounted

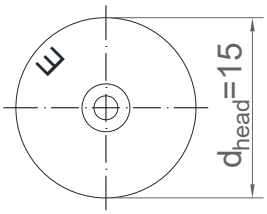




rivet mounted as fixpoint



1. EQUITONE
2. Subconstruction
3. Fixed point sleeve:
   08 for e_{nom} = *8 mm*
   12 for e_{nom} = *12 mm*



all dimensions in mm;
without scale

Materials:

Sleeve / head:	AlMg5 (Material no. 3.3555 acc. to EN AW-5019)
Rivet mandrel:	X6CrNiTi18-10 (Material no.: 1.4541 acc. to EN 10088-1)
Fixed point sleeve:	AlCu4PbMgM (Material No. 3.1645 acc. to EN AW-2007)
Corrosivity Rivet system:	with coloured coating rivet head EN ISO 12944-2 "C4 medium" with additional corrosion protection coating EN ISO 12944-2 "C5-M long" [when applied in chloride containing environments e.g. the coast (<25 km)]

4xL K15	$f_{u,sh}$	$f_{u,m}$	d_{sh}	$d_{sh,i}$	d_m	d_{sl}	H; H_{eff} [mm]		l_m	cr		$F_{tens,k}$	A_{sh}	A_m
-	N/mm²	N/mm²	mm	mm	mm	mm	e_{nom}=8	e_{nom}=12	mm	mm		N	mm²	mm²
4x18 K15	275	1.000	4	2,1	2,05	9,4	7,4	-	8,3	8-13		2.400	9,1	3,3
4x25 K15	275	1.000	4	2,1	2,05	9,4	7,4	11,1	8,3	14-20		2.400	9,1	3,3
Key figures*	t_{sub}	$f_{u,sub}$	$f_{head,k}$	e_{nom}	$F_{head,k}$	$F_{ax,k,sub}$**	$F_{b,Rk}$	$F_{vr,Rk}$	$F_{v,Rk}$	k_{mod}	$k_{mod,f}$	$F_{ax,Rd}$	$F_{v,Rd}$	
-	mm	N/mm²	N/mm²	mm	N	N	N	N	N	-	-	N	N	
4x18 K15	2	245	18,5	8	1.958	1.842	4.900	3.482	2.308	0,6	0,8	904	1.420	
4x25 K15	2	245	18,5	12	1.958	1.842	4.900	3.482	2.733	0,6	0,8	904	1.682	

* calculation according to EN 1995-1-1:2004/A2:2014 and ETA/-18/0955
** this value is only valid for the minimal indicated tensile strength $f_{u,sub}$ and the minimum thickness of t_{sub}

EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa

Rivets 4,0 x L K15 aluminum, fixed point sleeve

Annex A5

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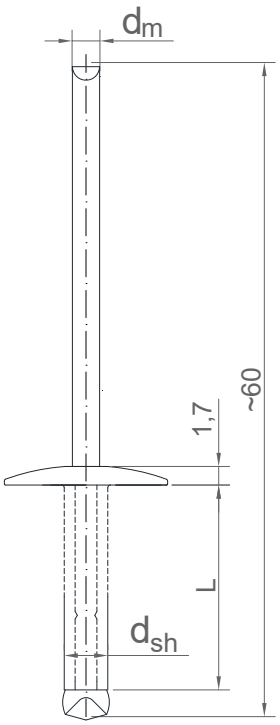
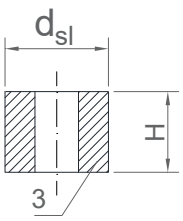
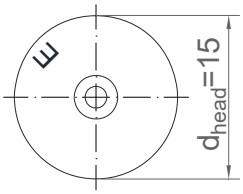
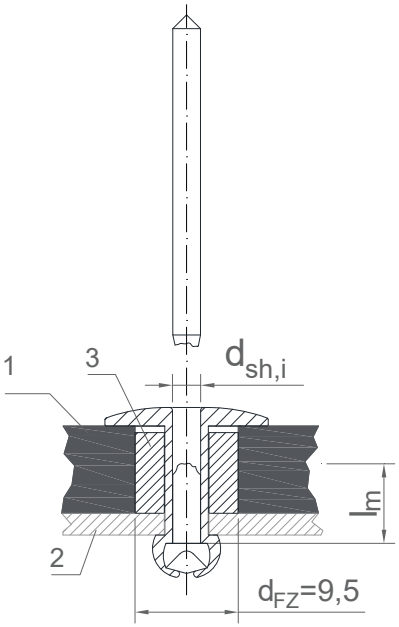
rivet unmounted







rivet mounted as fixpoint



1. EQUITONE
2. Subconstruction
3. Fixed point sleeve:
   08 for e_{nom} = *8 mm*
   12 for e_{nom} = *12 mm*

Materials:

Sleeve / head:	AlCu4PbMgM (Material no.: 1.4567 acc. to EN 10088-1)
Rivet mandrel:	X6CrNiTi18-10 (Material no.: 1.4541 acc. to EN 10088-1)
Fixed point sleeve:	X8CrNiS18-9 (Material no.: 1.4305 acc. to EN 10088)
Corrosivity Rivet system:	with coloured coating rivet head EN ISO 12944-2 "C4 medium" with additional corrosion protection coating EN ISO 12944-2 "C5-M long" [when applied in chloride containing environments e.g. the coast (<25 km)]

all dimensions in mm;
without scale

4xL K15	$f_{u,sh}$	$f_{u,m}$	d_{sh}	$d_{sh,i}$	d_m	d_{sl}	H; H_{eff} [mm]		l_m	cr	$F_{tens,k}$	A_{sh}	A_m
-	N/mm²	N/mm²	mm	mm	mm	mm	e_{nom}=8	e_{nom}=12	mm	mm	N	mm²	mm²
4x16 K15	497	1.000	4	2,6	2,55	9,4	7,4	-	8,3	10-12	3.600	7,3	5,1
4x18 K15	497	1.000	4	2,6	2,55	9,4	7,4	-	8,3	12-14	3.600	7,3	5,1
4x20 K15	497	1.000	4	2,6	2,55	9,4	7,4	11,1	8,3	14-16	3.600	7,3	5,1
4x22 K15	497	1.000	4	2,6	2,55	9,4	7,4	11,1	8,3	16-18	3.600	7,3	5,1
4x24 K15	497	1.000	4	2,6	2,55	9,4	7,4	11,1	8,3	18-20	3.600	7,3	5,1

Key figures*	t_{sub}	$f_{u,sub}$	$f_{head,k}$	e_{nom}	$F_{head,k}$	$F_{ax,k,sub}$**	$F_{b,Rk}$	$F_{vr,Rk}$	$F_{v,Rk}$	k_{mod}	$k_{mod,f}$	$F_{ax,Rd}$	$F_{v,Rd}$
-	mm	N/mm²	N/mm²	mm	N	N	N	N	N	-	-	N	N
4x16 K15 4x18 K15 4x20 K15	2	245	19,7	8	2.085	2.149	4.900	5.228	2.429	0,6	0,8	962	1.495
4x22 K15 4x24 K15	2	245	19,7	12	2.085	2.149	4.900	5.228	3.350	0,6	0,8	962	2.061

