

titolo del progetto

– NUOVA SCUOLA PER L'INFANZIA A SEI SEZIONI
IN LOCALITA' CASTELLO DI SERRAVALLE - VIALE G. VERDI
COMUNE DI VALSAMOGGIA (BO)
PROGETTO ESECUTIVO

committente

– COMUNE DI VALSAMOGGIA (Città Metropolitana di Bologna, BO), Piazza Garibaldi n° 1, 40053 - Valsamoggia (BO)

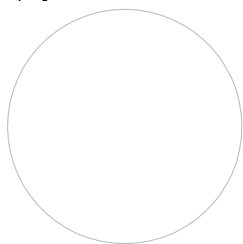
titolo della tavola

– RELAZIONE SUI MATERIALI
LA RELAZIONE SOSTITUISCE LA RELAZIONE 105 DEPOSITATA IN DATA 06/06/2017 PER RECEPIRE
LE RICHIESTE DI INTEGRAZIONE DE SERVIZIO AREA RENO E PO DI VOLANO

num. pratica	data emissione	redatto da	rapp. disegni	lay-out	fase operativa	file
4213	febbraio 2017	LB	–	–	esecutivo	4213–RM.pdf

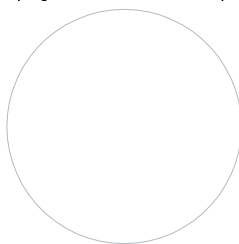
rev.	data	descrizione	redatto da
A	15/05/2017	REVISIONE COME DA INDICAZIONI DEL SERVIZIO AREA RENO E PO DI VOLANO DEL 14/04/2017	
B	05/07/2017	RICHIESTA DI INTEGRAZIONI DEL SERVIZIO AREA RENO E PO DI VOLANO DEL 29/06/2017 (VS–005–2017)	
C			
D			
E			

Il responsabile della
progettazione architettonica



Arch. Enrico Termanini

Il responsabile della
progettazione strutturale e impiantistica

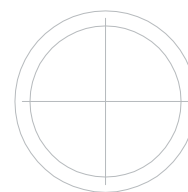


Ing. Davide Bedogni

N°. tavola

105

orientamento



NUOVA SCUOLA DELL'INFANZIA A SEI SEZIONI in località CASTELLO di SERRAVALLE
viale G. Verdi - COMUNE DI VALSAMOGGIA (BO)
PROGETTO ESECUTIVO
RELAZIONE ILLUSTRATIVA DEI MATERIALI

RELAZIONE SUI MATERIALI

ELENCO DEI MATERIALI AD USO STRUTTURALE UTILIZZATI

-Calcestruzzo (fondazioni e pilastri) $f_{ck}/R_{ck} = 25/30$

Classe di resistenza : C30

Classe di esposizione : XC2

Classe di consistenza : S3/S4

dim. max inerti : 32 mm

Con:

- $f_{ck} = 0,83$ $R_{ck} = 24,9$ N/mm²

- $R_{ck} = 30$ N/mm²

- $E_{cm} = 22'000[f_{cm}/10]^{0,3} = 22'000[(f_{ck}+8)/10]^{0,3} = 31'447,16$ N/mm²

- Coefficiente di Poisson 0,10

- $G = E_{cm}/2(1+0,1) = 14'294'163$ KN/m²

- $\gamma_c = 1,5$

Acciaio in barre per getti C.A.: tipo B 450 C controllato in stabilimento , saldabile

Proprietà reologiche:	$E = 20000$ (kN/cm ²) $\nu = 0.300$ $G = 7692.3$ (kN/cm ²)
<i>Tipologia del Materiale: Acciaio per Armature</i>	$f_{yk} = 45$ (kN/cm ²) $\gamma_{M,c} = 1.15$ $\gamma_{M,t} = 1.15$ $\gamma_{M,ecc} = 1$ $f_u = 54$ (kN/cm ²) $\epsilon_{ud} = 0.0675$ Aderenza Migliorata = Si
Valori di progetto	$f_{cd} = 39.13$ (kN/cm ²) $f_{ctd} = 39.13$ (kN/cm ²) $P_s = 7.85e-005$ (kN/cm ³) $\alpha = 1.2e-005$ (1/°C)

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RELAZIONE ILLUSTRATIVA DEI MATERIALI

Legno lamellare GL 24H

Classe di resistenza del legno lamellare incollato		GL 24h	GL 28h	GL 32h	GL 36h
Resistenza a flessione	$f_{m,g,k}$	24	28	32	36
Resistenza a trazione	$f_{t,0,g,k}$	16,5	19,5	22,5	26
	$f_{t,90,g,k}$	0,4	0,45	0,5	0,6
Resistenza a compressione	$f_{c,0,g,k}$	24	26,5	29	31
	$f_{c,90,g,k}$	2,7	3,0	3,3	3,6
Resistenza a taglio	$f_{v,g,k}$	2,7	3,2	3,8	4,3
Modulo di elasticità	$E_{0,g,mean}$	11 600	12 600	13 700	14 700
	$E_{0,g,05}$	9 400	10 200	11 100	11 900
	$E_{90,g,mean}$	390	420	460	490
Modulo di taglio	$G_{g,mean}$	720	780	850	910
Massa volumica	$\rho_{g,k}$	380	410	430	450

Profilati in acciaio S235

Acciai laminati				
Norma e tipo di acciaio	Spessore nominale della membratura			
	$t \leq 40 \text{ mm}$		$40 \text{ mm} < t \leq 80 \text{ mm}$	
EN 10025-2	$f_y [\text{N/mm}^2]$	$f_u [\text{N/mm}^2]$	$f_y [\text{N/mm}^2]$	$f_u [\text{N/mm}^2]$
S 235	235	360	215	360
S 275	275	430	255	410
S 355	355	510	335	470
S 450	440	550	410	550

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RELAZIONE ILLUSTRATIVA DEI MATERIALI

Legno XLAM sp240mm materiale C24

Resistenza a flessione	fm,k	24 MPa
Resistenza a trazione parallela	ft,0,k	14 MPa
Resistenza a trazione perpendicolare	ft,90,k	0.4 MPa
Resistenza a compressione parallela	fc,0,k	21 MPa
Resistenza a compressione perpendicolare	fc,90,k	2.5 MPa
Resistenza a taglio	fv,k	2.5 MPa
Massa volumica caratteristica	rho k	350 daN/m ³
Modulo elastico medio parallelo	E0,men	11000 MPa
Modulo elastico parallelo	Ek	7400 MPa
Modulo elastico medio perpendicolare	E90,mean	370 MPa
Modulo di taglio medio	Gmean	690 MPa
Modulo di taglio medio parallelo	GR,mean	50 MPa



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Authorised and notified according
to Article 29 of the Regulation (EU)
No 305/2011 of the European
Parliament and of the Council of 9
March 2011

MEMBER OF EOTA



European Technical Assessment ETA-10/0189 of 03/03/2016

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:

Knapp Clip Connectors type GIGANT 120, 150 and 180, Type RICON 60/40, 80/40, 100/40, 120/40, 140/40 and 160/40, Type RICON S 60/140, 60/170, 60/200, 60/230 and 80/200, 80/230, 80/260 and 80/290, and Type WALCO V60, V80 and WALCO 40

Product family to which the above construction product belongs:

Three-dimensional nailing plate (concealed beam hangers)

Manufacturer:

Knapp GmbH
Wassergasse 31
A-3324 Euratsfeld
Tel.: +43 (0) 7474 79910-0
Telefax: +43 (0) 7474 79910-99
Internet: www.knapp-verbinder.com

Manufacturing plant:

Knapp GmbH
Wassergasse 31
A-3324 Euratsfeld

This European Technical Assessment contains:

180 pages including 4 annexes which form an integral part of the document

This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:

Guideline for European Technical Approval (ETAG) No. 015 Three Dimensional Nailing Plates, April 2013, used as European Assessment Document (EAD).

This version replaces:

The previous ETA with the same number issued on 2015-10-22

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

Communication of this European Technical Assessment, including transmission by electronic means, shall be in full (excepted the confidential Annex(es) referred to above). However, partial reproduction may be made, with the written consent of the issuing Technical Assessment Body. Any partial reproduction has to be identified as such.

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product

Knapp Clip Connectors GIGANT, RICON, RICON S and WALCO 40 are two-piece or one-piece (WALCO V) non-welded, face-fixed connectors to be used in timber to timber connections as well as connections between a timber and a steel member or timber and concrete member. RICON S can also be welded.

The connectors are made from pre-galvanized steel grade DD13 according to EN 10111:2008-06 with minimum yield strength R_e of 235 MPa. Dimensions, hole positions and typical installations are shown in Annex A.

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

The connectors are intended for use in making end-grain to side-grain connections, end-grain to end-grain and side-grain to side-grain connections in load bearing timber structures, as a connection between a wood based joist and a solid timber (softwood or hardwood) or wood based header, where requirements for mechanical resistance and stability and safety in use in the sense of the Basic Works Requirements 1 and 4 of Regulation (EU) 305/2011 shall be fulfilled. They are also intended for use in making an end-grain or side-grain connection between a timber joist and a steel member or concrete.

The connectors can be installed as connections between wood based members such as:

- Structural solid timber of soft- or hardwood according to EN 338 / EN 14081,
- Glulam made of soft- or hardwood, classified according to EN 1194 / EN 14080, or with ETA or national approval
- LVL according to EN 14374 or ETA
- Parallam PSL,
- Intrallam LSL,
- Duo- and Triobalken,
- Cross laminated timber and similar structural glued products according EN16351 or ETA.
- Engineered wood products and solid wood panels according to EN13986 or ETA, the provisions of the ETA of the engineered wood product apply

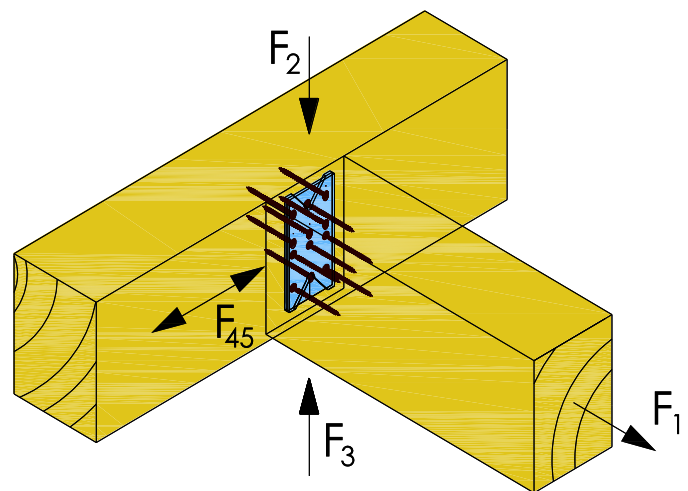
- Engineered wood products according to ETA if the ETA of the product includes provisions for the use of self-tapping screws, the provisions of the ETA of the engineered wood product apply.

However, the calculation methods are only allowed for a characteristic wood density of up to 500 kg/m³ for softwood and 590 kg/m³ for hardwood. Even though the wood based material may have a larger density, this must not be used in the formulas for the load-carrying capacities of the fasteners.

Where an interlayer made of wood-based panel is placed between the Knapp Clip Connector and the header, the influence of the interlayer on the load-carrying-capacity of the header fasteners has to be taken into account.

Annex B states the formulas for the characteristic load-carrying capacities of the connections. The design of the connections shall be in accordance with Eurocode 5 or a similar national Timber Code.

It is assumed that the forces acting on the connection are the following F_1 , F_2 , F_3 and F_{45} . The force F_1 acts perpendicular to the connector plate, F_2 and F_3 shall act in the middle of the connector in or against the direction of insertion. The force F_{45} is assumed to act with an eccentricity e_{45} with regard to the centre of gravity of the screws in the connector plate. It is assumed that the forces are acting right at the end of the joist.



It is assumed that the header beam is prevented from rotating. Similarly it is assumed that the steel member to which the connector is bolted does not rotate. If the header beam only has installed a connector on one side the eccentricity moment $M_v = F_d \times b_H/2$ shall be considered where b_H is the header width. The same applies when the header has connections on both sides, but with vertical forces which differ more than 20%.

It is a condition for a force F_1 , F_2 , F_3 and F_{45} that the connector plate is connected to a wood-based member with screws in all holes marked.

The connectors are intended for use in connections subject to static or quasi static loading. The zinc-coated connectors are for use in timber structures subject to dry, internal conditions defined by the service classes 1 and 2 of EN 1995-1-1, (Eurocode 5). The fasteners (screws and bolts) to be used shall be made from suitable material.

KNAPP clip connectors with $\geq 60 \mu\text{m}$ zinc-coating and screws with $\geq 15 \mu\text{m}$ zinc-coating are intended to be used for concealed connections in climatic conditions equivalent to swimming pool facilities with fresh water (this use does not apply to facilities with mineral or brine baths).

Details of the corrosion protection system are deposited at ETA-Danmark.

The scope of the brackets regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the concealed beam hangers of 50 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, 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

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability*) (BWR1)	
Characteristic load-carrying capacity	See Annex B
Stiffness	See Annex B
Ductility in cyclic testing	No performance determined
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The concealed beam hangers are made from steel classified as Euroclass A1 in accordance with EN 13501-1 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC
3.3 Hygiene, health and the environment (BWR3)	
Influence on air quality	The product does not contain/release dangerous substances specified in TR 034, dated March 2012**)
3.8 General aspects related to the performance of the product	The concealed beam hangers have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service class 1 and 2
Identification	See Annex A

*) See additional information in section 3.8 – 3.9.

**) In addition to the specific clauses relating to dangerous substances contained in this European technical Assessment, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Regulation, these requirements need also to be complied with, when and where they apply.

3.9 Methods of verification

The characteristic load-carrying capacities are based on the characteristic values of the connectors and the steel plates.

According to EN 1990 (Eurocode – Basis of design) paragraph 6.3.5 the design value of load-carrying capacity can be determined by reducing the characteristic values of the load-carrying capacity with different partial factors.

Therefore, to obtain design values according to the Eurocodes or appropriate national codes of practice, the capacities have to be multiplied with different partial factors for the material properties and – for the connectors mounted in wood – also the coefficient k_{mod} that takes into account the load duration class.

Thus, the characteristic or design values of the load-carrying capacity are determined also for timber failure $F_{Rk,H}$ (obtaining the embedment strength of connectors subjected to shear or the withdrawal capacity of the most loaded connector, respectively (see Annex B) as well as for steel plate failure $F_{KCC,Rd}$. The design value of the load-carrying capacity is the smaller value of both load-carrying capacities.

$$F_{Rd} = \min \left\{ \frac{k_{mod} \cdot F_{Rk,H}}{\gamma_{M,H}}; F_{KCC,Rd} \right\}$$

Therefore, for timber failure the load duration class and the service class are included. The different partial factors γ_M for steel or timber, respectively, are also correctly taken into account.

3.10 Mechanical resistance and stability

See annex B for characteristic load-carrying capacities of the connectors.

The characteristic capacities of the connectors are determined by calculation assisted by testing as described in the EOTA Guideline 015 clause 5.1.2. They should be used for designs in accordance with Eurocode 5 or a similar national Timber Code.

The design models allow the use of fasteners described in Annex A:

Screws in accordance with EN 14592

In the formulas in Annex B the capacities for self-drilling screws calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral nail load-carrying-capacity.

Further, the connectors can be fastened to a steel member by bolts with a diameter of 5 to 10 mm in holes with a diameter up to 1 mm larger than the bolt, and to a concrete member by concrete dowels.

No performance has been determined in relation to ductility of a joint under cyclic testing. The contribution to the performance of structures in seismic zones, therefore, has not been assessed.

3.11 Aspects related to the performance of the product

3.11.1 Corrosion protection in service class 1 and 2.

In accordance with ETAG 015 the connectors from 5 mm thick mild steel either have a zinc coating weight of min Z275 or an equivalent coating Fe/Zn 12c. The steel employed is DD13 according to EN 10111:2008-06 with minimum yield strength R_e of 235 MPa.

3.12 General aspects related to the fitness for use of the product

Knapp Clip Connectors GIGANT, RICON, RICON S WALCO V and WALCO 40 are manufactured in accordance with the provisions of this European Technical Assessment using the manufacturing processes as identified in the inspection of the plant by the notified inspection body and laid down in the technical documentation.

