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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

European Technical Assessment ETA-19/0831 of 2022/09/14

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:	Rotho Blaas LOCK Connectors
Product family to which the above construction product belongs:	Three-dimensional nailing plate (Connectors for timber, CLT, LVL, Glulam members to timber, steel or concrete)
Manufacturer:	Rotho Blaas s.r.l Via dell'Adige 2/1 IT-39040 Cortaccia (BZ) Tel. + 39 0471 818400 Fax + 39 0471 818484 Internet www.rothoblaas.com
Manufacturing plant:	Rotho Blaas s.r.l Manufacturing Plants: 1A-2A-3A
This European Technical Assessment contains:	45 pages including 2 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:	EAD 130186-00-0603 for Three-dimensional nailing plates
This version replaces:	The ETA with the same number issued on 2020-06-22

II SPECIAL PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product

Technical description of the product
LOCK connectors are two-piece, face-fixed connectors to be used in timber-to-timber (LOCK T), in steel-to-timber or concrete-to-timber (LOCK C) connections.

LOCK connectors can be manufactured and supplied as extruded profiles and cut to length on site as multiples of the basic module width (LOCK T, LOCK T FLOOR, LOCK C FLOOR) or pre-cut to the fixed connector width required. The characteristic load-carrying capacity of LOCK connectors made of multiples basic modules is to be calculated according to the formulas in Annex B.

The LOCK connectors are made from aluminium grade AW 6005A T6 according to EN 755-2. Dimensions, hole positions and typical installations are shown in Annexes A and B.

The load-carrying capacity and geometry of LOCK T, LOCK T FLOOR and LOCK C FLOOR refer to the basic module with a standard connector width as shown in Annexes A and B. The load-carrying capacity of LOCK C is calculated in relation to the fixed connector width provided in Annex B.

Face mount one or two-piece LOCK STOP connectors are used as lateral locking system to resist loads perpendicular to the LOCK connector axis, F_{lat}. LOCK STOP connectors are made from carbon or stainless steel, as defined in Annex B. Dimensions, typical installations and load-carrying capacity of LOCK STOP connectors are provided in Annex B.

2 Specification of the intended use in accordance with the applicable European Assessment Document (hereinafter EAD)

LOCK connectors are intended for use in making end grain to side grain connections in load bearing timber structures, as a connection between a main and secondary solid timber or wood based member, as well as steel-to timber or concrete-to-timber connections, where requirements for mechanical resistance and stability and safety in use in the sense of the Basic Work Requirements 1 and 4 of the Regulation 305/2011 (EU) shall be fulfilled.

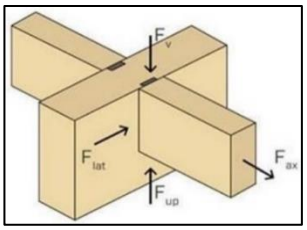
The LOCK connectors can be installed as connections between members such as:

- Structural solid timber according to EN 14081,
- Glued laminated or glued solid timber according to EN 14080,
- LVL according to EN 14374 or ETA,
- Cross laminated timber according to ETA,
- Steel or concrete members.

However, the calculation methods are only allowed for a characteristic wood density of up to 500 kg/m^3. 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.

Annex B states the formulas for the characteristic load-carrying capacities and slip moduli of the connections with LOCK connectors. 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 F_{up} or F_{down} or F_{ax} perpendicular to the header axis and F_{lat} perpendicular to the connector axis. The forces F_{up} and F_{down} shall act in the symmetry plane of the connector. It is assumed that the forces F_{up}, F_{down} or F_{lat} are acting with an eccentricity e regarding the side grain surface of the header.



$F_1 = F_{ax}$	axial
$F_2 = F_v = F_{down}$	downward
$F_3 = F_{up}$	uplift
$F_{45} = F_{lat}$	lateral

It is assumed that the header beam is prevented from rotating. If the header beam only has installed a connector on one side the eccentricity moment $M_v = F_d \cdot (B_H / 2 + e)$ shall be considered. The same applies when the header has connector connections on both sides, but with vertical forces which differ more than 20%.

The LOCK connectors are intended for use for connections subject to static or quasi static loading.

The LOCK connectors made of aluminium are for use in timber structures subject to the conditions defined by the service classes 1, 2 and 3 of EN 1995-1-1 (Eurocode 5).