* calculation according to EN 1995-1-1:2004/A2:2014 and ETA/-18/0955

** this value is only valid for the minimal indicated tensile strength $f_{u,sub}$ and the minimum thickness of t_{sub}

EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa

Rivets 4,0 x L K15 stainless steel, fixed point sleeve

Annex A6

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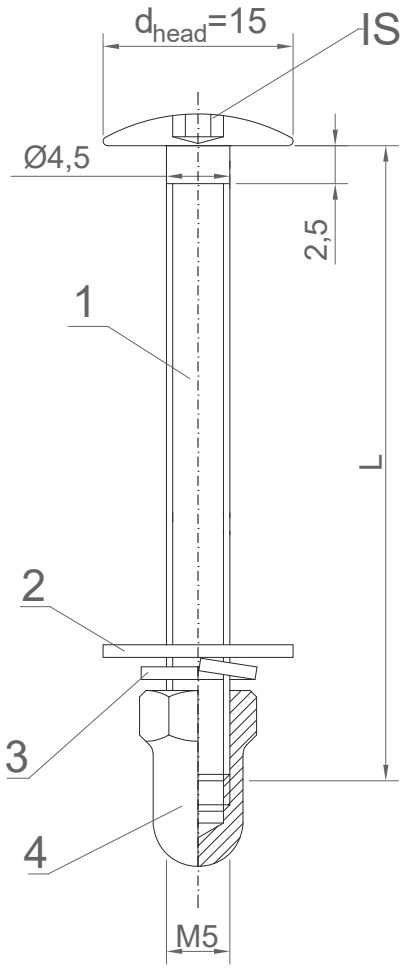
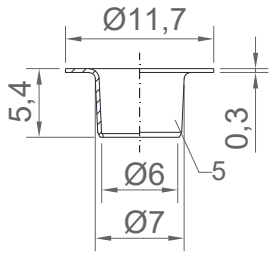
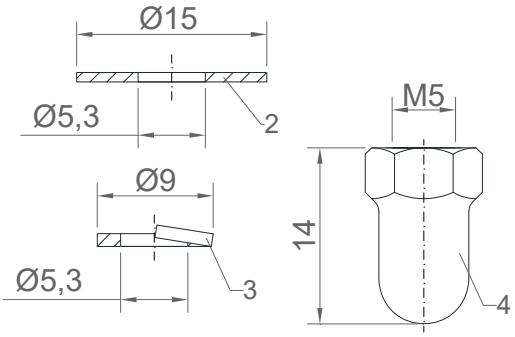




1. Balcony Screw
2. Washer
3. Spring washer
4. Cap nut
5. Screw collar for EQUITONE [natura] PRO, [pictura]



all dimensions in mm;
without scale

Materials:

Screw: X3CrNiCu18-9-1 (Material-no.: 1.4567 acc. to EN 10088-1)

Washer: X3CrNiCu18-9-1 (Material-no.: 1.4567 acc. to EN 10088-1)

Spring washer: X5CrNiMo17-12-2 (Material-no.: 1.4401 acc. to EN 10088-1)

Cap nut: X3CrNiCu18-9-1 (Material no.: 1.4567 acc. to EN 10088-1)

Screw collar for EQUITONE [natura] PRO, [pictura]: X5CrNi18-10 (Material-no.: 1.4301 acc. to EN 10088-1)

Corrosivity Screw system: with coloured coating screw head and additional corrosion protection coating EN ISO 12944-2 "C5-M long" [when applied in chloride containing environments e.g. the coast (< 25 km)]

M5xL K15	cr	$F_{lens,k}$	$f_{u,k}$	$M_{y,Rk}$	d_{FZ}
–	mm	N	N/mm²	Nm	mm
M5x20 K15	8,5 - 12,5	7.500	382	7.524	7
M5x25 K15	13,5 - 17,5	7.500	382	7.524	7
M5x30 K15	18,5 - 22,5	7.500	382	7.524	7
M5x35 K15	23,5 - 27,5	7.500	382	7.524	7
M5x40 K15	28,5 - 32,5	7.500	382	7.524	7
M5x45 K15	33,5 - 37,5	7.500	382	7.524	7
M5x50 K15	38,5 - 42,5	7.500	382	7.524	7
M5x55 K15	43,5 - 47,5	7.500	382	7.524	7
M5x60 K15	48,5 - 52,5	7.500	382	7.524	7
M5x65 K15	53,5 - 57,5	7.500	382	7.524	7
M5x70 K15	58,5 - 62,5	7.500	382	7.524	7

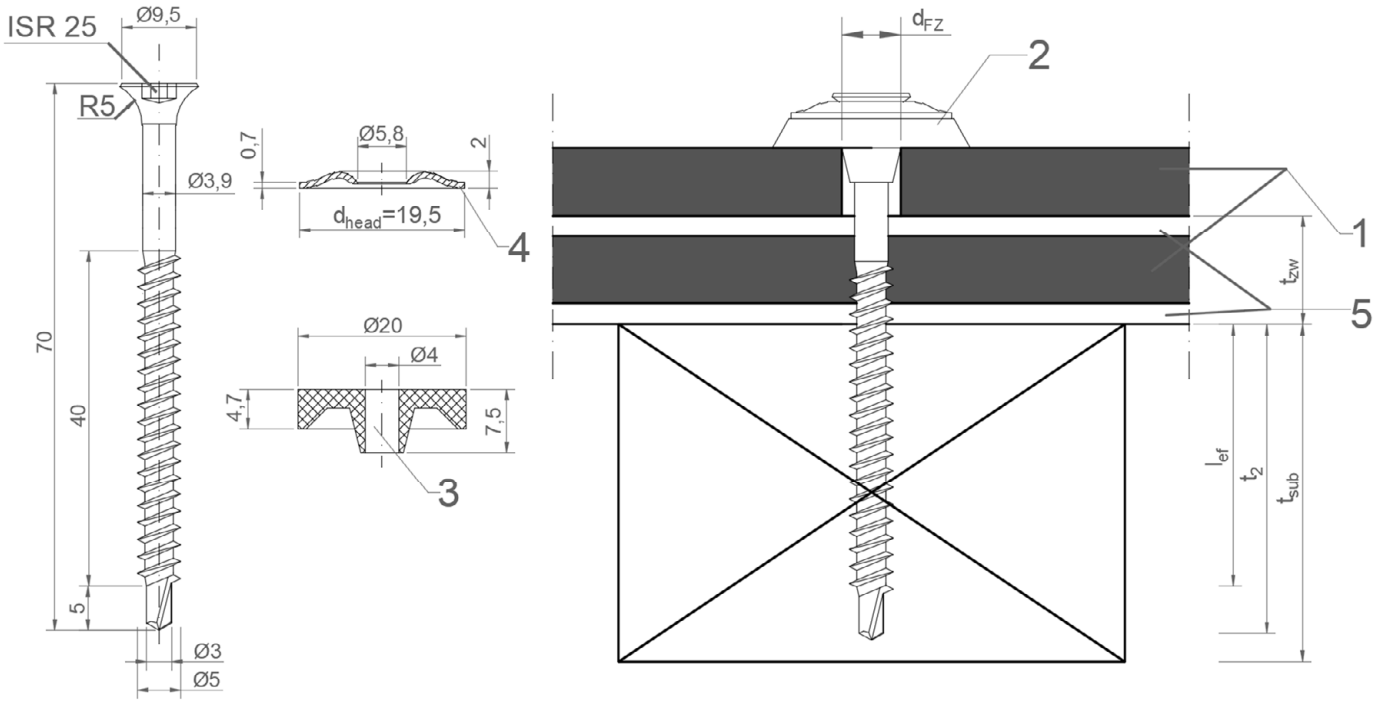
Key figures*	t_{sub}	$f_{u,sub}$	$f_{head,k}$	e_{nom}	$F_{head,k}$	$F_{ax,k,sub}$**	$F_{b,Rk}$	$F_{vr,Rk}$	$F_{v,Rk}$	k_{mod}	$k_{mod,f}$	$F_{ax,Rd}$	$F_{v,Rd}$
-	mm	N/mm²	N/mm²	mm	N	N	N	N	N	-	-	N	N
M5xL K15	2	245	15,2	12	2.101	13.854	6.125	3.750	2.783	0,6	0,8	970	1.389