Connector joints

A connector joint is deemed fit for its intended use provided:

Header – support conditions

- The header beam shall be restrained against rotation and be free from wane under the connector.

If the header carries joists only on one side the eccentricity moment from the joists

$M_{ec} = R_{joist} \times b_H/2$ shall be considered at the strength verification of the header.

R_{joist} Reaction force from the joists
 b_H Width of header

- For a header with joists from both sides but with vertical forces which differ more than 20% a similar consideration applies.

Wood to wood connections

- Connectors are fastened to wood-based members by screws or bolts.
- There shall be screws in all marked holes as prescribed in Annex A.
- The characteristic capacity of the connector joint is calculated according to the manufacturer's technical documentation, dated 2009-12-05.
- The connector joint is designed in accordance with Eurocode 5 or an appropriate national code.
- There is no gap between the end of the joist and the connector plate or between the header surface and the connector plate.
- For Knapp Clip Connectors the width of the joist shall be at least the minimum width as prescribed in Annex A or D.
- The cross section of the joist at the connector joint shall have sharp edges, it shall be without wane.
- The cross section of the header shall have a plane surface against the whole connector plate.
- The depth of the joist or header shall be so large that the minimum fastener end and edge distances are observed.
- Screws to be used shall have a diameter, which fits the holes of the connector plates.
- The screws shall be driven into softwood without predrilling for:
 - RICON (Ø5 mm) and RICON S
 - WALCO V60
 or after pre-drilling:
 - RICON (Ø8 mm)
 - WALCO V80 and WALCO 40
 - GIGANT

The screws shall be driven into hardwood after pre-drilling.

The drill hole diameters are:

Outer thread diameter	Drill hole diameter	
	Softwood	Hardwood
5,0	3,0	3,5
6,0	4,0	4,0
8,0	5,0	6,0
10,0	6,0	7,0
KS12x60	8,0	9,0
KS16x60	12,0	13,0

Wood to steel and wood to concrete

The above mentioned rules for wood to wood connections are applicable also for the connection between the joist and the steel-header or concrete-header.

- The connector joint is designed in accordance with Eurocodes 2, 3, 5 or 9 or an appropriate national code.
- The connector plate shall be in close contact with the steel or concrete over the whole face. There shall be no intermediate layers in between, except static calculations are made for the interlayer.
- The bolt shall have a diameter not less than the hole diameter minus 2 mm.
- The bolts shall be placed symmetrically about the vertical symmetry line. The number of bolts shall equal the number of the respective screws in the joist.
- Concrete bolts shall be in accordance with an ETA based on ETAG 001

4 Attestation and verification of constancy of performance (AVCP)

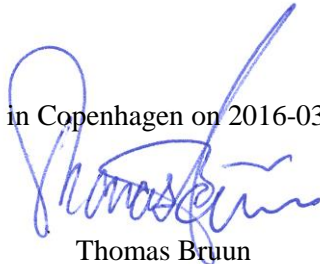
4.1 AVCP system

According to the decision 97/638/EC of the European Commission¹, as amended, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 2+.

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

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark

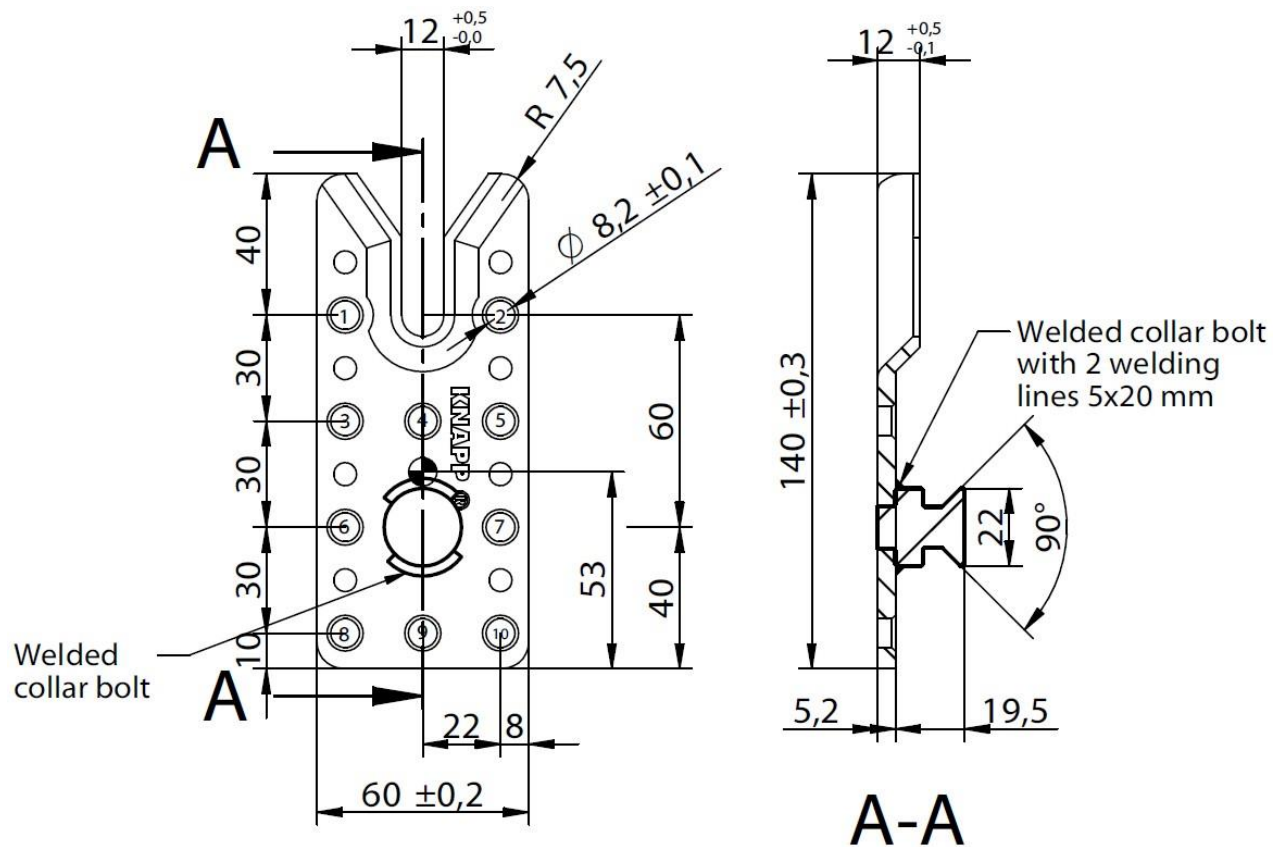
Issued in Copenhagen on 2016-03-03 by



Thomas Bruun
Managing Director, ETA-Danmark

KNAPP® Clip Connector RICON® S 140/60 VS

5.2 mm thick steel grade DD13 according to EN 10111:2008-06 with yield strength R_e of 235 MPa;
Corrosion protection according to Eurocode 5-1-1



● Centre of gravity of screw pattern
Screw holes: Spacing and end/edge distance tolerance $\pm 0,2$
Welded collar bolt with 2 welding lines 5x20 mm

Screws in Header / Joist:

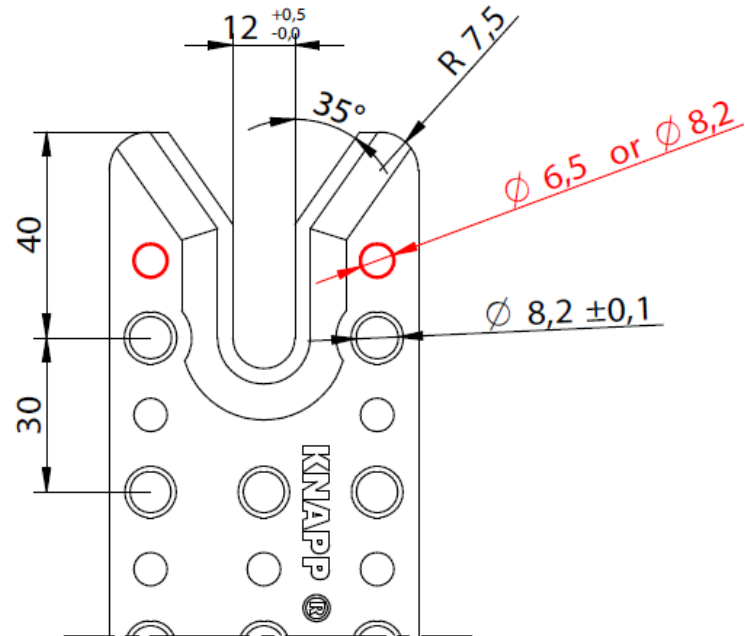
Min. 7 screws position: 1,2,4,6,7,8,10

Max. 10 screws position: 1,2,3,4,5,6,7,8,9,10

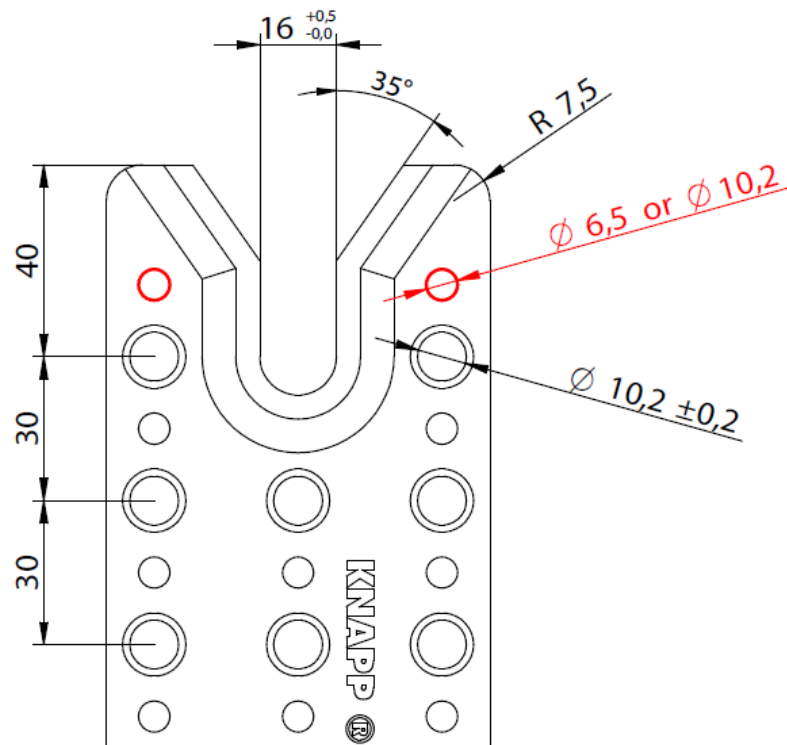
KNAPP® Clip Connector RICON® S 60 / RICON® S 80

Alternative screw position for uppest two screws (holes in red color):

RICON® S 60

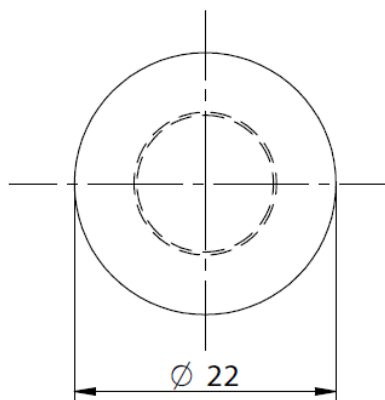
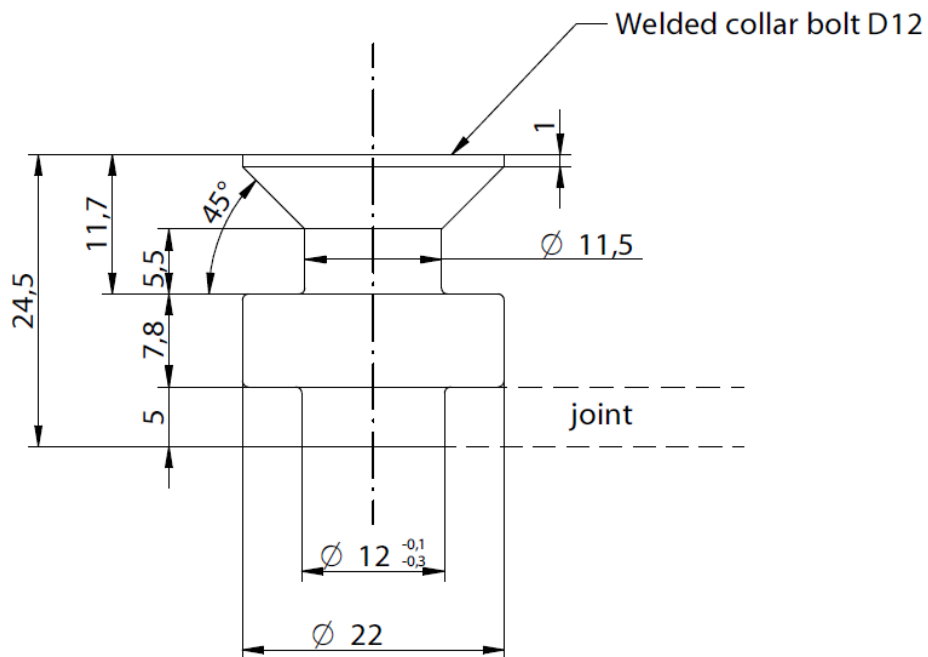


RICON® S 80:



KNAPP® RICON® S 60 welded collar bolt D12

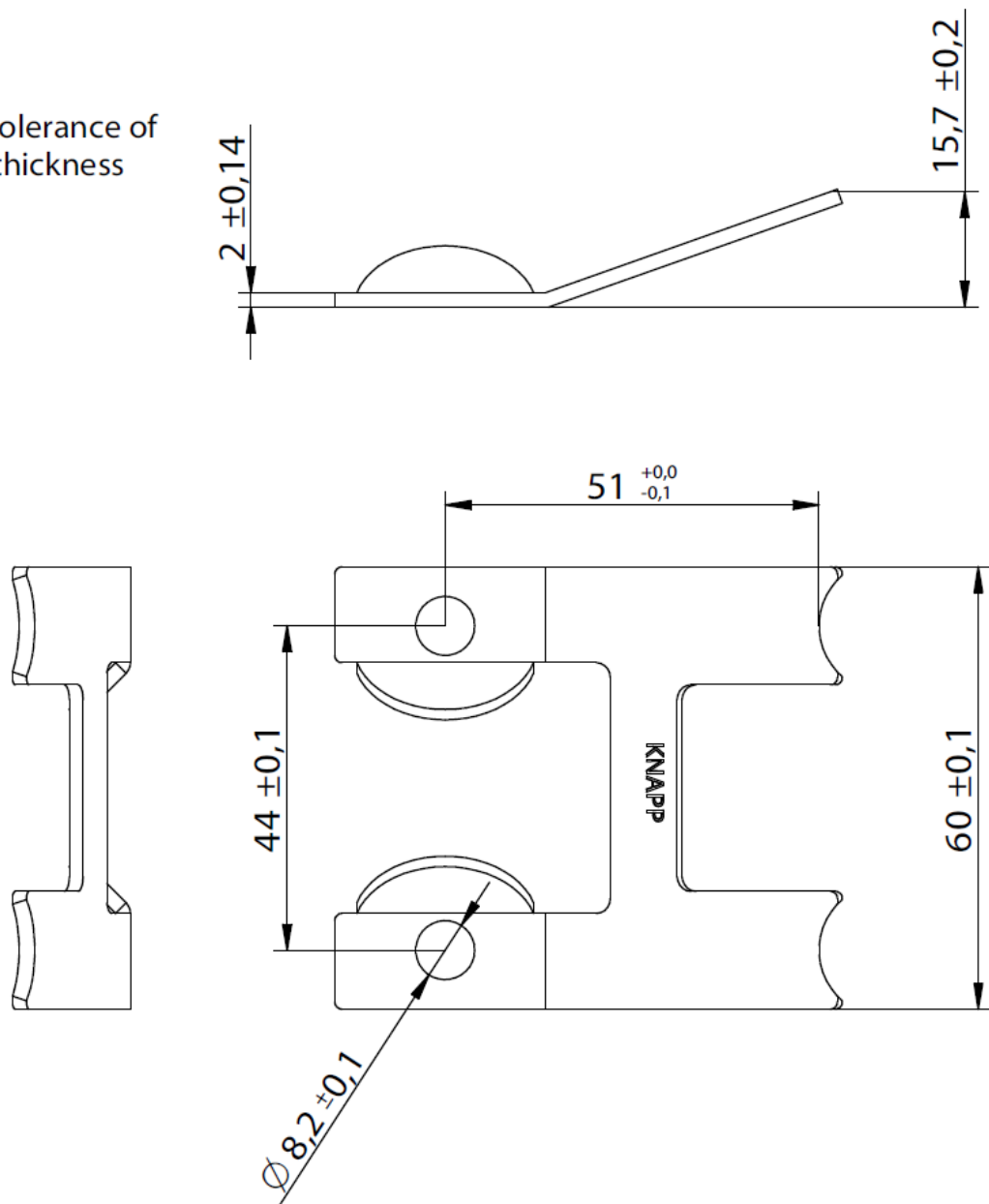
Collar bolt of steel grade 16MnCr5 according to EN 10084 with HBW values 156 – 207
Corrosion protection according to Eurocode 5-1-1;