The LOCK STOP connectors made of carbon or stainless steel are for use in timber structures subject to the conditions defined by the service classes 1, 2 and 3, based on the material and coating as defined in EN 1995-1-1 (Eurocode 5).

The scope of the connectors regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmen-

tal conditions and in conjunction with the admissible service conditions according to EN 1995-1-1 and the admissible corrosivity category as described and defined in EN ISO 12944-2.

Assumed working life

The assumed intended working life of the LOCK connectors for the intended use is 50 years, provided that they are subject to appropriate use and maintenance.

The information on the working life should not be regarded as a guarantee provided by the manufacturer or ETA Danmark. An "assumed intended working life" means that it is expected that, when this working life has elapsed, the real working life may be, in normal use conditions, considerably longer without major degradation affecting the essential requirements.

3 Characteristics of product and assessment

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability*) (BWR1)	
Joint Strength - Characteristic load-carrying capacity	See Annex B
Joint Stiffness	See Annex B
Joint ductility	No performance assessed
Resistance to seismic actions	No performance assessed
Resistance to corrosion and deterioration	See section 3.6
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The connectors are made from aluminium classified as Euroclass A1 in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364
3.3 General aspects related to the performance of the product	The aluminium 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, 2 and 3
Identification	See Annex A

*) See additional information in section 3.4 – 3.7

3.4 Methods of verification

Safety principles and partial factors

The characteristic load-carrying capacities are based on the characteristic values of the connections with metal fasteners, the aluminium plates and the timber members.

In the case of timber failure or failure of the metal fasteners, the design values shall be calculated according to EN 1995-1-1 by dividing the characteristic values of the load-carrying capacities by different partial factors for the strength properties, and in addition multiplied with the coefficient k_{mod}.

In the case of aluminium failure, the design value shall be calculated according to EN 1999 by reducing the characteristic values of the load-carrying capacity with different partial factors.

The design value of the load-carrying capacity is the smaller value of all load-carrying capacities:

$$F_{Rd} = \min\left\{\frac{k_{mod} \cdot F_{Rk,T}}{\gamma_{M,T}}; \frac{F_{Rk,alu}}{\gamma_{M2,alu}}\right\}$$

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

3.5 Mechanical resistance and stability

See Annex B for characteristic load-carrying capacities of the LOCK connections.

The characteristic capacities of the connectors are determined by calculation assisted by testing as described in the EAD 130186-00-0603. 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 the table on page 31 in Annex A:

- *Screws in accordance with EN 14592 or ETA-11/0030*
- *Bolts in accordance with EN ISO 898, EN ISO 4014, EN ISO 4016, EN ISO 4017, EN ISO 4018, EN 15048 or ETA*
- *Metal anchors in accordance with ETA*

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.

3.6 Aspects related to the performance of the product

In accordance with EAD 130186-00-0603 the LOCK connectors are produced from aluminium grade AW 6005A T6 according to EN 755-2 and could be either anodized or coated with an organic coating.

3.7 General aspects related to the use of the product

LOCK connectors 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.

The following provisions concerning product performance apply:

LOCK connector joints

A LOCK connector joint is assessed for the intended use provided:

- The timber member shall be free from wane under the LOCK connector.
- LOCK connectors are fastened to wood-based members by self-tapping screws in pre-drilled or non-pre-drilled holes.
- There shall be screws of equal length in all specified holes of each separate joist or header connector part. The screw lengths may be different in one connection in the joist or header part, respectively.
- The characteristic capacity of the LOCK connector joint is calculated according to the manufacturer's technical documentation dated 2022-06-13.
- The LOCK connector joint is designed in accordance with Eurocode 5 or an appropriate national code.
- The gap between the timber member and the connector surface, where contact stresses can occur during loading shall be limited. This means that for LOCK connectors the gap between the joist or header connector part and the timber members shall be maximum 1 mm.
- When a LOCK T connector is used on each side of the main member, the width of the main member shall be so large to avoid contact between the screw tips.
- The spacing between adjacent LOCK connectors in connections containing more than one connector shall be large enough to fulfil minimum spacing requirements of the fasteners.
- Screws to be used shall have a diameter of 5 mm or 6 mm or 7 mm and head shape which fits the holes of the LOCK connectors.