* calculation according to EN 1995-1-1:2004/A2:2014 and ETA/-18/0955
** calculation according to EN 1999-1-1:2014

EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa

Balcony Screws M5 x L K15

Annex A7



1. EQUITONE
2. System-Roof Screw
3. Rosette with tenon
4. Washer
5. Spacer attachment profile (non-load bearing)

all dimensions in mm;
without scale

Materials:

Screw:	X3CrNiCu18-9-1 (Material-no.: 1.4567 acc. to EN 10088-1)
Washer:	X3CrNiCu18-9-1 (Material-no.: 1.4567 acc. to EN 10088-1)
Rosette with tenon:	EPDM
Spacer attachment:	Polyvinylchloride (PVC)
Corrosivity Screw system:	with coloured coating screw head and additional corrosion protection coating EN ISO 12944-2 "C5-M long" [when applied in chloride containing environments e.g. the coast (<25 km)]

System-Roof Screw	L	d_{head}	t_{sub}	t_2	l_{ef}	t_{zw}	d	d_{sh}	H_{eff}	$f_{ax,k}$	ρ_a	$M_{y,Rk}$	$F_{tens,k}$	d_{FZ}
-	mm	mm	mm	mm	mm	mm	mm	mm	mm	N/mm²	kg/m³	Nm	N	mm
5 x 70	70	19,5	40	36	31	13	5	3,9	e_{nom}	13,8	350	4,67	5.400	7

Key figures*	t_{sub}	ρ_k	$f_{head,k}$	e_{nom}	$F_{head,k}$	$F_{ax,k,sub}$	$F_{v,Rk}$	k_{mod}	$k_{mod,f}$	$F_{ax,Rd}$	$F_{v,Rd}$
-	mm	kg/m³	N/mm²	mm	N	N	N	-	-	N	N
5 x 70	40	350	8,1	8	2.107	1.749	1.416	0,6	0,8	973	516

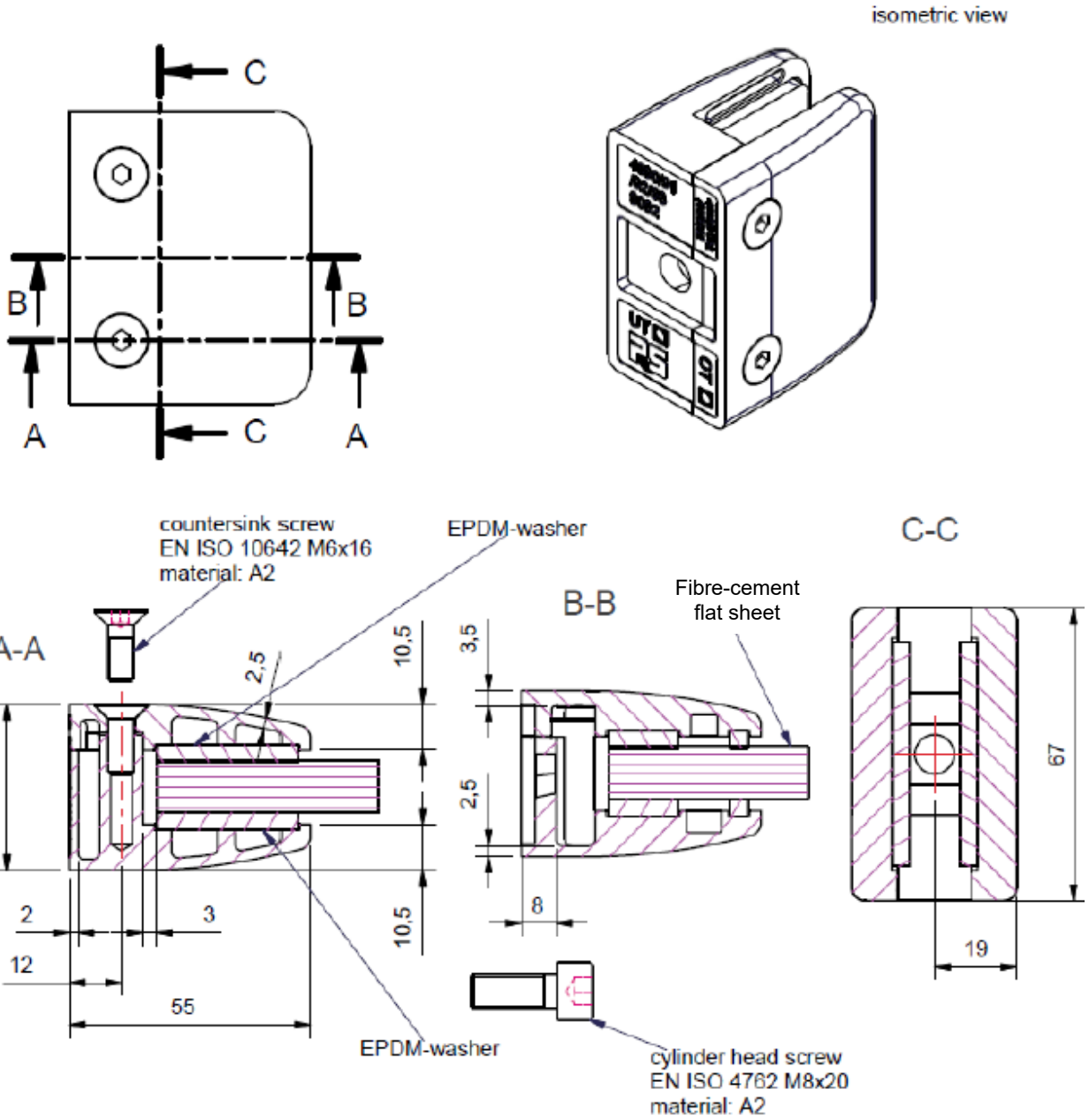
* calculation according to EN 1995-1-1:2004/A2:2014 and ETA-18/0955 and Blaß, H.J. und Lakewitz, B.: Tragfähigkeit von Verbindungen mit stiftförmigen Verbindungsmitteln und Zwischenschichten. Bauen mit Holz, H. 1 S. 26

EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa

System-Roof Screw 5,0 x 70 mm

Annex A8

Deutsches Institut für Bautechnik DIBt



Art. No.	material	e_{nom}	PVB-thickness	EPDM thickness	locking pin	locking plate
4891	ZL5 refined zinc	12 mm	0,76 mm	4 mm	no	yes or no

EQUITONE [natura], EQUITONE [pictura], EQUITONE [textura], EQUITONE [natura] PRO, EQUITONE [materia], EQUITONE balcony sheets, Elementa