KNAPP® RICON® S 60 clip lock

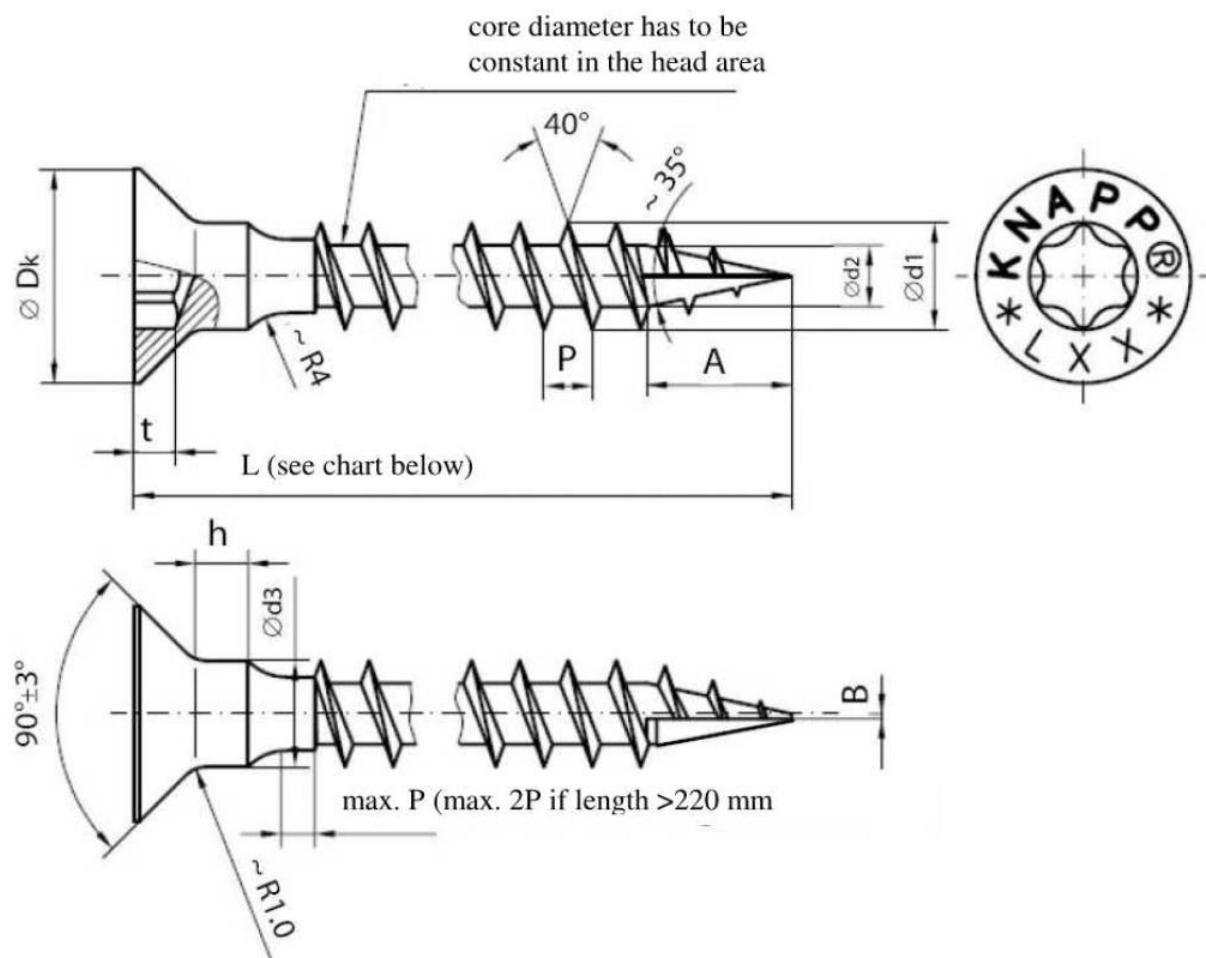
2.0 mm thick stainless steel grade X10CrNi18-8 according to EN 10088-1 with tensile strength R_m of 1350 MPa

Maximum tolerance of
steel plate thickness
 $\pm 0.14\text{mm}$



KNAPP® RICON® S screw diameter 8 mm and 10 mm

Screws according to EN 14592 manufactured of carbon steel, tension $f_{tens,k}$ of 20 kN and torque $M_{t,u,k}$ of 23 Nm for screw diameter 8 mm; for screw diameter 10 mm is tension $f_{tens,k}$ of 32 kN and torque $M_{t,u,k} = 45$ Nm; corrosion protection according to Eurocode 5-1-1; other self-tapping tip forms are possible.

**RICON® S60**

$\varnothing d_1$	bolt \varnothing	core $\varnothing d_2$	gradient P	milling length A
8.0	5.8	5.1	3.6	11

head \varnothing	joining height h	joining $\varnothing d_3$	drive	m	t	length L
15.0	3.00	7.4	Torx40	6.8	3.2	160 -1,5 120 -1,5 80 -1.5 50 -1.5

RICON® S80

$\varnothing d_1$	bolt \varnothing	core $\varnothing d_2$	gradient P	milling length A
10.0	7.0	6.1	4,3	13

head \varnothing	joining height h	joining $\varnothing d_3$	drive	m	t	length L
18,0	3.20	9.4	Torx40	6.8	3.6	200 -1,8 100 -1.8 60 -1.5

Annex B

Design values of load-carrying- capacities

B.1 Design capacities of timber-to-timber connector joints.

The downward and the upward directed forces are assumed to act in the middle of the joist. The force F_{45} is assumed to act at a distance e_{45} from the centre of gravity of the fasteners.

Force F_1 for Knapp Clip Connectors GIGANT, RICON and RICON S:

$$F_{1,Rd} = n_{ef} \cdot \min \{ F_{ax,Rd}; F_{t,Rd}; F_{1,KCC,Rd} \} \quad (B.1.1)$$

Force F_1 for Knapp Clip Connectors WALCO:

$$\text{WALCO V: } F_{1,Rd} = \min \{ 2 \cdot F_{ax,Rd}; 2 \cdot F_{t,Rd}; F_{ax,CS,Rd}; 2 \cdot F_{1,KCC,Rd} \} \quad (B.1.2a)$$

$$\text{WALCO 40: } F_{1,Rd} = F_{1,KCC,Rd} \quad (\text{for } k_{mod} = 0,9 \text{ and C24; see table C.1}) \quad (B.1.2b)$$

Force F_2 or F_3 for Knapp Clip Connectors GIGANT, RICON and RICON S:

$$F_{23,Rd} = \min \left\{ \sum_{i=1}^n F_{v,J,Rd}^i; \frac{1}{\sqrt{\left(\frac{1}{\sum_{i=1}^n F_{v,H,Rd}^i} \right)^2 + \left(\frac{1}{k_{H,2} \cdot F_{ax,H,Rd}} \right)^2}}; F_{23,KCC,Rd} \right\} \quad (B.1.3)$$

$F_{v,J,Rd} \dots$ shear force of the screws in the end grain of the joist for RICON S:

$$F_{v,J,Rd} = \frac{k_{mod}}{\gamma_M} \cdot \min \left\{ \begin{aligned} & f_{h,J,k} \cdot l_{ef,J} \cdot d \\ & 2,3 \cdot \sqrt{M_{y,Rk} \cdot f_{h,J,k} \cdot d} + \frac{F_{ax,J,Rk}}{4} \\ & f_{h,J,k} \cdot l_{ef,J} \cdot d \cdot \left[\sqrt{2 + \frac{4 \cdot M_{y,Rk}}{f_{h,J,k} \cdot d \cdot l_{ef,J}^2}} - 1 \right] + \frac{F_{ax,J,Rk}}{4} \end{aligned} \right\} \quad (B.1.3.1)$$

$F_{ax,J,Rk} \dots$ tensile load of screw in the end grain of the joist for RICON S:

$$F_{ax,J,Rk} = \frac{0,52 \cdot \sqrt{d} \cdot l_{ef,J}^{0,9} \cdot \rho_k^{0,8}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \quad (B.1.3.1a)$$

$F_{v,H,Rd}$... shear force of the screw perpendicular to grain of the header for RICON S
(similar for column = screw is parallel to grain):

$$F_{v,H,Rd} = \frac{k_{mod}}{\gamma_M} \cdot \min \left\{ \begin{array}{l} f_{h,H,k} \cdot l_{ef,H} \cdot d \\ 2,3 \cdot \sqrt{M_{y,Rk} \cdot f_{h,H,k} \cdot d} + \frac{F_{ax,H,Rk}}{4} \\ f_{h,H,k} \cdot l_{ef,H} \cdot d \cdot \left[\sqrt{2 + \frac{4 \cdot M_{y,Rk}}{f_{h,H,k} \cdot d \cdot l_{ef,H}^2}} - 1 \right] + \frac{F_{ax,H,Rk}}{4} \end{array} \right. \quad (B1.3.2)$$

$F_{ax,H,Rk}$... tensile load of screw perpendicular to grain of the header for RICON S
(similar for column = screw is parallel to grain):

$$F_{ax,H,Rk} = \frac{0,52 \cdot \sqrt{d} \cdot l_{ef,H}^{0,9} \cdot \rho_k^{0,8}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \quad (B1.3.2a)$$

Load capacity $F_{23,Rd}$ for RICON S connections depending on the number of screws (up from minimum up to maximum number of screws):

Load capacity with n_{min} screws in the joist and header ($n_{ef} = n_{min}$):	Load capacity with n_{max} screws in the joist and header ($n_{ef} = n^{0,9}$):
$\sum_{i=1}^n F_{v,J,Rd}^i = n \cdot F_{v,J,Rd}$	$\sum_{i=1}^n F_{v,J,Rd}^i = n_{ef} \cdot F_{v,J,Rd}$
$\sum_{i=1}^n F_{v,H,Rd}^i = n \cdot F_{v,H,Rd}$	$\sum_{i=1}^n F_{v,H,Rd}^i = n_{ef} \cdot F_{v,H,Rd}$
$\sum_{i=1}^n F_{ax,H,Rd}^i = n \cdot F_{ax,H,Rd}$	$\sum_{i=1}^n F_{ax,H,Rd}^i = n_{ef} \cdot F_{ax,H,Rd}$

The load capacity $F_{2,Rd}$ between n_{min} and n_{max} screws has to be linear interpolated.

$$\left(\frac{F_{2,Rd,max} - F_{2,Rd,min}}{n_{2,max} - n_{2,min}} \right) \cdot (n - n_{2,min}) + F_{2,Rd,min} \quad (B1.3.2b)$$

Knapp Clip Connector	Min. number of screws n_{min}	Max. number of screws n_{max}
RICON S 140x60	7	10
RICON S 170x60	8	13
RICON S 200x60		16
RICON S 230x60		19
RICON S 200x80		16
RICON S 230x80	8	19
RICON S 260x80		22
RICON S 290x80		25

Force F_2 or F_3 for Knapp Clip Connectors WALCO V:

$$F_{2,Rd} = \min \{ F_{v,CS,Rd}; n \cdot F_{v,Rd}; F_{23,KCC,Rd} \} \quad (B.1.4a)$$

Force F_2 for Knapp Clip Connectors WALCO 40:

$$F_{2,Rd} = F_{2,KCC,Rd} \quad (\text{for } k_{mod} = 0,9 \text{ and C24; see table C.1}) \quad (B.1.4b)$$

Force $F_{45, \text{eccentric}}$ for Knapp Clip Connectors GIGANT, RICON and RICON S:

$$F_{45, \text{Rd}} = \min \left\{ \begin{array}{l} \frac{F_{v, J, \text{Rd}}}{\sqrt{\left(\frac{1}{n_{45}} + \frac{e_{J, 45}}{a_1} \right)^2 + \left(\frac{e_{J, 45}}{a_2} \right)^2}} \quad \dots \text{design capacity for centric load} \\ \frac{F_{v, H, \text{Rd}}}{\sqrt{\left(\frac{1}{n_{45}} + \frac{e_{H, 45}}{a_1} \right)^2 + \left(\frac{e_{H, 45}}{a_2} \right)^2 + \left(\frac{F_{v, H, \text{Rd}}}{k_{H, 45} \cdot F_{ax, H, \text{Rd}}} \right)^2}} \quad \dots \text{reduction factor for eccentricity} \\ F_{45, \text{KCC}, \text{Rd}} \end{array} \right. \quad (\text{B.1.5a})$$

Force $F_{45, \text{centric}}$ for Knapp Clip Connectors GIGANT, RICON and RICON S:

$$F_{45, \text{Rd}} = \min \left\{ \begin{array}{l} F_{v, J, \text{Rd}} \\ F_{v, H, \text{Rd}} \\ F_{45, \text{KCC}, \text{Rd}} \end{array} \right. \quad (\text{B.1.5b})$$

An effective number of screws n_{45} is used, for Knapp Clip Connectors RICON based on the load-carrying capacity of 8 mm screws, see Table C.1. Only for Knapp Clip Connectors RICON, a reinforcing plate may be used. In this case, the load-carrying capacity of the reinforcing plate $F_{45, \text{RC}, \text{Rd}}$ may be added to $F_{45, \text{Rd}}$. See also page 97 for calculation of RICON.

$$F_{45, \text{RC}, \text{Rk}} = 4,0 \text{ kN} \quad (\text{B.1.6})$$

Force F_{45} for Knapp Clip Connectors WALCO:

$$\text{WALCO V: } F_{45, \text{Rd}} = \min \{ F_{v, \text{CS}, \text{Rd}}; 2 \cdot F_{v, \text{Rd}}; F_{45, \text{KCC}, \text{Rd}} \} \quad (\text{B.1.7a})$$

$$\text{WALCO 40: } F_{45, \text{Rd}} = F_{45, \text{KCC}, \text{Rd}} \quad (\text{for } k_{\text{mod}} = 0,9 \text{ and C24; see table C.1}) \quad (\text{B.1.7b})$$

Where:

$F_{ax, \text{Rd}}$ Design withdrawal capacity of a tensile screw

$$F_{ax, \text{Rd}} = \frac{k_{\text{mod}}}{\gamma_M} \cdot \frac{0,52 \cdot \sqrt{d} \cdot \ell_{\text{ef}}^{0,9} \cdot \rho_k^{0,8}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \quad (\text{B.1.4})$$

$F_{ax, \text{CS}, \text{Rd}}$ Design withdrawal capacity of a collar screw (WALCO V) according to eq. (B.1.4)

d outer thread diameter of a screw in mm;

ℓ_{ef} point side penetration length of the threaded part in mm; for screws parallel to the grain in the joist ℓ_{ef} should be at least 50 % larger than ℓ_{ef} in the header; exceptions are possible for tilted joints (see Annex D)

ρ_k characteristic density in kg/m³;

α angle between grain direction and screw axis;

n_{ef} effective number of screws;

$$n_{\text{ef}} = \frac{a_c}{a_c - e_1} \quad \text{for Knapp Clip Connectors GIGANT, RICON and RICON S (VK);}$$

$$n_{\text{ef}} = \frac{2 \cdot a_c}{a_c - e_1} \quad \text{for Knapp Clip Connectors RICON S (GK, EK, VS);}$$

a_c spacing between the tensile screws of Connectors GIGANT, RICON and RICON S, see Table C.1;

e_1 distance between load F_1 and the tensile screw considered (see Figure B.1). e_1 is positive if F_1

	acts within the length a_c , otherwise e_1 is negative;
$F_{t,Rd}$	Design screw tensile capacity;
$F_{1,KCC,Rd}$	Design capacity of the Knapp Clip Connector, values see Table C.1.
$F_{v,Rd}$	Design lateral load-carrying capacity per shear plane per fastener according to EN 1995-1-1 8.2.3 for thick outer steel plates in the joist or in the header indicated by the indices J or H, where the embedding strength is as follows;
$f_{h,k}$	characteristic embedding strength for joist or header screw;
$f_{h,k} =$	$(0,033 + 0,049 \cdot \alpha/90^\circ) \cdot \rho_k \cdot d^{-0,3}$ in MPa;
$F_{v,CS,Rd}$	Design load-carrying capacity of a collar screw according to EN 1995-1-1 8.2.3 for thin outer steel plates;
$F_{ax,H,Rd}$	Design axial capacity of an outer header screw according to EN 1995-1-1 8.7.2, for Knapp Clip Connectors RICON for the 8 mm screw;
n	number of screws per connector plate;
$k_{H,2}$	form factor, see Table C.1;
$F_{23,KCC,Rd}$	Design capacity of the Knapp Clip Connector, values see Table C.1.
n_{45}	effective number of screws per connector plate for load F_{45} ;
e_{45}	Distance between the force F_{45} and the centroid of the fasteners in the joist or in the header indicated by the indices J or H;
a_1, a_2	factors for calculating the polar moment, see Table C.1;
$k_{H,45}$	form factor, see Table C.1;
$F_{45,KCC,Rd}$	Design capacity of the Knapp Clip Connector, values see Table C.1.

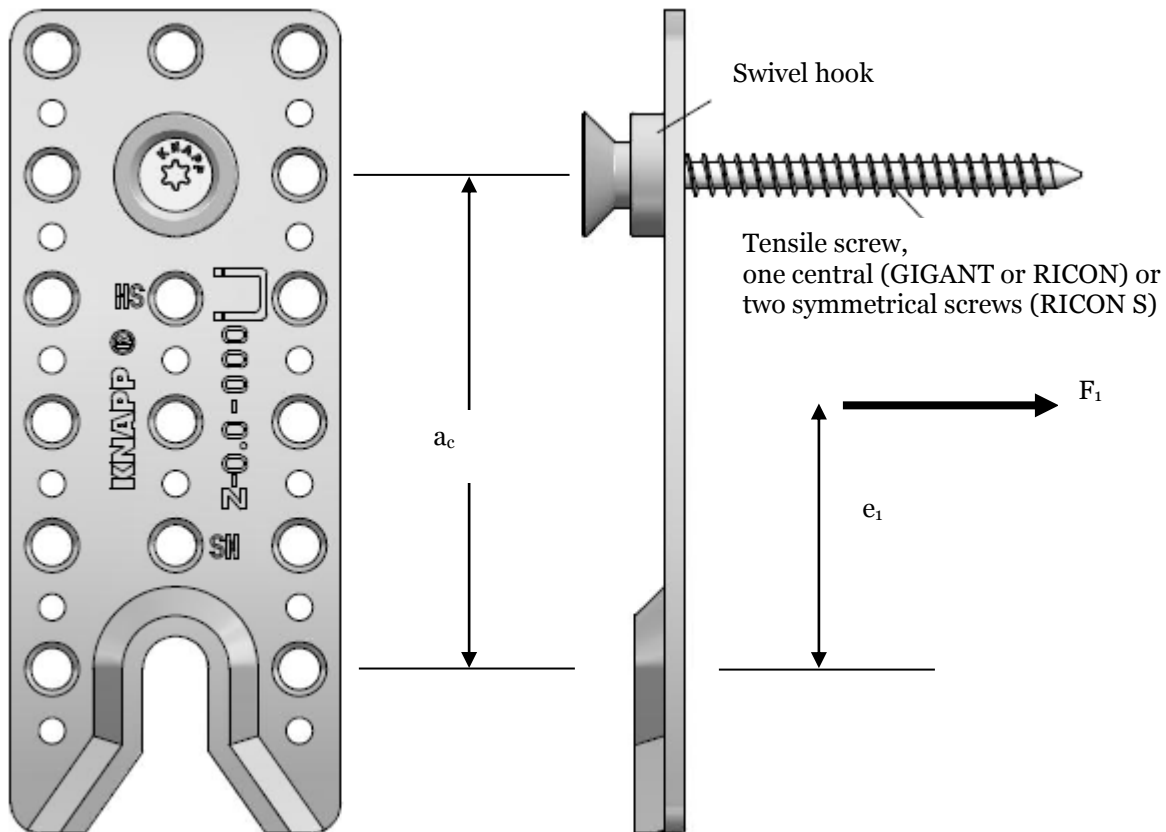


Fig. B.1: Definition of e_1

Combined forces

In case of combined forces the following inequality shall be fulfilled:

$$\left(\frac{F_{1,Ed}}{F_{1,Rd}}\right)^2 + \left(\frac{F_{23,Ed}}{F_{23,Rd}}\right)^2 + \left(\frac{F_{45,Ed}}{F_{45,Rd}}\right)^2 \leq 1 \quad (\text{B.1.8})$$

B.2 Design capacities of connector joints with bolts

For connector plates connected to a steel member or to a timber member using bolts or interconnection nuts the assumptions for the calculation of the load-carrying capacity of the connection are:

- The transfer of force from the joist to the connector plate is as for a wood-wood connection, see clause B.1;
- The bolts or interconnection nuts shall always be arranged as the screws they are replacing;
- No washers are required.

The static behaviour is the same as for a wood-wood connection with screws. The bolt capacities replace the respective header screw capacities in equations B.1 to B.7.

B.3 Connection stiffness

The following slip moduli K_{ser} are to be used for Knapp Clip Connectors joints:

Load direction F1

Knapp Clip Connectors GIGANT:	$K_{ser} = 8,0 \text{ kN/mm}$
Knapp Clip Connectors RICON:	$K_{ser} = 12,0 \text{ kN/mm}$
Knapp Clip Connectors RICON S:	$K_{ser} = 25,0 \text{ kN/mm}$
Knapp Clip Connectors WALCO V, WALCO 40:	$K_{ser} = 4,0 \text{ kN/mm}$

Load directions F₂, F₃ or F₄₅ – centric load

For a centric load parallel to the plane of the connector plates, the slip modulus for joints with Knapp Clip Connectors may be calculated as:

Knapp Clip Connectors RICON:

RICON	60/40	80/40	100/40	120/40	140/40	160/40
K_{ser}	$4,5 \cdot \rho_k$	$6,0 \cdot \rho_k$	$7,5 \cdot \rho_k$	$9,0 \cdot \rho_k$	$10,5 \cdot \rho_k$	$12,0 \cdot \rho_k$

Where:

ρ_k The lower value of the characteristic density of the joist or header; max. 500 kg/m³

Knapp Clip Connectors GIGANT and RICON S:

$$K_{ser} = 0,07 \cdot n_s \cdot \rho_k^{1,5} \cdot d_i^{0,8} \quad (\text{B.3.1})$$

Where:

ρ_k The lower value of the characteristic density of the joist or header; max. 460 kg/m³

n_s Number of screws in the joist or header connection; $n_s = 12$ maximum!

d_i Outer thread diameter;

Knapp Clip Connectors WALCO V, WALCO 40: $K_{ser} = 1,0 \text{ kN/mm}$

Load directions F_2 , F_3 or F_{45} – eccentric load

For an eccentric load parallel to the plane of the connector plates, the slip modulus for joints with Knapp Clip Connectors GIGANT, RICON and RICON S may be calculated as:

Knapp Clip Connectors GIGANT:	$K_{ser} = 1,0 \text{ kN/mm}$
Knapp Clip Connectors RICON without reinforcing plate:	$K_{ser} = 1,0 \text{ kN/mm}$
Knapp Clip Connectors RICON with reinforcing plate:	$K_{ser} = 2,5 \text{ kN/mm}$
Knapp Clip Connectors RICON S:	$K_{ser} = 4,0 \text{ kN/mm}$

Annex C

Table C.1: design capacities $F_{KCC,Rd}$, ($\gamma_M = 1,0$) form factors k_H , dimensions a_c , a_1 , a_2 and numbers n_{45}

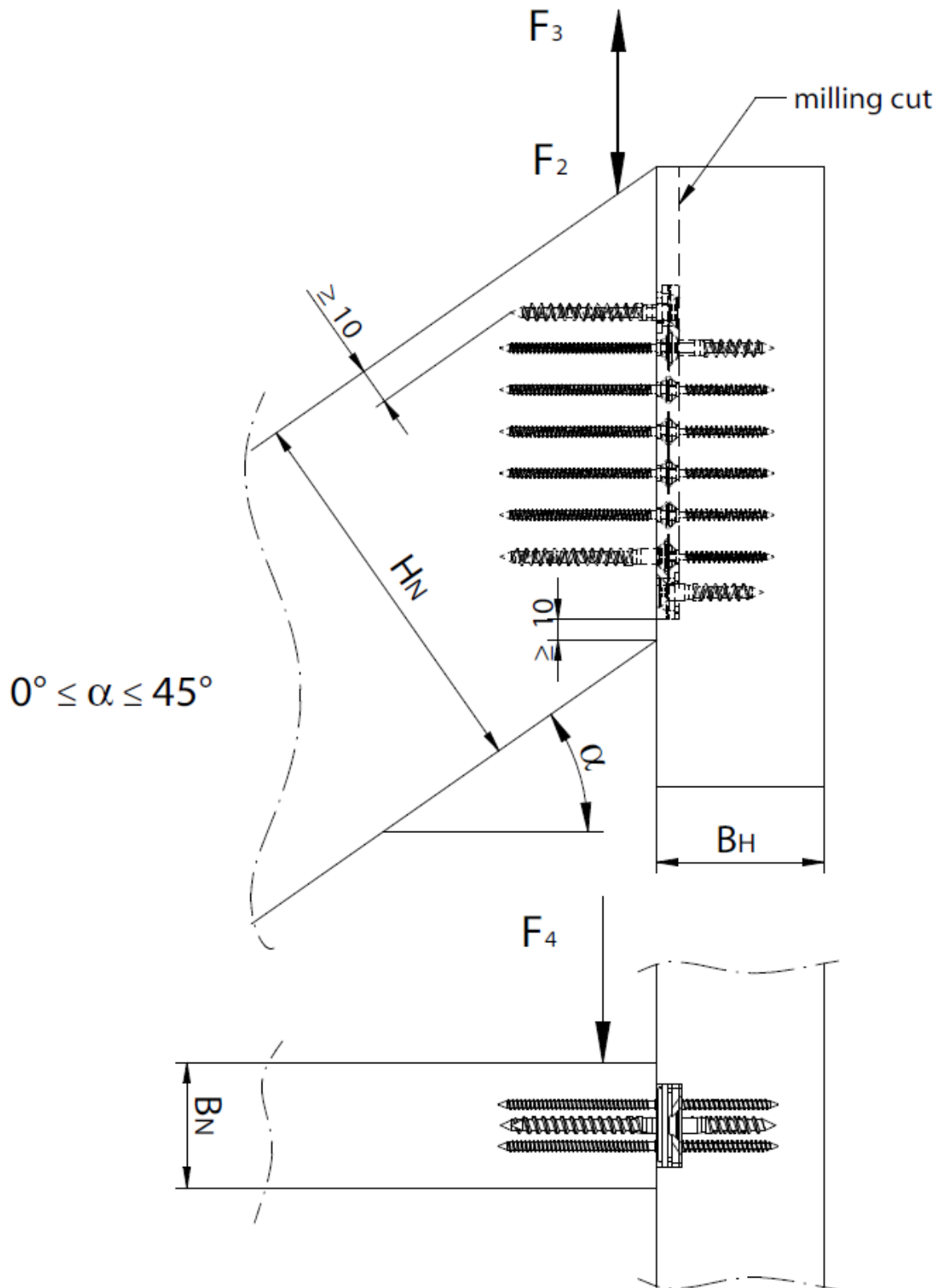
Knapp Clip Connectors	F _{1,KCC,Rd} [kN]	F _{2,KCC,Rd} [kN]	F _{3,KCC,Rd} [kN]	F _{45,KCC,Rd} [N]	k _{H,2}	k _{H,45}	a _c [mm]	a ₁ [mm]	a ₂ [mm]	n ₄₅
GIGANT 120/40	6,2	17,0	12,0	12,0	2,55	2,22	58	56	∞	3
GIGANT 150/40 without clip lock		24,0	-	16,0	4,74	2,22	90	91	422	4
GIGANT 150/40 with clip lock			12,0		4,95	2,96	90	98	∞	4
GIGANT 180/40 without clip lock		33,0	-	20,0	8,84	3,46	122	140	882	6
GIGANT 180/40 with clip lock			12,0		8,15	3,70	122	151	∞	5
RICON 60/40	5,9	6,0	n _{CL} · 2,7	4,0	2,30	3,42	34	33	42	1,9
RICON 80/40		11,0		8,0	4,68	4,75	54	43	81	2,9
RICON 100/40		14,0		10,0	9,34	6,83	74	73	213	3,8
RICON 120/40		18,0		12,0	15,7	8,92	94	110	434	4,8
RICON 140/40		18,0		12,0	23,7	11,0	114	155	771	5,7
RICON 160/40		18,0		12,0	33,3	13,1	134	209	1247	6,6
Double RICON 80/40 ¹⁾		11,0		8,0	23,2	8,17	134	181	1145	4,8
Double R. 100/40 ¹⁾		14,0		10,0	44,9	12,3	174	319	2619	6,7
Double R. 120/40 ¹⁾		18,0		12,0	73,3	16,5	214	487	4953	8,5
Double R. 140/40 ¹⁾							254			
Double R. 160/40 ¹⁾							294			
RICON S 140/60	9,0	34,0 (60) ²⁾	18,0	34,0	10,7	5,9 8,25	60	247 313	529 683	7 10
RICON S 170/60					18,3	6,48 10,6	90	312 438	904 1240	8 13
RICON S 200/60					27,8	6,48 13,0	120	318 590	868 2061	8 16
RICON S 230/60					39,3	6,48 15,3	150	378 771	1354 3210	8 19
RICON S 200/80		50,0 (99) ³⁾		50,0	27,8	8,67 17,3	120	360 665	720 1678	8 16
RICON S 230/80					39,3	8,67 20,5	150	410 835	1076 2548	8 19
RICON S 260/80					52,9	9,52 23,6	180	480 1045	1440 3704	8 22
RICON S 290/80					68,4	9,52 26,8	210	566 1284	1980 5189	8 25
WALCO V 60 / 80		17,0		5,0	17,0	-	-	-	-	-
WALCO 40 (C24)		3,3	6,7	-	5,5	-	-	-	-	-
n _{CL} : Number of clip locks in RICON connections, n _{CL} = 1 or n _{CL} = 2										

n_{CL} : Number of clip locks in RICON connections, $n_{CL} = 1$ or $n_{CL} = 2$

- 1) ... Characteristic and design values can be used for double RICON with distance or without distance between the two members
- 2) ... $F_{2,KCC,Rd} = 60,0$ kN for RICON S60 with welded collar bolt (VS) and retaining screw bolt (with insert screw, long nut, press nut or nut M12)
- 3) ... $F_{2,KCC,Rd} = 99,0$ kN for RICON S80 only with welded collar bolt (VS)