P+S glass clamp according to ETA-11/0380

Annex A9

cr	clamping area of the fastener
d	diameter of the screw according to EN 1995-1-1
d_{FZ}	diameter of the borehole in the fibre-cement flat sheets "EQUITONE"
d_{head}	diameter of the fasteners head
d_m	diameter of the rivet mandrel
d_{sh}	diameter of the rivet shank or the diameter of a screw or the unthreaded part of a screw
$d_{sh,i}$	inner diameter of the rivet shank
d_{sl}	diameter of the fix point sleeve
d_{ss}	diameter of the spacer sleeve
e_{nom}	nominal thickness of the fibre-cement flat sheet "EQUITONE"
$f_{ax,k}$	characteristic value of the withdrawal parameter according to EN 1995-1-1
$f_{head,k}$	characteristic value of the pull through resistance
$f_{tor,k}$	characteristic value of the torsional strength
$f_{u,m}$	tensile strength of the rivet mandrel
$f_{u,sh}$	tensile strength of the shank
$f_{u,sub}$	tensile strength of the substructure
k_{mod}	global modification factor
$k_{mod,f}$	modification factor for shear connections
l_{ef}	penetration length of the threaded part according to EN 1995-1-1, clause 8.7
l_m	breaking point of the rivet mandrel
t_2	embedment depth of the screw on shear load
t_{sub}	thickness of the substructure
t_{zw}	movable intermediate layer
A_m	cross section of the rivet mandrel
A_{sh}	cross section of the shank
$F_{ax,k,sub}$	characteristic value of the withdrawal resistance of the fastener depending on the substructure
$F_{ax,Rd}$	design value of the axial tension resistance
$F_{b,Rk}$	characteristic value of the embedment resistance of the metal substructure according to EN 1993-1-1 for steel and EN 1999-1-1 for aluminium
$F_{head,k}$	characteristic value of the pull through resistance
$F_{tens,k}$	characteristic value of the tensile resistance of the fastener
$F_{v,Rd}$	design value of the shear resistance
$F_{v,Rk}$	characteristic value of the shear resistance calculated with the "Johansen yield theory"
$F_{vr,Rk}$	characteristic value of the shear resistance of the fastener
H	height of the fix point sleeve
H_{eff}	load bearing height of the fix point sleeve
L	lenght of the rivet or screw
$M_{y,k}$	characteristic value of the yield moment
$R_{tor,k}$	characteristic value of the torsional resistance during screw installation
$f_{tor,k} / R_{tor,k}$	ratio of torsional strength/torsional resistance
ρ_a	corresponding density for $f_{ax,k}$
ρ_k	characteristic value of the density (for wooden substructures) according to EN 1995-1-1

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Specification of the intended use

Fibre-cement flat sheets according to EN 12467 with additional characteristics subject to non-structural partitions

- Ventilated cladding kit, ceiling kits and roofs cladding
- Parapets (balcony sheets)

Use conditions

Fibre-cement flat sheets

Category **A** acc. to EN 12467:	Sheets which are intended for applications where they may be subjected to heat, high moisture and severe frost.
Category **B** acc. to EN 12467:	Sheets 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:	Sheets 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:	Sheets 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

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Durability of metallic fasteners, sleeves, washers and sealings

General

- 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)

Screws and clamps:

- Stainless steel number 1.4301 or 1.4567 according to EN 10088-1

Rivets:

- Aluminium grade: AlMg5 according to EN AW-5019
- Stainless steel number 1.4541 or 1.4567 according to EN 10088-1

Sleeves:

- Aluminium grade: AlCu4PbMgMn according to EN AW-2007
- Stainless steel number 1.4305 according to EN 10088-1
- Polyamide PA6 (chemical designation)

Metal washer:

- Stainless steel number 1.4401 according to EN 10088-1

EPDM sealing:

- Shore hardness - A scale, hardness 60 – 80 or D scale, hardness 45 – 65, according ISO 7619-1
- Mean density 1,4 g/cm^3, according to ISO 1183-1
- Mean tensile strength 5 MPa and elongation at break about 300 % according to ISO 37

For other materials the grades may be similar or better.

Design

1. The design, calculation and execution of building components which are manufactured using the fibre-cement flat sheet according to EN 12467 with additional characteristics "EQUITONE" can be carried out according to EN 1995-1-1 considering the Technical Report TR 071 "Basis of design and installation for ventilated cladding kits, ceiling kits, roof cladding kits and parapets of fibre-cement flat sheets based on EAD 210025-00-0504 and substructure.
   For ventilated claddings kits, ceilings kits, parapets and roof cladding shall be made a verifiable proof of stability by the designer.
2. The relationship between use categories and area categories according to EN 1991-1-1 are given in Table B.1.

   Table B.1: Relationship between use categories and area categories according to EN 1991-1-1

Use category / RSB/RHB	Description	Area category
I	Zones accessible primarily to those with high incentive to exercise care, small risk of accidents occurring and misuse.	A, B
II	Zones accessible primarily to those with some incentive to exercise care. Some risk of accidents occurring and of misuse.	
III	Zones accessible primarily to those with little incentive to exercise care. Risk of accidents occurring and of misuse.	C1 - C4, D1 - D2
IV	Zone and risk as II and III In case of failure risk includes the fall to a floor at a lower level.	C5 A, B, C1 - C4, D1 - D2 where the partition has a function of a barrier

3. As partial safety factor for the fibre-cement flat sheets "EQUITONE" γ_M = 1,3 is recommended.
4. Poisson's ratio can be assumed similar to the Poisson´s ratio of concrete structures (ν = 0,2).
5. As design data of the global modification factor k_{mod} the following values are valid:

Load-duration class LCD	Service Class		
	SC 1	SC 2	SC 3
Permanent action	0,60	0,55	0,25
Long-term action	0,65	0,60	0,30
Medium-term action	0,70	0,65	0,45
Short-term action	0,80	0,75	0,60
Instantaneous action	1,00	1,00	1,00

6. As design data of the modification factor for the shear resistance of the screws and rivets $k_{mod,f}$ the following values are valid:

Load duration class LCD	Service class SC 1 to SC 3
Permanent action	0,80
Long-term action	0,80
Medium-term action	0,85
Short-term action	0,85
Instantaneous action	0,90

Note:

The determination of the global modification factor k_{mod} is based on a four-point bending test. In this type of test the weakest durable characteristic of tensile strength, compressive strength and shear strength is relevant for failure. In case of fibre-cement flat sheets "EQUITONE" the durable compressive strength is much bigger than the durable tensile strength. The tensile strength is related to the amount and characteristics of the man-made fibres. The compressive strength is related to the compressive strength of the cement.

The embedment strength of fixings is strongly related to the compressive strength in fact that the loading of the embedment causes compression. Regarding the higher durability of the embedment of fixings the modification factor $k_{mod,f}$ is determined.

7. As design data of the deformation factor k_{def} the following values are valid:

Service class	Load duration class (LDC)				
	Permanent action	Long-term action	Medium-term action	Short-term action	Instantaneous action
SC 1	2,50	1,50	0,60	0,25	0,05
SC 2	3,00	2,00	0,80	0,35	0,05
SC 3	1,70	1,35	0,80	0,50	0,20

8. Design value of axial tension resistance and shear resistance for fibre-cement flat sheets "EQUITONE" screwed into wooden substructure

<u>Design value of the axial tension resistance</u>

$$F_{ax,Rd} = \min \begin{cases} k_{mod} \cdot \dfrac{f_{ax,k}}{\gamma_M = 1{,}3} \cdot d \cdot l_{ef} \cdot \left(\dfrac{\rho_k}{\rho_a}\right)^{0,8} \\ k_{mod} \cdot \dfrac{f_{head,k}}{\gamma_M = 1{,}3} \cdot \dfrac{\pi}{4} \cdot \left(d_{head}{}^2 - d_{FZ}{}^2\right) \\ \dfrac{F_{tens,k}}{\gamma_M = 1{,}33} \end{cases}$$

with:

$f_{ax,k}$: characteristic value of the withdrawal parameter of the screw according to Annex A3, Annex A4 and Annex A8

ρ_k: characteristic value of the density (for wooden substructure) according to EN 1995-1-1

ρ_a: corresponding density for $f_{ax,k}$ according to Annex A3, Annex A4 and Annex A8

8. (Continuation from page 4)

with:

d: diameter of the screw according to Annex A3, Annex A4 and Annex A8

l_{ef}: penetration length of the threaded part acc. to EN 1995-1-1, clause 8.7

$f_{head,k}$: characteristic value of the pull through parameter according to clause 3.4

d_{head}: diameter of the head of the screw according to Annex A3, Annex A4 and Annex A8

d_{FZ}: diameter of the borehole in the fibre-cement flat sheet "EQUITONE"

k_{mod}: global modification factor according to Annex B, clause 5 and for wooden substructure according to EN 1995-1-1

$F_{tens,k}$: characteristic value of the tensile resistance of the screw according to Annex A3, Annex A4 and Annex A8

Design value of the shear resistance

$$F_{v,Rd} = \sqrt{k_{mod,f} \cdot k_{mod}} \cdot \frac{F_{v,Rk}}{\gamma_M = 1{,}3}$$

with:

$F_{v,Rk}$: characteristic value of the shear resistance according to EN 1995-1-1, clause 8.2.2

k_{mod}: modification factor of wooden substructure according to EN 1995-1-1

$k_{mod,f}$: modification factor for shear connections according to Annex B, clause 6

Characteristic value of the shear resistance calculated with the "Johansen yield theory" according to EN 1995-1-1, clause 8.2.2

$$F_{v,Rk} = \min \begin{cases} f_{h,1,k} \cdot e_{nom} \cdot d & (a) \\ f_{h,2,k} \cdot t_2 \cdot d & (b) \\ \frac{f_{h,1,k} \cdot e_{nom} \cdot d}{1+\beta} \left[\sqrt{\beta + 2\beta^2 \left[1 + \frac{t_2}{e_{nom}} + \left(\frac{t_2}{e_{nom}} \right)^2 \right] + \beta^3 \left(\frac{t_2}{e_{nom}} \right)^2} - \beta \left(1 + \frac{t_2}{e_{nom}} \right) \right] + \frac{F_{ax,Rk}}{4} & (c) \\ 1{,}05 \frac{f_{h,1,k} \cdot e_{nom} \cdot d}{2+\beta} \left[\sqrt{2\beta(1+\beta) + \frac{4\beta(2+\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot {e_{nom}}^2}} - \beta \right] + \frac{F_{ax,Rk}}{4} & (d) \\ 1{,}05 \frac{f_{h,1,k} \cdot t_2 \cdot d}{1+2\beta} \left[\sqrt{2\beta^2(1+\beta) + \frac{4\beta(1+2\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot {t_2}^2}} - \beta \right] + \frac{F_{ax,Rk}}{4} & (e) \\ 1{,}15 \sqrt{\frac{2\beta}{1+\beta}} + \sqrt{2 M_{y,Rk} \cdot f_{h,1,k} \cdot d} + \frac{F_{ax,Rk}}{4} & (f) \end{cases}$$

with:

$$f_{h,1,k} = 107{,}4 \cdot d^{-0{,}7} \cdot {e_{nom}}^{0{,}4}$$

$$\beta = \frac{f_{h,2,k}}{f_{h,1,k}}$$

Characteristic value of the axial tension resistance:

$$F_{\mathrm{ax,Rk}} = min \begin{cases} f_{\mathrm{ax,k}} \cdot d \cdot l_{\mathrm{ef}} \cdot \left(\frac{\rho_{\mathrm{k}}}{\rho_{\mathrm{a}}}\right)^{0,8} \\ f_{head,k} \cdot \frac{\pi}{4} \cdot \left({d_{\mathrm{head}}}^2 - {d_{\mathrm{FZ}}}^2\right) \\ F_{tens,k} \end{cases}$$

In the expressions the first term on the right-hand side is the load-carrying capacity according to the Johansen yield theory, whilst the second term is the contribution from the rope effect. The contribution to the load-carrying capacity due to the rope effect should be limited to the Johansen part.

with:

ρ_a: corresponding density for $f_{\mathrm{ax,k}}$ according to Annex A3, Annex A4 and Annex A8
ρ_{k}: characteristic density (for wooden substructure) according to EN 1995-1-1
β: the ratio of the embedment strength of the components to each other
d: diameter of the screw according to EN 1995-1-1
d_{head}: diameter of the head of the screw according to Annex A3, Annex A4 and Annex A8
d_{FZ}: diameter of the borehole in the fibre-cement flat sheet "EQUITONE"
e_{nom}: nominal value of the thickness of the fibre-cement flat sheet "EQUITONE"
$f_{\mathrm{ax,k}}$: characteristic value of the withdrawal parameter according to EN 1995-1-1
$f_{\mathrm{head,k}}$: characteristic value of the pull-through parameter according to clause 3.4
$f_{\mathrm{h,1,k}}$: characteristic value of the embedment strength of fibre-cement flat sheet "EQUITONE"
$f_{\mathrm{h,2,k}}$: characteristic value of the embedment strength of the wooden substructure according to EN 1995-1-1
l_{ef}: penetration length of the threaded part according to EN 1995-1-1, clause 8.7
t_2: wood thickness or embedding depth of the screw
$F_{\mathrm{ax,Rk}}$: characteristic value of the axial tension resistance
$F_{\mathrm{tens,k}}$: characteristic value of the tensile resistance of the screws according to Annex A3, Annex A4 and Annex A8
$M_{\mathrm{y,Rk}}$: characteristic value of the yield moment

9. Design value of axial tension resistance and shear resistance for fibre-cement flat sheets "EQUITONE" fastener in metal substructure

Design value of the axial tension resistance

$$F_{\mathrm{ax,Rd}} = \min \begin{cases} \dfrac{F_{\mathrm{ax,k,sub}}}{\gamma_{\mathrm{M}} = 1{,}33} \\ k_{\mathrm{mod}} \cdot \dfrac{f_{\mathrm{head,k}}}{\gamma_{\mathrm{M}} = 1{,}3} \cdot \dfrac{\pi}{4} \cdot \left({d_{\mathrm{head}}}^2 - {d_{\mathrm{FZ}}}^2 \right) \\ \dfrac{F_{\mathrm{tens,k}}}{\gamma_{\mathrm{M}} = 1{,}33} \end{cases}$$

with:

$f_{\mathrm{head,k}}$: characteristic value of the pull through parameter according to clause 3.4

d_{head}: diameter of the head of the fasteners according to Annex A1, Annex A2, Annex A5, Annex A6 and Annex A7

d_{FZ}: diameter of the borehole in the fibre-cement flat sheet "EQUITONE"

k_{mod}: global modification factor according to Annex B, clause 5 and for wooden substructure according to EN 1995-1-1

$F_{\mathrm{tens,k}}$: characteristic value of the tensile resistance of the fasteners according to Annex A1, Annex A2, Annex A5, Annex 6 and Annex A7

$F_{\mathrm{ax,k,sub}}$: characteristic value of the withdrawal resistance of the fasteners depending on the substructure according to Annex A1, Annex A2, Annex A5, Annex A6 and Annex A7