RICON®

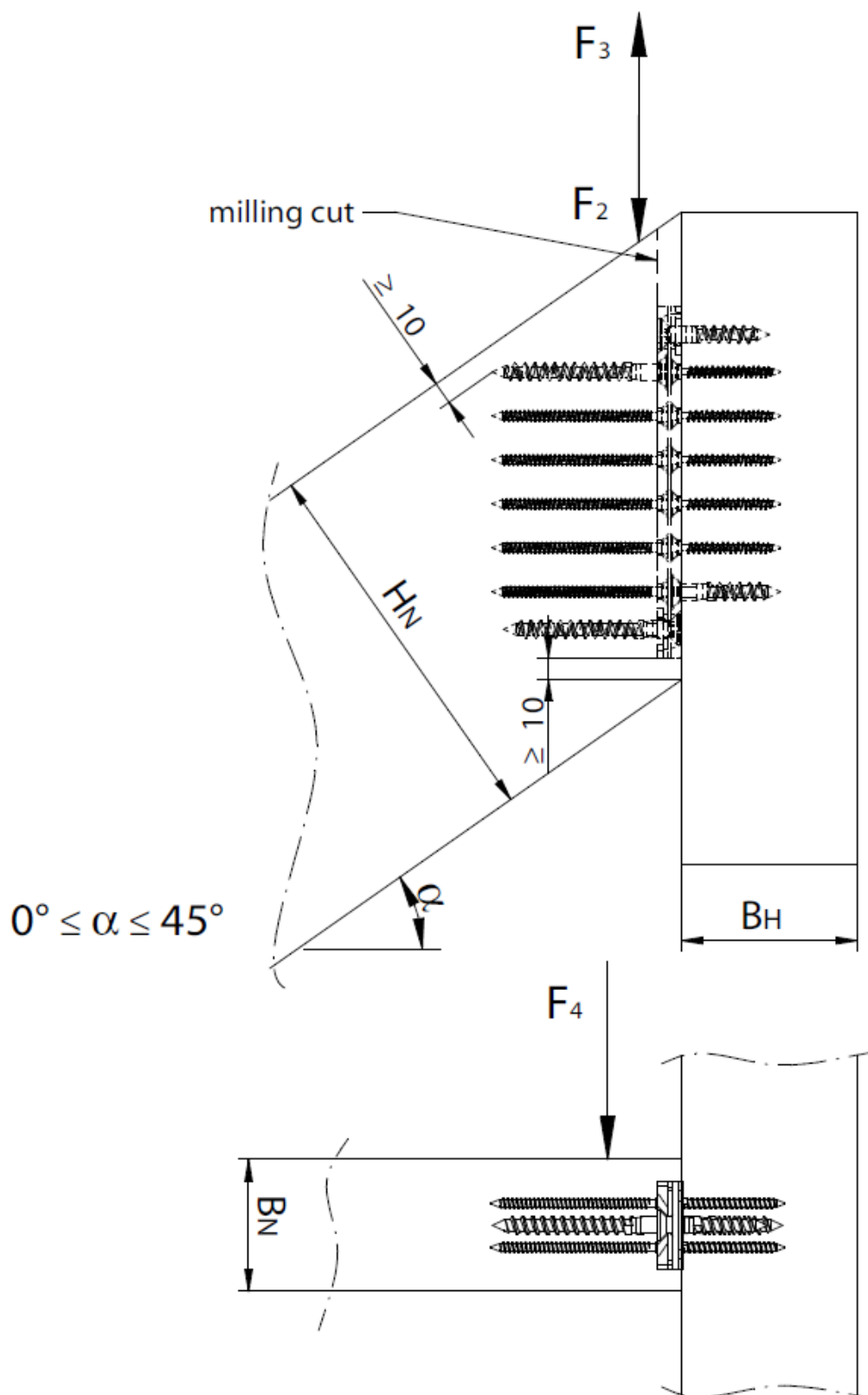
Tilted joints
 $\alpha \leq 45^\circ$



Screw length can be reduced on top

RICON®

Tilted joints
 $\alpha \leq 45^\circ$

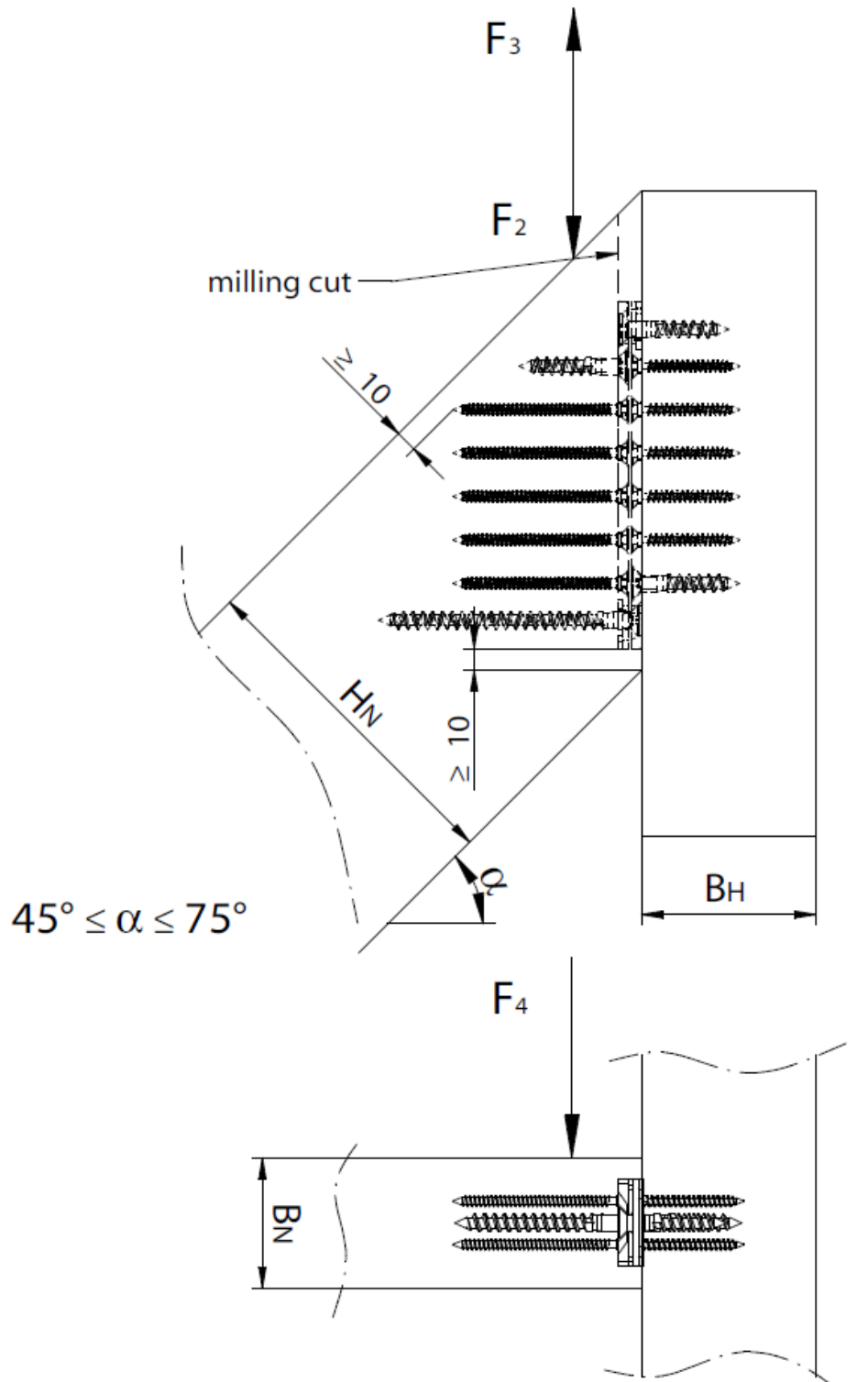


RICON®

Tilted joints

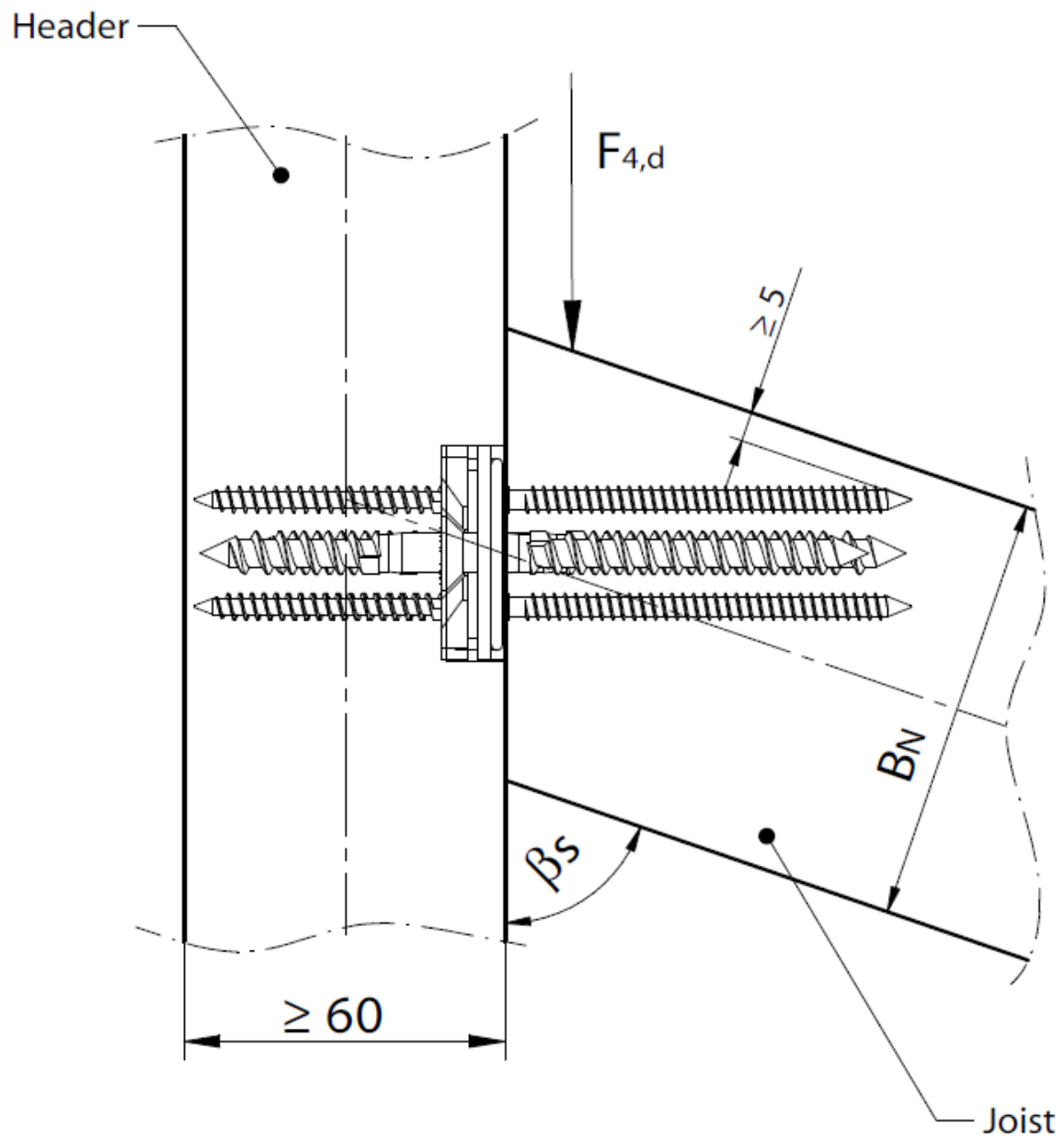
$$\alpha \geq 45^\circ$$

Screw length can be reduced on top



RICON®

Tilted joints

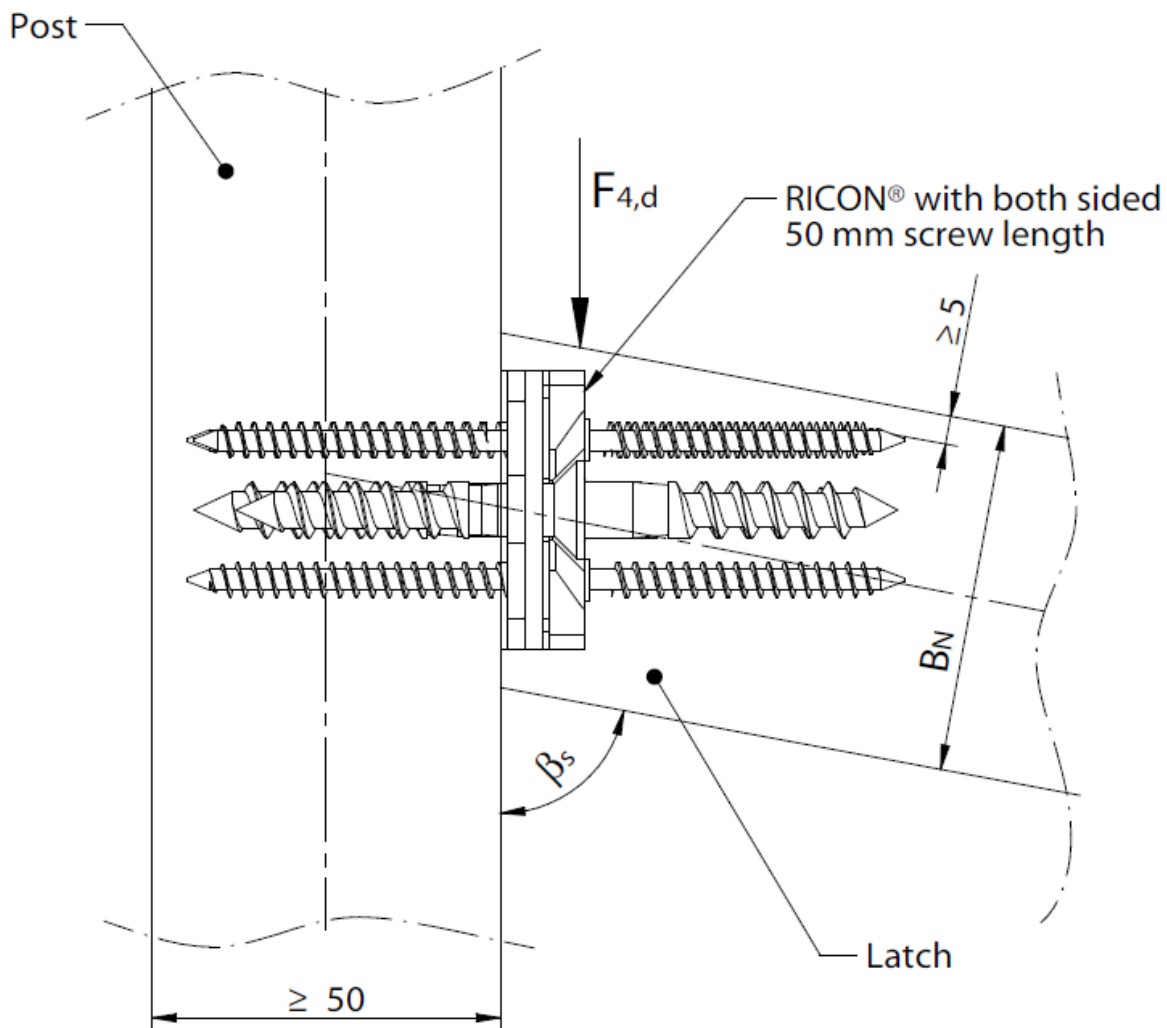


Width B_N	Angle β_s
50 mm	83°
80 mm	71°

Screw length can be reduced on top

RICON®

Tilted joints

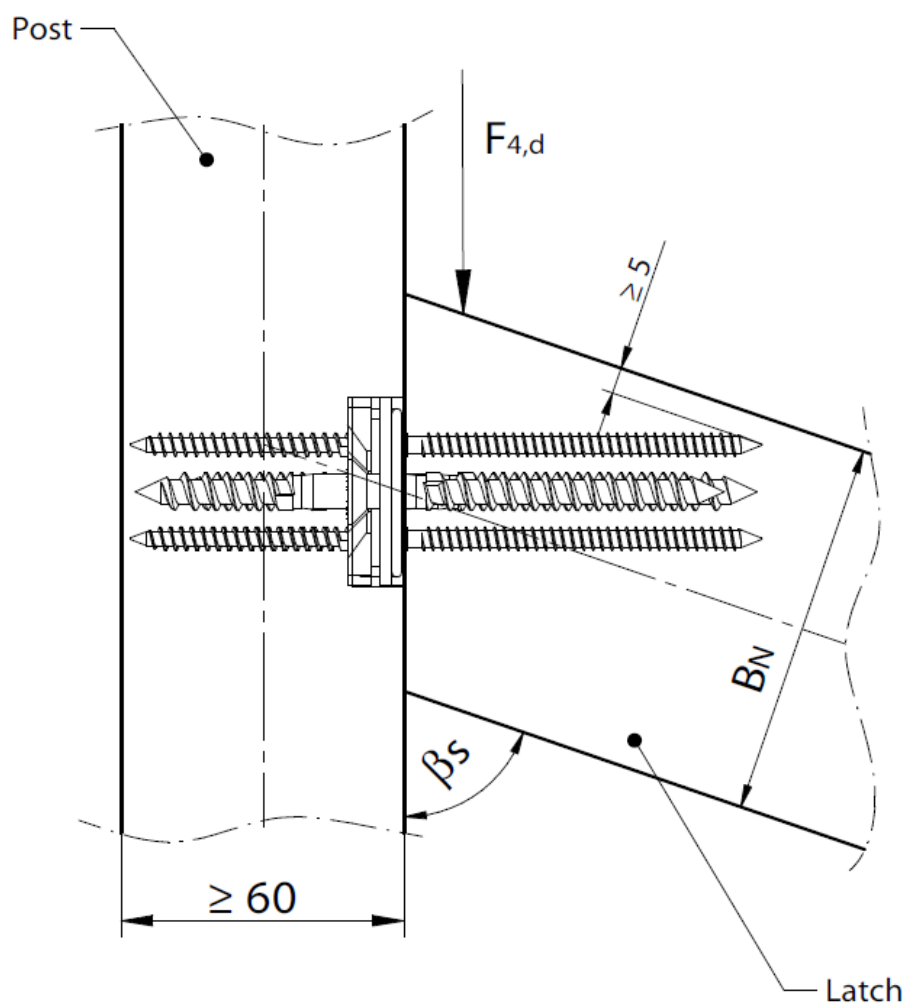


width B_N	angle β_s
50 mm	80
60 mm	72
80 mm	45

Screw length can be reduced on top

RICON®

Tilted joints

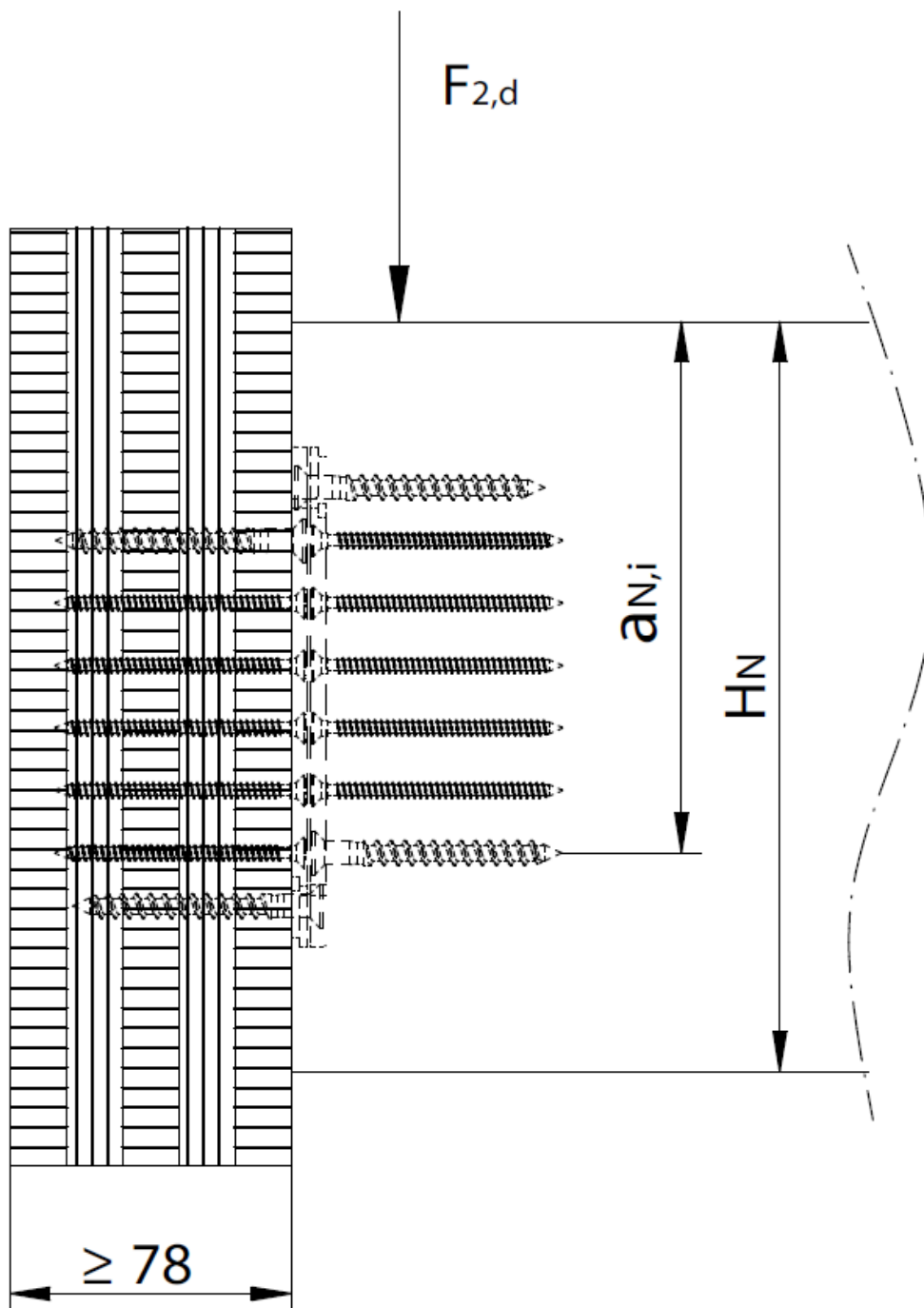


Width B_N	Angle β_s
50 mm	83°
80 mm	71°

Screw length can be reduced on top!