Design value of the shear resistance

$$F_{\mathrm{v,Rd}} = \min \begin{cases} \dfrac{F_{\mathrm{vr,Rk}}}{\gamma_{\mathrm{M}} = 1{,}33} \\ k_{\mathrm{mod,f}} \cdot \dfrac{F_{\mathrm{v,Rk}}}{\gamma_{\mathrm{M}} = 1{,}3} \\ \dfrac{F_{\mathrm{b,Rk}}}{\gamma_{\mathrm{M}} = 1{,}25} \end{cases}$$

with:

$k_{\mathrm{mod,f}}$: modification factor for shear connections according to Annex B, clause 6

$F_{\mathrm{vr,Rk}}$: characteristic value of the shear resistance of the fastener

$F_{\mathrm{b,Rk}}$: characteristic value of the embedment resistance of the metal substructure according to EN 1993-1-1 for steel and EN 1999-1-1 for aluminium

$F_{\mathrm{v,Rk}}$: characteristic value of the shear resistance calculated with the "Johansen yield theory"

Characteristic value of the embedment resistance of the metal substructure:

$$F_{\mathrm{b,Rk}} = 2{,}5 \cdot f_{\mathrm{u,sub}} \cdot d_{\mathrm{sh}} \cdot t_{\mathrm{sub}}$$

with:

$f_{\mathrm{u,sub}}$: tensile strength of the substructure

t_{sub}: thickness of the substructure

d_{sh}: diameter of the rivet shank or the diameter of a screw or the untreaded part of a screw

Characteristic value of the shear resistance of the fastener:

$$F_{vr,Rk} = 0{,}6 \cdot \left(f_{u,sh} \cdot A_{sh} + f_{u,m} \cdot A_m \right)$$

with:

A_{sh}: cross section of the shank
A_m: cross section of the rivet mandrel
$f_{u,m}$: tensile strength of the rivet mandrel
$f_{u,sh}$: tensile strength of the shank

The characteristic value of the shear resistance $F_{v,Rk}$ shall be calculated according to EN 1995-1-1, clause 8.2.3. The following formula is a modification in relation to the formula symbols. The remaining regulations according to EN 1995-1-1 must be observed.

For thin substructure thicknesses ≤ 0,5 · d_{sh}:

$$F_{v,Rk} = \min \begin{cases} 0{,}4 \cdot f_{h,sl,k} \cdot H_{eff} \cdot d_{sl} & (a) \\ 1{,}15 \cdot \sqrt{2 M_{y,Rk} \cdot f_{h,k} \cdot d_{sh}} + \frac{F_{ax,Rk}}{4} & (b) \end{cases}$$

For thick substructure thicknesses $\geq d_{sh}$:

$$F_{v,Rk} = \min \begin{cases} f_{h,sl,k} \cdot H_{eff} \cdot d_{sl} & (c) \\ f_{h,k} \cdot H_{eff} \cdot d_{sh} \cdot \left[\sqrt{2 + \frac{4 M_{y,Rk}}{f_{h,k} \cdot {H_{eff}}^2 \cdot d_{sh}}} - 1 \right] + \frac{F_{ax,Rk}}{4} & (d) \\ 2{,}3 \cdot \sqrt{M_{y,Rk} \cdot f_{h,k} \cdot d_{sh}} + \frac{F_{ax,Rk}}{4} & (e) \end{cases}$$

For fiber-cement flat sheets "EQUITONE" with rivet fixing and thin substructure thicknesses ≤ 0,5 · d_{sh} the failure mechanisms (a) and (b) can be modified.

$$F_{v,Rk} = \min \begin{cases} 0{,}4 \cdot f_{h,sl,k} \cdot H_{eff} \cdot d_{sl} + \frac{F_{ax,Rk}}{2} \\ 1{,}15 \cdot \sqrt{2 M_{y,Rk} \cdot f_{h,k} \cdot d_{sh}} + \frac{F_{ax,Rk}}{2} \end{cases}$$

Embedment strength for the shank failure mode (b), (d) and (e):

$$f_{h,k} = 107{,}4 \cdot d_{sh}^{-0,7} \cdot {e_{nom}}^{0,4}$$

Embedment strength for the sleeve failure mode (a) and (c):

$$f_{h,sl,k} = 107{,}4 \cdot d_{sl}^{-0,7} \cdot {H_{eff}}^{0,4}$$

Interpolation between levels of thin and thick metal plates is allowed for substructure thicknesses $> 0{,}5 \cdot d_{sh}$ and $< 1{,}0 \cdot d_{sh}$

Calculation of the characteristic value of the yield moment $M_{y,Rk}$:

For rivets with load bearing mandrel, after tightening mandrel penetrates more than $2/3$ of sheet thickness, as illustrated in Figure B.9.1:

$$M_{y,Rk} = 0{,}3 \cdot d_{sh}^{2.6} \cdot f_{u,sh} \cdot \left(\frac{d_{sh-}^4 d_m^4}{d_{sh}^4}\right) + 0{,}3 \cdot d_m^{2.6} \cdot f_{u,m}$$

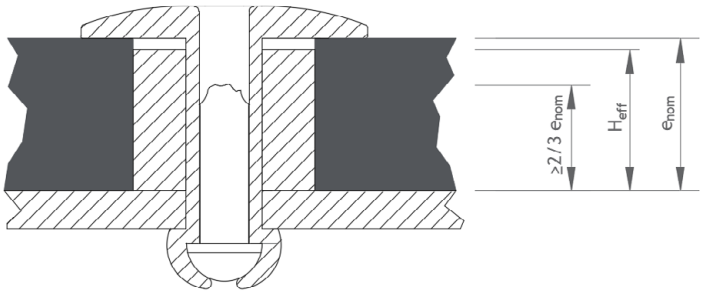

Figure B.9.1: Rivet with load bearing mandrel

For rivet with non-load bearing mandrel:

$$M_{y,Rk} = 0{,}3 \cdot d_{sh}^{2.6} \cdot f_{u,sh} \cdot \left(\frac{d_{sh-}^4 d_m^4}{d_{sh}^4}\right)$$

Characteristic value of the axial tension resistance:

$$F_{ax,Rk} = \min \begin{cases} F_{ax,k,sub} \\ f_{head,k} \cdot \frac{\pi}{4} \cdot \left(d_{head}{}^2 - d_{FZ}{}^2\right) \\ F_{tens,k} \end{cases}$$

In the formulas, the first summand on the right hand side represents the load-bearing capacity according to Johansen's flow theory, while the second summand contains the part from the rope action. The share of rope effect in the load bearing capacity must be limited to the share according to Johansen's theory.

with:

d_{head}: diameter of the head of the fasteners according Annex A1, Annex A2, Annex A5, Annex A6 and Annex A7

d_{sh}: diameter of the rivet shank or the diameter of a screw or the unthreaded part of a screw

d_{sl}: diameter of the fix point sleeve

d_{FZ}: diameter of the borehole in the fibre-cement flat sheets "EQUITONE"

d_m: diameter of the rivet mandrel

$f_{u,sh}$: tensile strength of the shank

$f_{head,k}$: characteristic value of the pull-through parameter according clause 3.4

H_{eff}: load bearing height of the fix point sleeve

$F_{tens,k}$: characteristic value of the tensile resistance of the fasteners according Annex A1, Annex A2, Annex A5, Annex A6 and Annex A7

$F_{ax,k,sub}$: characteristic value of the withdrawal resistance of the fasteners depending on the substructure according Annex A1, Annex A2, Annex A5, Annex A6 and Annex A7

10. Verifications of fibre-cement flat sheets "EQUITONE" fasteners

Axial tension:

$$\frac{F_{\mathrm{ax,Ed}}}{F_{\mathrm{ax,Rd}}} \leq 1$$

with:

$F_{ax,Ed}$: design value of the existing axial tension force

$F_{ax,Rd}$: design value of axial tension resistance

Shear:

$$\frac{F_{\mathrm{v,Ed}}}{F_{\mathrm{v,Rd}}} = \frac{\frac{G_{\mathrm{d}}}{n_{\mathrm{fix}}}}{F_{\mathrm{v,Rd}}} \leq 1$$

with:

n_{fix}: total number of fixpoints carrying the self-weight ($n_{fix} \leq 2$)

$F_{v,Ed}$: design value of the existing shear force

$F_{v,Rd}$: design value of the shear resistance

G_d: design value of the self-weight

Combined shear and axial tension:

For a fastener loaded in combined shear and tension the load bearing capacity of the connection may be verified using:

$$\left(\frac{F_{\mathrm{ax,Ed}}}{F_{\mathrm{ax,Rd}}}\right)^{1,2} + \left(\frac{\frac{G_{\mathrm{d}}}{\mathrm{n}}}{F_{\mathrm{v,Rd}}}\right)^{1,2} \leq 1$$

with:

n: total number of fasteners for fixing the sheet

11. Verifications of fibre-cement flat sheets "EQUITONE"

$$\frac{\sigma_{\mathrm{m,Ed}}}{f_{\mathrm{m,d}}} \leq 1$$

with:

$\sigma_{m,Ed}$: design value of the bending stress in the span

$f_{m,d}$: design value of the bending strength

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Installation

During transport and storage the fibre-cement flat sheets "EQUITONE" and the components manufactured by using these sheets 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).

Protect the non-installed sheets from direct sunlight. Where supplied the paper or foil liners serves to protect the high-quality surface and must always be inserted again in the event of restacking. Standing moisture between stored sheets can lead to lime efflorescence which cannot be removed and permanently damages the quality of the visible surface.

Untrimmed (EN 12467, clause 5.3.4.1: level II) fibre-cement flat sheets "EQUITONE" must be trimmed (EN 12467, clause 5.3.4.1: level I) according to the manufacturer instruction on all four sides.

Damaged or with visual defects fibre-cement flat sheets "EQUITONE" or components manufactured by using these sheets may not installed.

During the installation of the fibre-cement flat sheets "EQUITONE" the moisture of the timber substructure may not detrimentally increase until installing the sheets (protection from precipitation or high building moisture).

For the installation of the fibre-cement flat sheets "EQUITONE" the information and regulations of the manufacturer (instruction for installation) shall be observed.

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C.1 Reaction to fire

Table C.1.1: Test conditions and classifications "Reaction to fire" for the fibre-cement flat sheet "EQUITONE"

Sub-structure	Thickness of the sheet	Description of the sheet and test conditions	Intended uses	Classification
Metall	8,0 mm, 12,0 mm	uncoated and all coated sheets types open joints ≤ 12,0 mm air gap ≥ 20,0 mm	Ventilated cladding kits, ceiling kits and roof cladding	A2-s1,d0
Wood	8,0 mm, 12,0 mm	uncoated and all coating variations open joints ≤ 12,0 mm air gap about 20,0 mm	Ventilated cladding kits, ceiling kits and roof cladding	A2-s1,d0
Wood	8,0 mm, 12,0 mm	uncoated and all coating variations open joints ≤ 12,0 mm air gap ≥ 20,0 mm	Ventilated cladding kits, ceiling kits and roof cladding	C-s2,d0
Metall	12,0 mm	uncoated and all coating variations open joints ≤ 10,0 mm	Parapets (Balcony sheets)	A2-s1,d0

The depth of the ventilation gap must be at least 20 mm for flat building products (e.g. thermal insulation according to EN 13162) of building material class A1or A2-s1,d0 according to EN 13501-1.

All these tests were performed with a joint of 10 mm width between the bottom of the specimen and top level of U-profile of the SBI-test device.

C.2 Typical load deflection curves

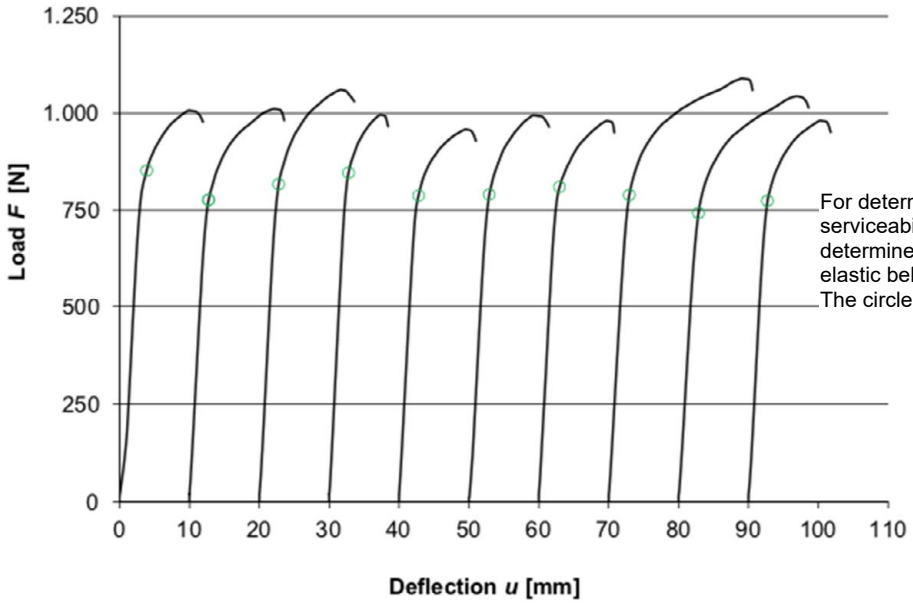
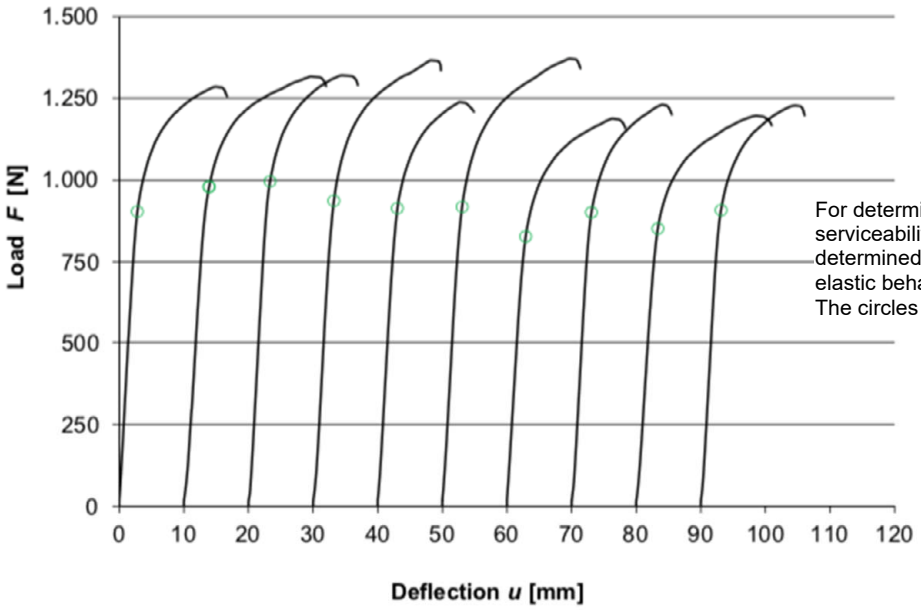


Figure C.2.1: Typical load deflection curve tested perpendicular to the plane of the flat sheet and bending stress perpendicular to the production direction

C.2 Typical load deflection curves - continuation



For determination of the bending strength at serviceability limit state the stress shall be determined at the point of leaving the linear elastic behaviour.
The circles mark these points.