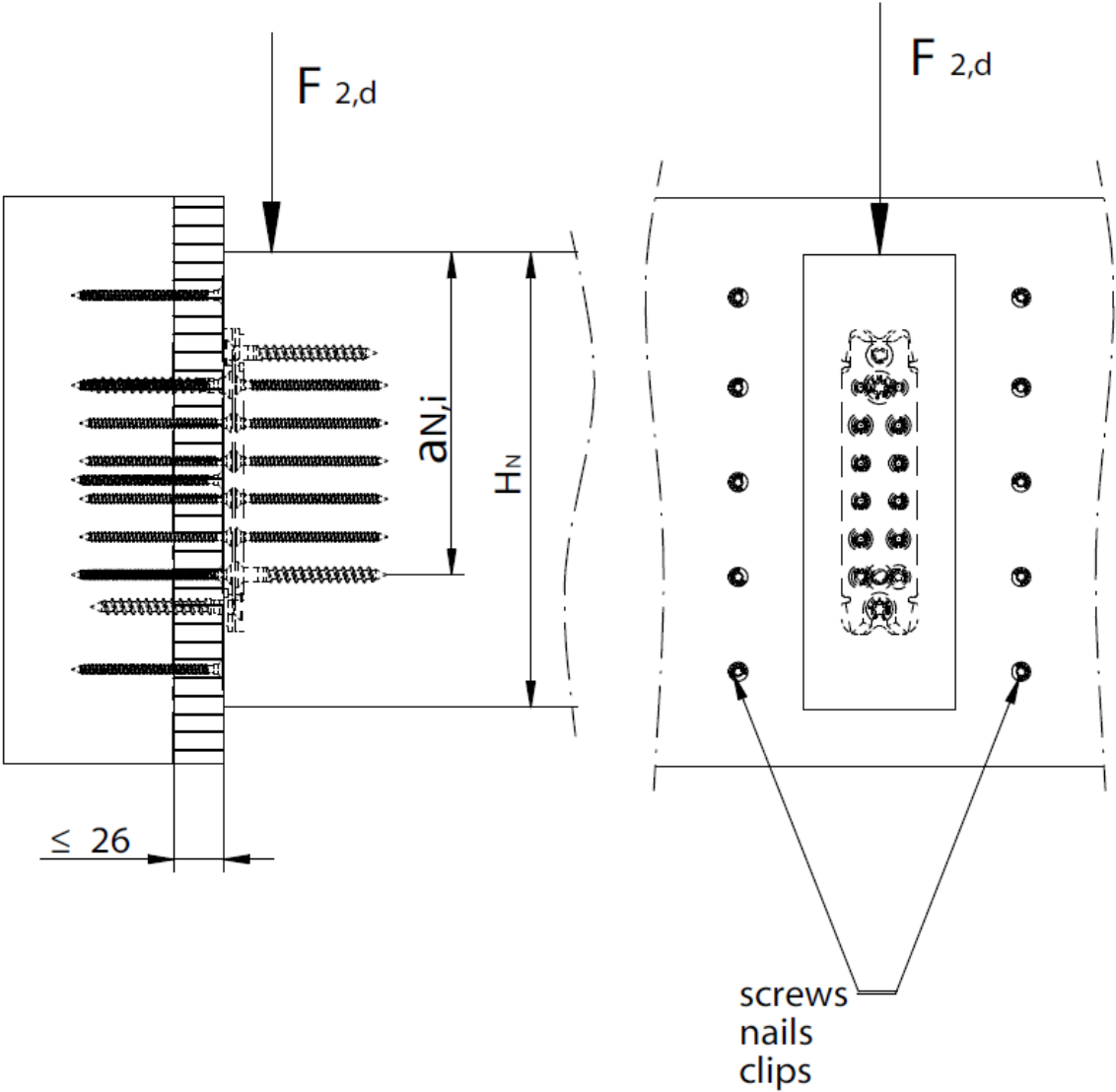
RICON®

Joint with cross laminated timber (similar structural glued products) header



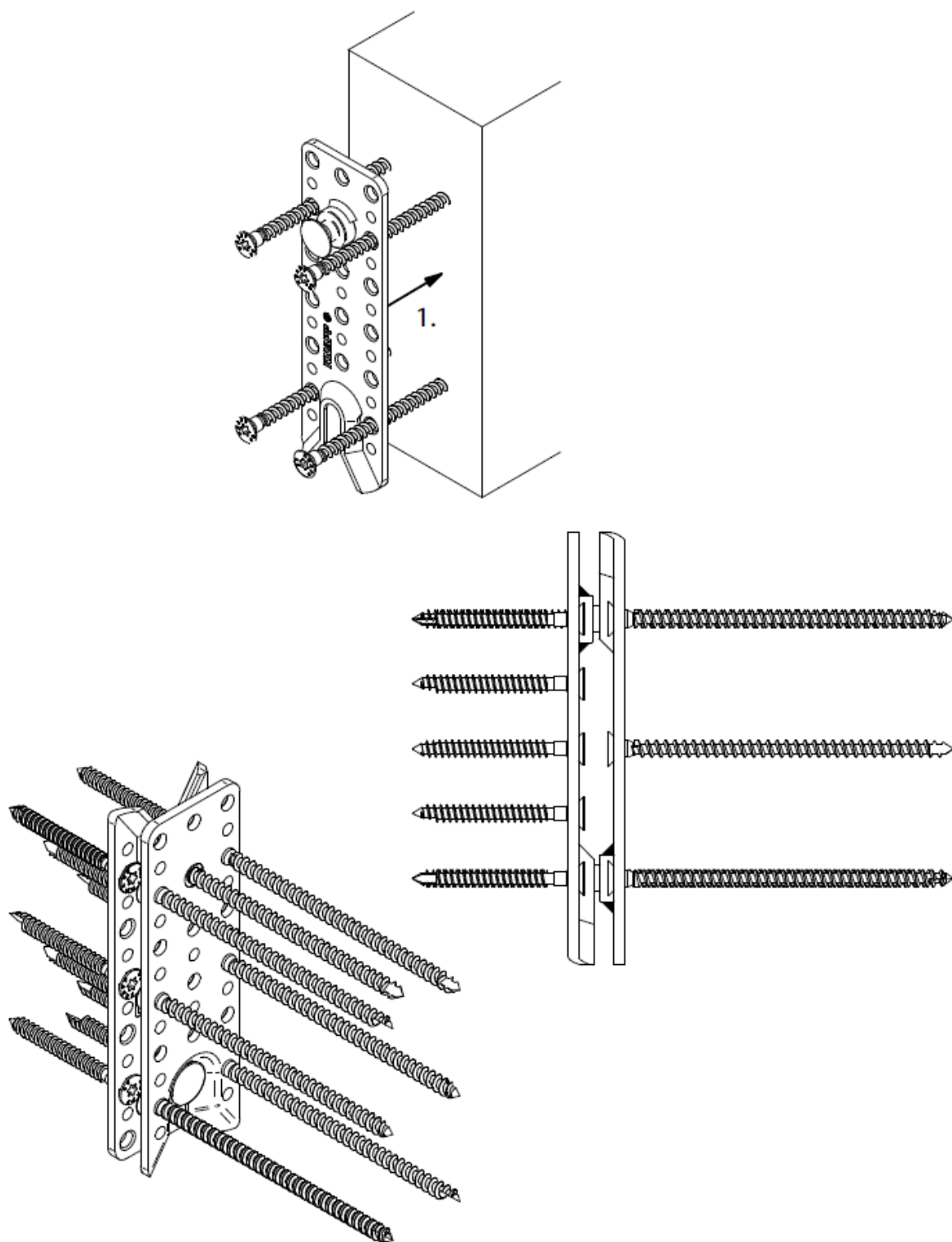
RICON®

Joint with interlayer



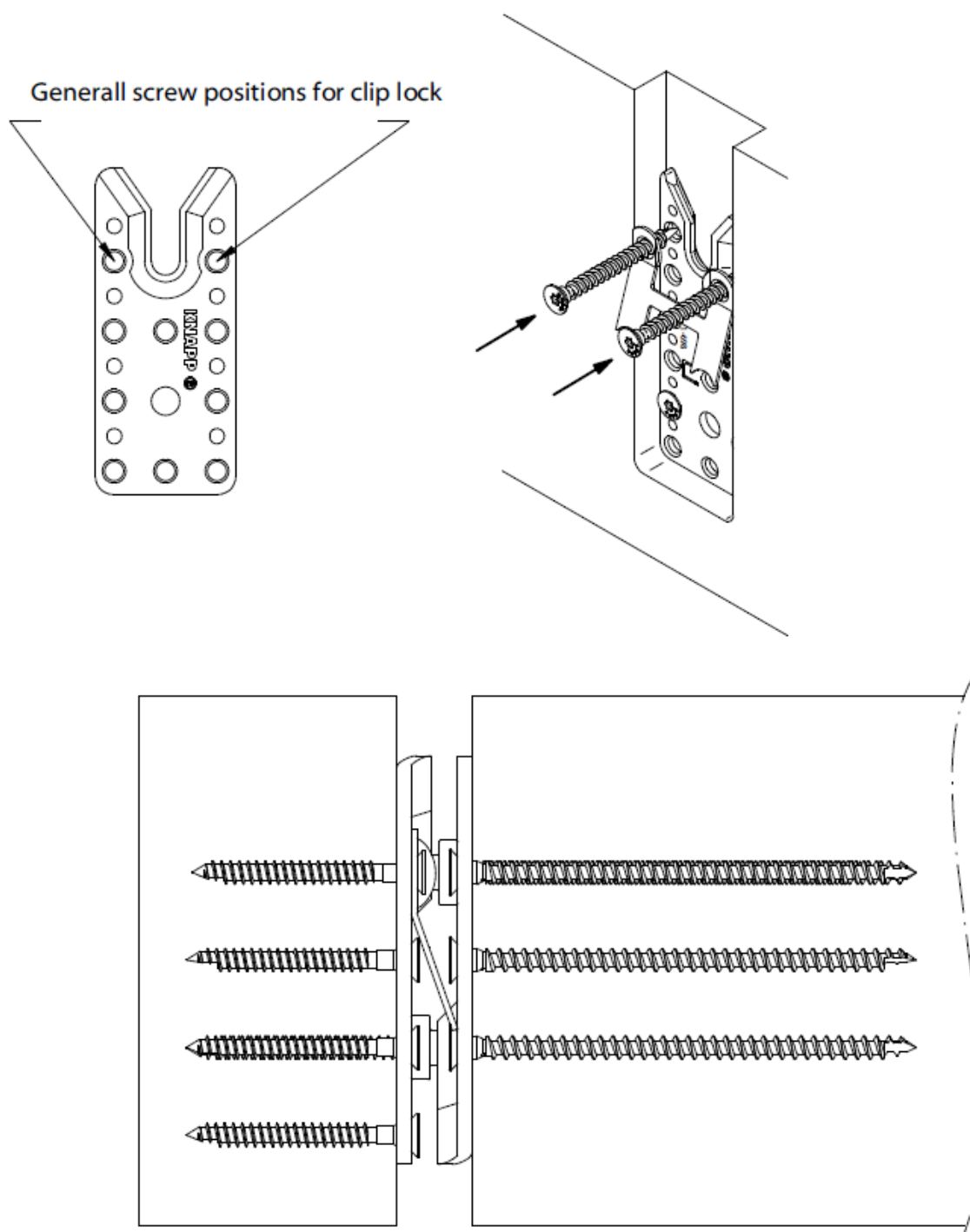
RICON® S

Installation welded collar bolt



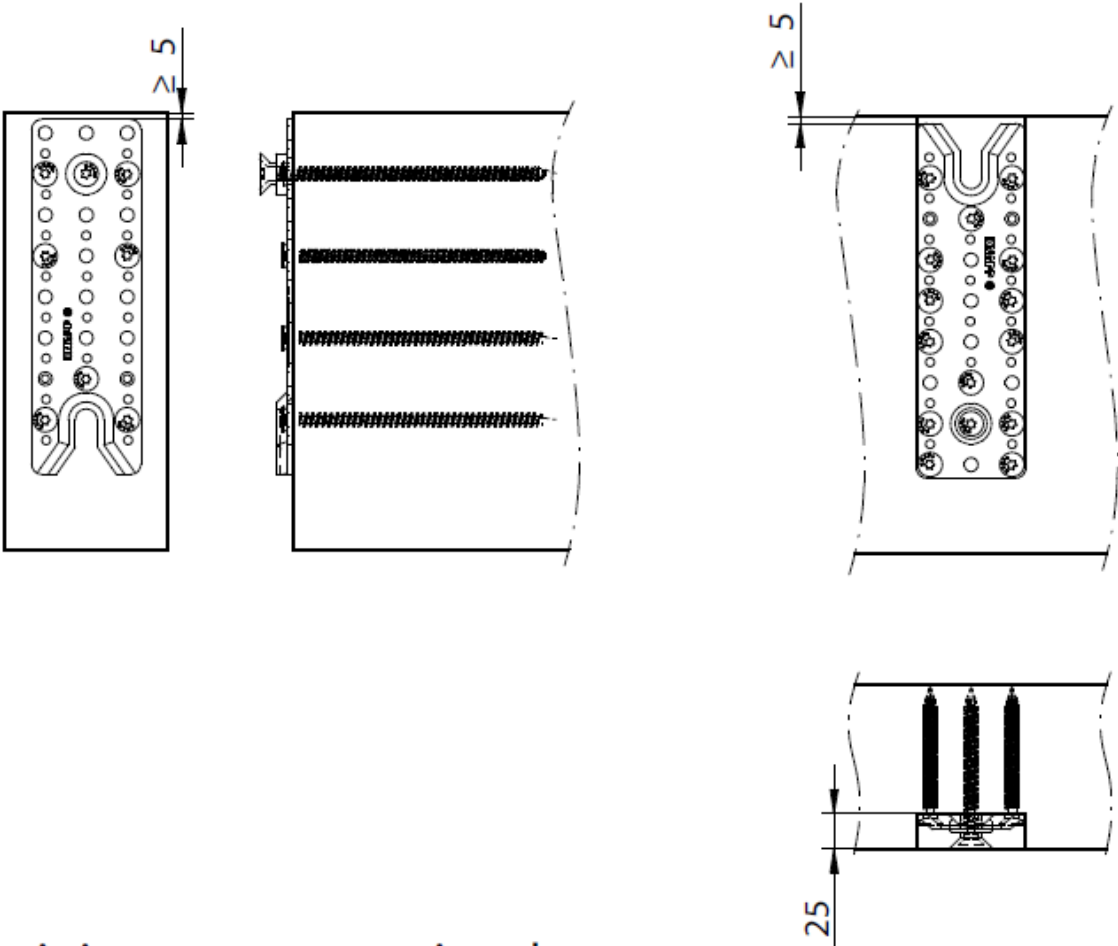
RICON® S

Installation clip lock



RICON® S

Minimum cross-section sizes