Figure C.2.2: Typical load deflection curve tested perpendicular to the plane of the flat sheet and bending stress parallel to the production direction

C.3 Modification factors

Table C.3.1: Global modification factor k_{mod} for fibre-cement flat sheets "EQUITONE"

Service class	Load duration class (LDC)				
	Permanent action	Long-term action	Medium-term action	Short-term action	Instantaneous action
1	0,60	0,65	0,70	0,80	1,00
2	0,55	0,60	0,65	0,75	1,00
3	0,25	0,30	0,45	0,60	1,00

Table C.3.2: Modification factor for shear connections $k_{mod,f}$ of fibre-cement flat sheets "EQUITONE"

Service class	Load duration class (LDC)				
	Permanent action	Long-term action	Medium-term action	Short-term action	Instantaneous action
1 - 3	0,80	0,80	0,85	0,85	0,90

Note:
The determination of the global modification factor k_{mod} is based on a four-point bending test. In this type of test the weakest durable characteristic of tensile strength, compressive strength and shear strength is relevant for failure. In case of fibre-cement flat sheets "EQUITONE" the durable compressive strength is much bigger than the durable tensile strength. The tensile strength is related to the amount and characteristics of the man-made fibres. The compressive strength is related to the compressive strength of the cement.
The embedment strength of fixings is strongly related to the compressive strength in fact that the loading of the embedment causes compression. Regarding the higher durability of the embedment of fixings the modification factor $k_{mod,f}$ is determined.

C.4 Deformation factor

Table C.4.1: Values of deformation factor k_{def} for fibre-cement flat sheets "EQUITONE"

Service Class	Load duration class (LDC)				
	Permanent action	Long-term action	Medium-term action	Short-term action	Instantaneous action
1	2,50	1,50	0,60	0,25	0,05
2	3,00	2,00	0,80	0,35	0,05
3	1,70	1,35	0,80	0,50	0,20

C.5 Application quantity and solid content of the surface coating

Table C.5.1: Application quantity and solid content of the surface coating of the fibre-cement flat sheets "EQUITONE"

Name	Surface coating / Treatment	Max. dry matter quantity
EQUITONE [natura]	with a transparent acrylate layer with or without pigments	0,08 kg/m²
EQUITONE [textura]	with an opaque, optionally granular coating with acrylate-based binders with pigments	0,15 kg/m²
EQUITONE [natura] PRO	with a transparent acrylate coating with and without pigments as medium coating and a UV-cured functional layer	0,15 kg/m²
EQUITONE [pictura]	with an opaque acrylate coating as medium coating and a UV-cured functional layer	0,16 kg/m²
EQUITONE [materia]	with a mechanical surface treatment without coating	-
EQUITONE balcony sheets	Each coating or treatment variant can be combined on the both surfaces	0,08 kg/m² – 0,16 kg/m²
Elementa	with an opaque coating with acrylate-based binders	0,09 kg/m²

C.6 Resistance to soft body impact

Table C.6.1: Resistance to soft body impact (RSB) and span for the substructure (L_i) for ventilated cladding kits

Fastener	Thickness e_{nom}	Sheet direction	RSB / L_i
-	mm	°	class / mm
Sheets with rivets /screws according to Annex A1 to Annex A7 with $d_{head} \geq 15$ mm	8,0	0	I - IV / 800
	8,0	90	I - IV / 800
	12,0	0	I - IV / 800
	12,0	90	I - IV / 800

Table C.6.2: Resistance to soft body impact (RSB-P) and span for the substructure (L_i) for parapets (balcony sheets)

Fastener	Thickness e_{nom}	Sheet direction[2)]	$E_{impact,r}$ / L_i
-	mm	°	Nm / mm
Sheets with rivets / screws according to Annex A1 to Annex A7 with $d_{head} \geq 15$ mm and fixing distance between ≤ 500 mm	12,0	0	416 / 800
	12,0	90	408 / 700
Sheets[1)] with rivets / screws according to Annex A1 to Annex A7 with $d_{head} \geq 15$ mm	12,0	0	272 / 700
Sheets with clamp mounting according to Annex A9 and a clamp distance between ≤ 500 mm	12,0	0	278 / 950
	12,0	90	278 / 850

1) Width of the sheet w = 160 mm, fixed with one fastener at each bearing profile.
2) The values of sheet direction 0° may only be used if the installation direction and the production direction are known.

with:

RSB Resistance to structural damage for use category according Annex B, Table B1 from soft body impact
L_i span of the substructure
$E_{impact,r}$ impact energy from soft body impact of parapets (balcony sheets)

C.7 Resistance to hard body impact

Table C.7.1: Resistance to hard body impact (RHB) and span for the substructure (L_i) for ventilated cladding kits

Fastener	Thickness e_{nom}	Sheet direction	RHB / L_i
-	mm	°	class / mm
Sheets with rivets / screws according to Annex A1 to Annex A7 with $d_{head} \geq 15$ mm	8,0	0	I - IV / 800
	8,0	90	I - IV / 800
	12,0	0	I - IV / 800
	12,0	90	I - IV / 800

Table C.7.2: Resistance to hard body impact (RHB-P) and span for the substructure (L_i) for parapets (balcony sheets)

Fastener	Thickness e_{nom}	Sheet direction	RHB-P / L_i
-	mm	°	class / mm
Sheets with rivets/ screws according to Annex A1 to Annex A7 with $d_{head} \geq 15$ mm and fixing distance between ≤ 500 mm	12,0	0	(1), (2), (3) / 800
	12,0	90	(1), (2), (3) / 800
Sheets with clamp mounting according to Annex A9 and clamp distance between ≤ 500 mm	12,0	0	(1), (2), (3) / 800
	12,0	90	(1), (2), (3) / 800

with:

RHB Resistance to structural damage for use category according Annex B, Table B.1 from hard body impact

L_i span of the substructure

RHB-P Resistance level to structural damage from hard body impact

(1) no collapse the test result is favourable when, after the test, the sheet or assembly maintains its mechanical integrity and is still capable of carrying its own weight in the tested position.

(2) no penetration the test result is favourable when, after the test, the impactor has not passed through the test specimen.

(3) no projection: the test result is favourable when, after the test, the impactor has not created parts of the sheet to project from the face of the sheet, on the other side of the specimen than the impact side, creating sharp cutting edges or surfaces likely to cause personal injury by contact.

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C.8 Shatter properties

SP = Group A
(In combination with the specific conditions according to Annex C6 and Annex C7)

A description concerning the shatter properties and the level of impact energy shall be made according to the following provisions:

- Group A: No cracks are visible from 1 m, and any crack visible from closer than 1 m unlikely to lead to significant deterioration.
- Group B: A lot of cracks occur, but all pieces belong still together and do not quarry out of the specimen.
- Group C: A lot of cracks occur. The edges of the shatter pieces are sharp and some of them have a bigger size. Pieces of the specimen are quarried out.