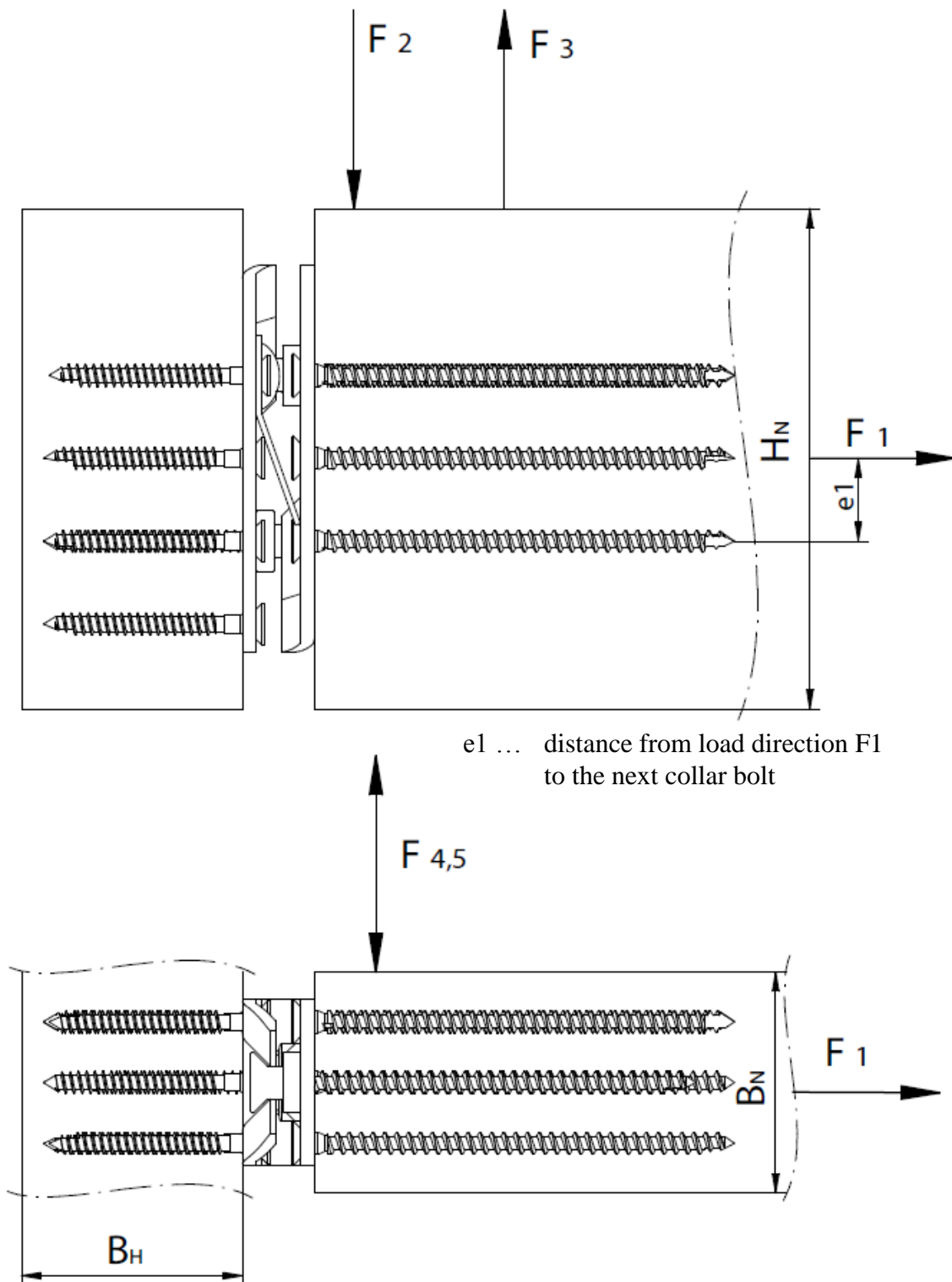


minimum cross sectional area:

joint size		minimum cross section	
width	height	width	height
60	140	100	160
60	170	100	190
60	200	100	220
60	230	100	250
80	200	120	230
80	230	120	260
80	260	120	290
80	290	120	320

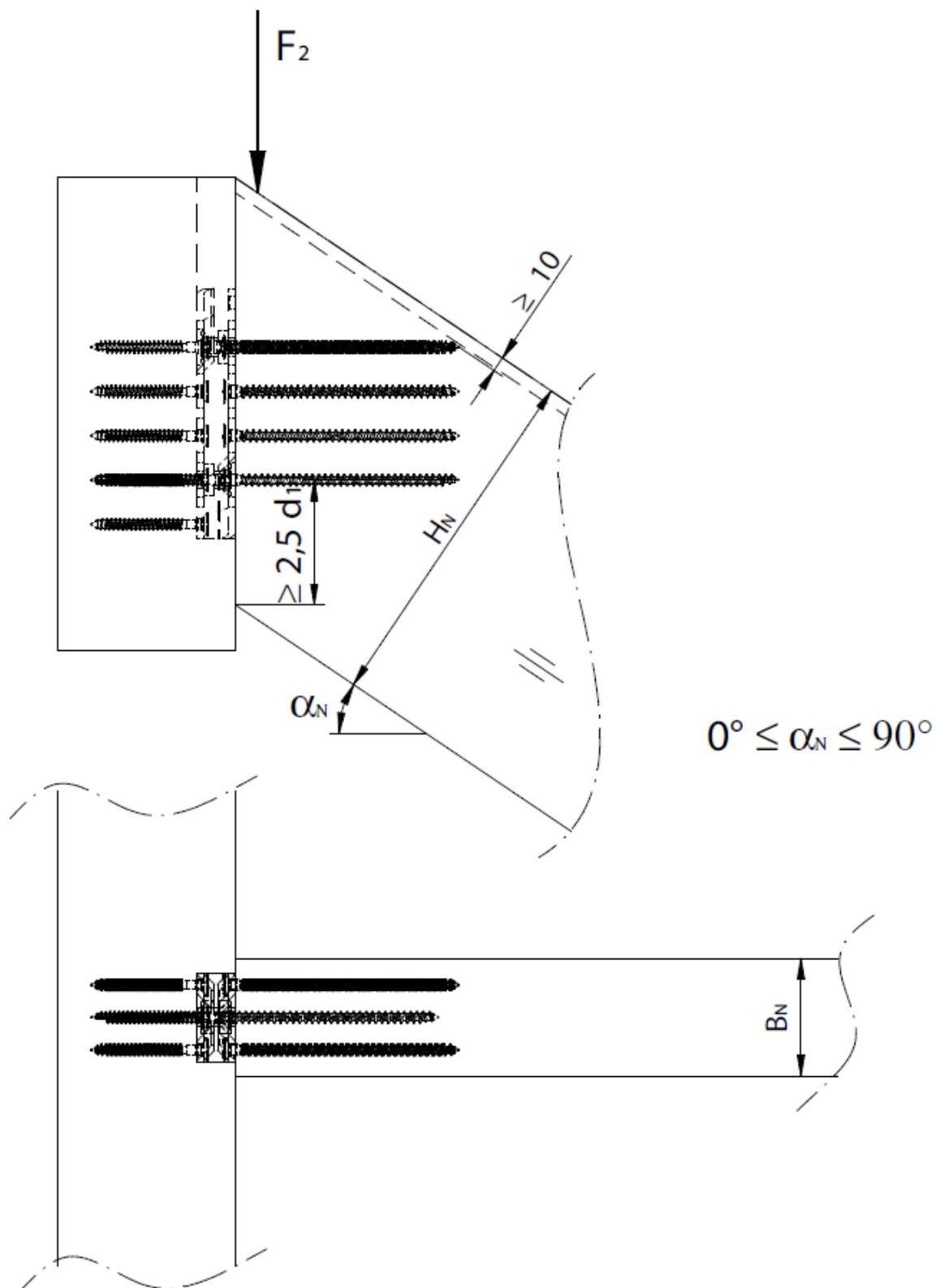
RICON® S

Load directions



RICON® S

Tilted joint

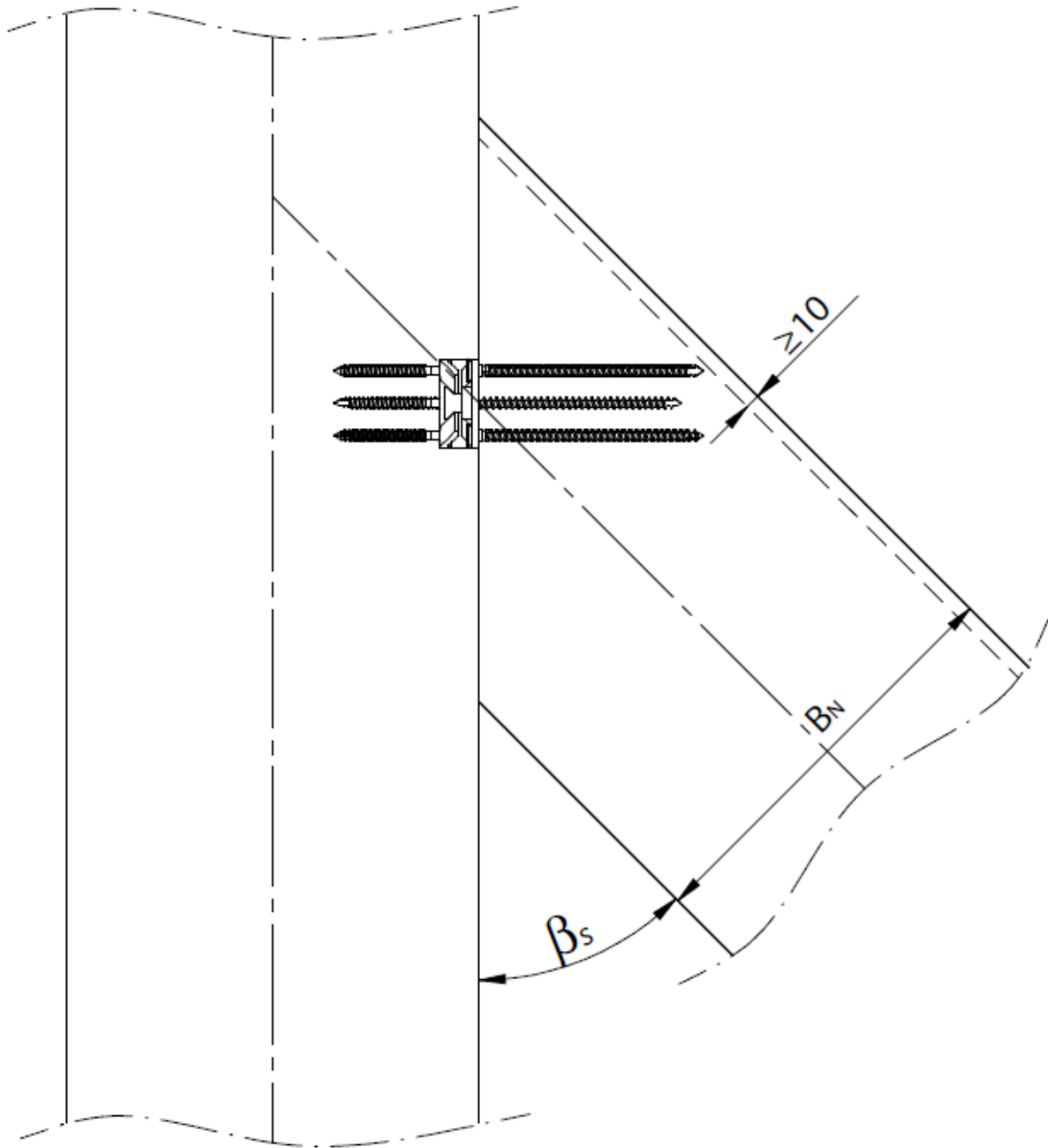


Screw length can be adopted to fit in secondary beam!

RICON® S

Tilted joint

Screw length can be adopted to fit in secondary beam



$$35^\circ \leq \beta_s \leq 90^\circ$$

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

ETA-06/0009
of 7 April 2016

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

Binderholz Brettsper Holz BBS

Product family
to which the construction product belongs

Binderholz Brettsper Holz BBS
Multilayered timber elements for walls, ceilings, roofs and
special construction components

Manufacturer

Binderholz Bausysteme GmbH
Zillertalstraße 39
6263 FÜGEN
ÖSTERREICH

Manufacturing plant

W01, W02, W03, W04

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of this assessment

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Page 2 of 19 | 7 April 2016

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Specific part

1 Technical description of the product

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

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

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

Not load-bearing outer layers are permissible.

Building elements are plane.

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

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

The building components in *Systemformat* with a width up to 1.25 m may be connected in the plant in longitudinal direction by large finger jointing in accordance with EN 14080¹ to a length of up to 24 m.

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

Manufacturing

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

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

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

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

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

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

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

¹ EN 14080:2013

Timber structures - Glued laminated timber and glued solid timber - Requirements

Design

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

The following conditions shall be observed:

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

The design of the solid wood slab element can be performed according to EN 1995-1-1², taking into account Annexes 2 to 5 of the European Technical Assessment. Standards and regulations valid in the place of use shall be considered.

Packaging, transport, storage, maintenance and repair

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

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

Installation

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

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

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

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

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

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

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

The solid wood slab element is intended to be used in service classes 1 and 2 according to EN 1995-1-1.

Members which are directly exposed to the weather shall be provided with an effective protection for the solid wood slab element in service.

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

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

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

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

3.1 Mechanical resistance and stability ¹⁾ (BWR 1)

Essential characteristic	Performance
Bending ²⁾	Annex 3
Tension and compression ²⁾	Annex 3
Shear ²⁾	Annex 3
Embedment strength	Annex 3
Creep and duration of the load	Annex 3
Dimensional stability	Annex 3
In-service environment	Annex 3
Bond integrity	Annex 3
¹⁾ This characteristic also relates to BWR 4. ²⁾ Load bearing capacity and stiffness regarding mechanical actions perpendicular to and in plane of the solid wood slab element.	

For gluing the board layers, for the finger joint connection of the individual boards and for the large finger joint connection an adhesive which meet the requirements of EN 301³ shall be used. Alternatively a one component polyurethane adhesive which meets the requirements of EN 15425⁴ and EN 14080⁵, annex B.2 considering annex B.1, may be used.

Regarding the applicable type of adhesive national regulations apply.⁶

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

3.2 Safety in case of fire (BWR 2)

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

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

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

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

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

3.3 Hygiene, health and the environment (BWR 3)

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

3.4 Safety and accessibility in use (BWR 4)

Essential characteristic	Performance
Impact resistance	Annex 3

3.5 Protection against noise (BWR 5)

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

3.6 Energy economy and heat retention (BWR 6)

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

3.7 Sustainable use of natural resources (BWR 7)

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

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

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

The system to be applied is: 1

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

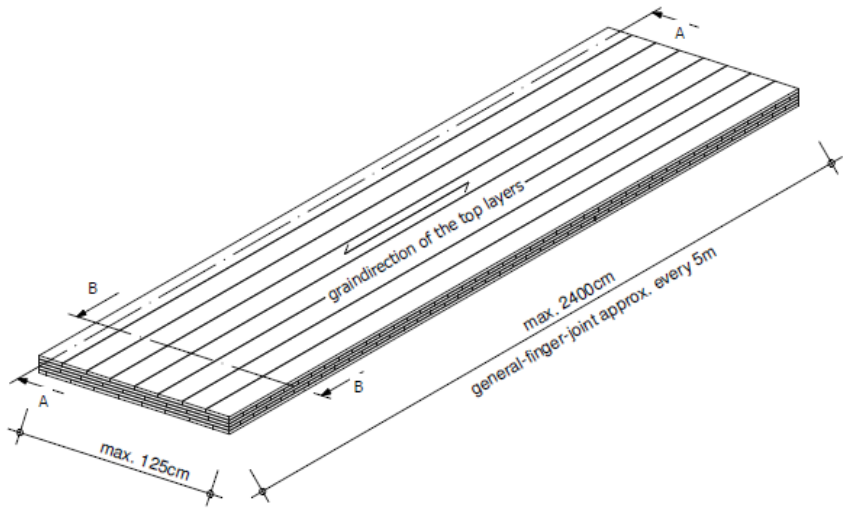
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

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

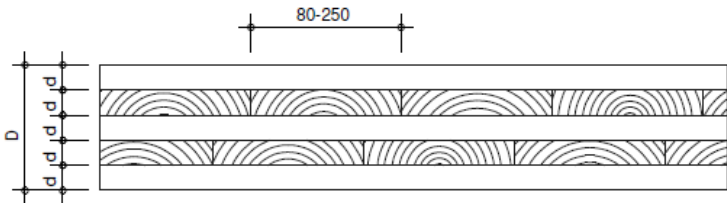
Andreas Kummerow
p.p. Head of Department

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Deniz

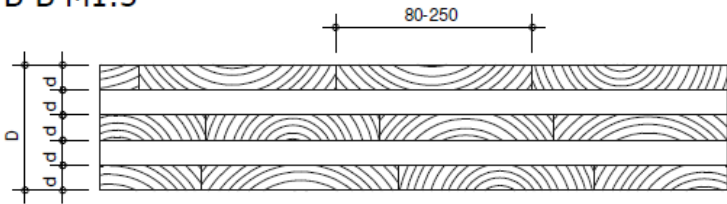
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section A-A M1:5



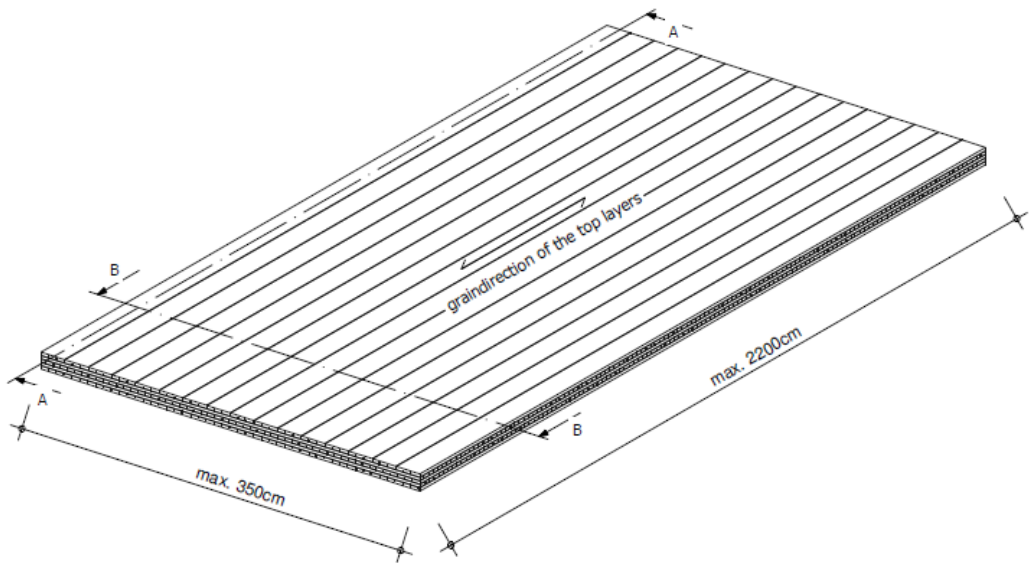
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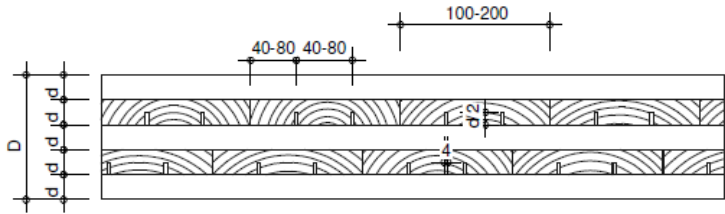
d= board thickness (18mm - 45mm)
D= element thickness (54mm - 350mm)

Binderholz Brettsper Holz BBS	Annex 1
Construction of a multilayered timber element of Systemformat	

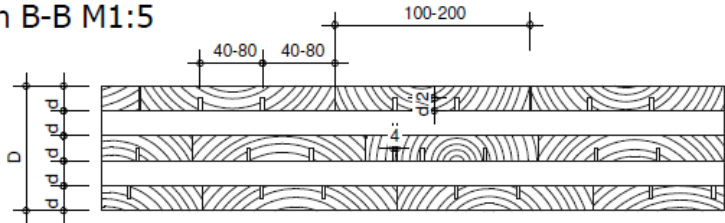
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section A-A M1:5



section B-B M1:5

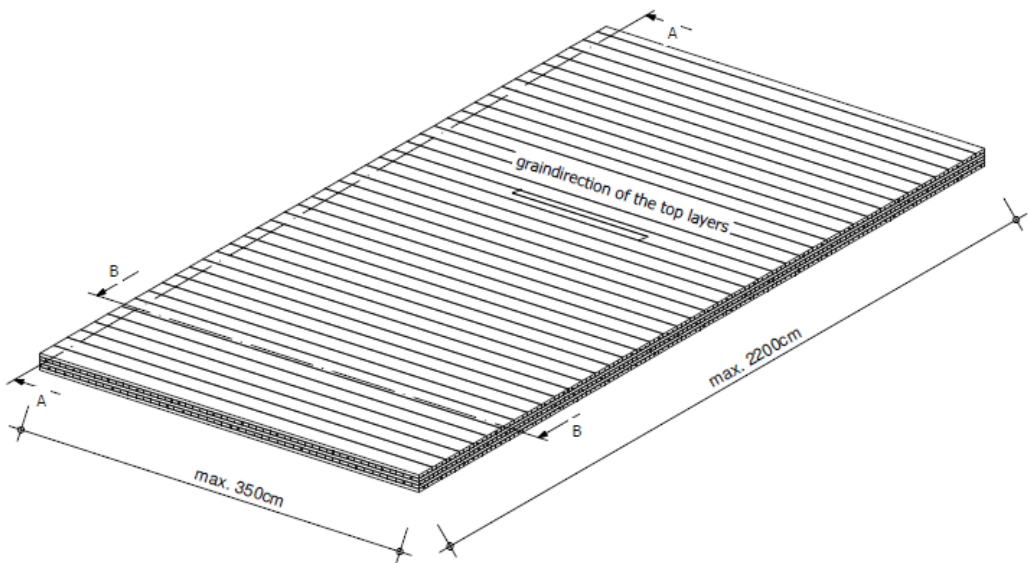


d= board thickness (17mm - 43mm)
D= element thickness (51mm - 215mm)

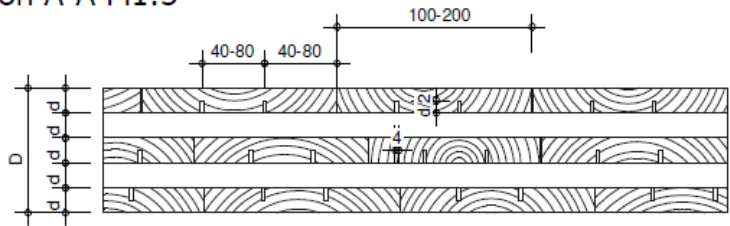
Binderholz Brettsperrholz BBS

Construction of a multilayered timber element of Großformat

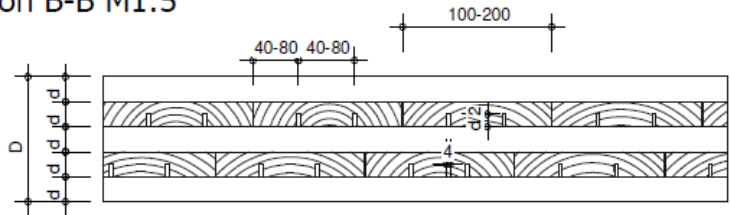
Annex 1



section A-A M1:5



section B-B M1:5



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

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

Table 1: Dimensions and specifications of the multilayered timber elements

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

¹ EN 338:2009

Structural timber - Strength classes

² EN 13183-2:2002

Moisture content of a piece of sawn timber – Part 2: Estimation by electrical resistance method

Binderholz Brettsper Holz BBS

Dimensions and specifications of the multilayered timber elements

Annex 2

Table 1 (continued)

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

Binderholz Brettsperrholz BBS

Dimensions and specifications of the multilayered timber elements

Annex 2

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

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

Binderholz Brettsperrholz BBS

Strength and stiffness values

Annex 2

Table 3: Essential requirements of the multilayered timber elements

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

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

Binderholz Brettsperholz BBS

Essential requirements of the multilayered timber elements

Annex 3

Table 3 (continued)

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

Binderholz Brettsper Holz BBS

Essential requirements of the multilayered timber elements

Annex 3

1 Recommendations for the design of the elements

1.1 General

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

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

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

1.2 Characteristic values

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

While calculating the part of the deformation due to shear forces, the elements thickness D regardless of the configuration and a shear modulus of $G = 60 \text{ N/mm}^2$ may be used.

1.3 Mechanical actions perpendicular to the element's plane

1.3.1 Bending and shear

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

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

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

with n = number of boards lying side by side.

1.3.2 Tension and compression

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

1.4 Mechanical actions in plane of the element

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

1.4.1 Shear

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

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

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

Binderholz Brettsper Holz BBS

Recommendations for the design of the elements and the fasteners

Annex 4

- I_p = polar moment of inertia of a certain crossing area i (mm^4)
 $\sum I_p$ = sum of all polar moments of inertia of the crossing areas in the element
 $f_{v,d}$ = design value of the torsional shear strength; the characteristic value shall be set to $f_{v,k} = 2.5 \text{ N/mm}^2$ for this calculation
 $\tau_{T,d}$ = design value of the torsional stresses occurring if boards of one layer are not glued on their narrow sides

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

1.4.2 Tension and compression

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

2 Recommendations for the design of the fasteners

2.1 General

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

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

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

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

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

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

2.2 Connections with dowels and bolts

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

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

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Recommendations for the design of the elements and the fasteners

Annex 4

2.3 Nails

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

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

2.4 Screws

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

Screws must have a diameter of at least 4 mm.

2.5 Split ring connectors and toothed-plate connectors

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

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

Binderholz Brettsperrholz BBS

Recommendations for the design of the elements and the fasteners

Annex 4

Design according to the theory of flexible bonded beams

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

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

The effective moment of inertia is calculated by:

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

$$\gamma_1 = \frac{1}{1 + \frac{\pi^2 \cdot E_0 \cdot A_1 \cdot \bar{h}_1}{G_R \cdot b \cdot l^2}}; \quad \gamma_2 = 1; \quad \gamma_3 = \frac{1}{1 + \frac{\pi^2 \cdot E_0 \cdot A_3 \cdot \bar{h}_2}{G_R \cdot b \cdot l^2}}$$

$$a_1 = \left(\frac{h_1}{2} + \bar{h}_1 + \frac{h_2}{2} \right) - a_2; \quad a_3 = \left(\frac{h_2}{2} + \bar{h}_2 + \frac{h_3}{2} \right) + a_2$$

$$a_2 = \frac{\gamma_1 \cdot A_1 \cdot \left(\frac{h_1}{2} + \bar{h}_1 + \frac{h_2}{2} \right) - \gamma_3 \cdot A_3 \cdot \left(\frac{h_2}{2} + \bar{h}_2 + \frac{h_3}{2} \right)}{\sum_{i=1}^3 (\gamma_i \cdot A_i)}$$

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

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

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

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

Legend:

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

Binderholz Brettsper Holz BBS

Recommendations for the design according to the theory of flexible bonded beams

Annex 5