- For loads perpendicular to the member axis it must be checked in accordance with Eurocode 5 or a similar national Timber Code that splitting will not occur in either the joist or the header.

4 Assessment and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the decision 97/638/EC of the European Commission, 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 prior to CE marking.

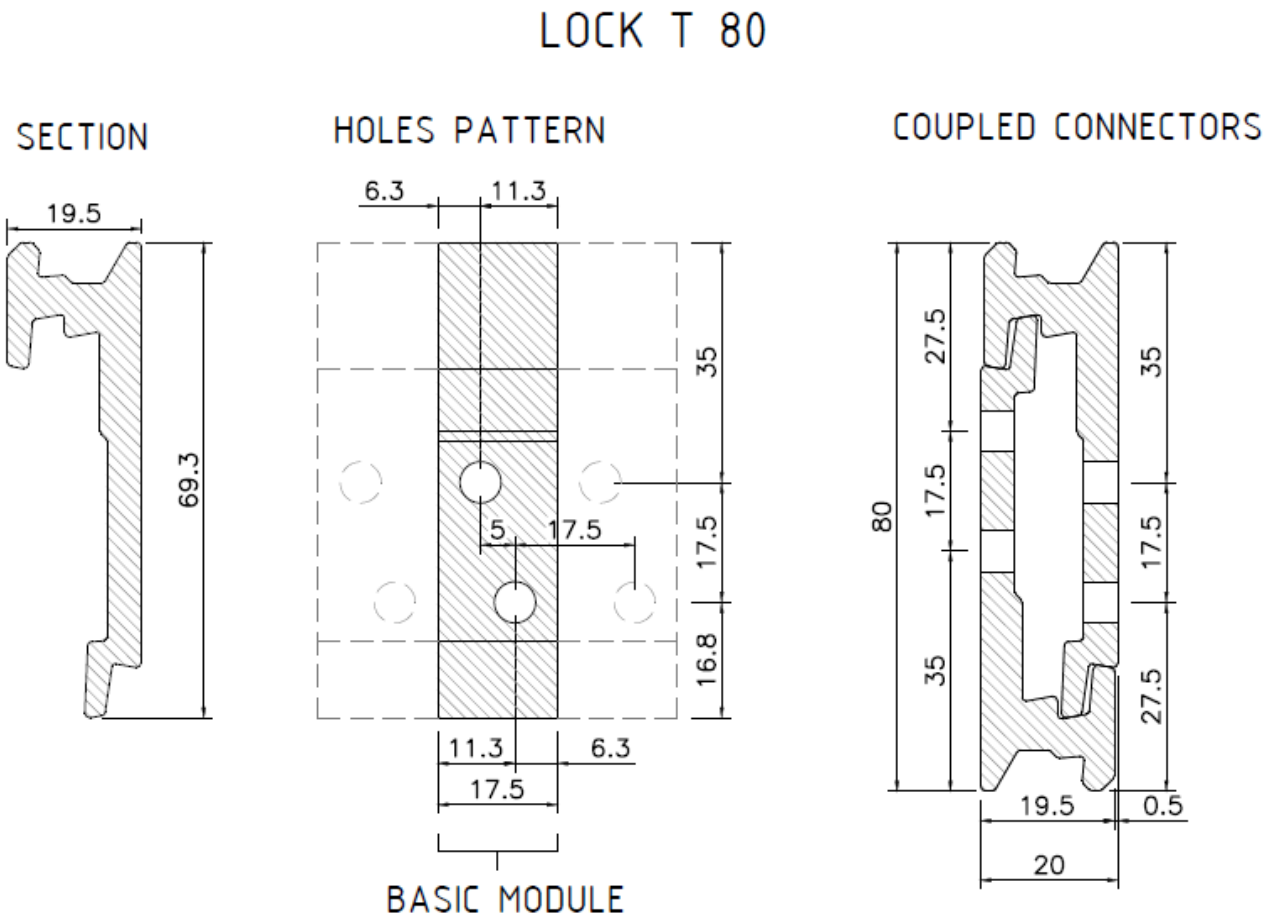
Issued in Copenhagen on 2022-09-14 by

Thomas Bruun
Managing Director, ETA-Danmark

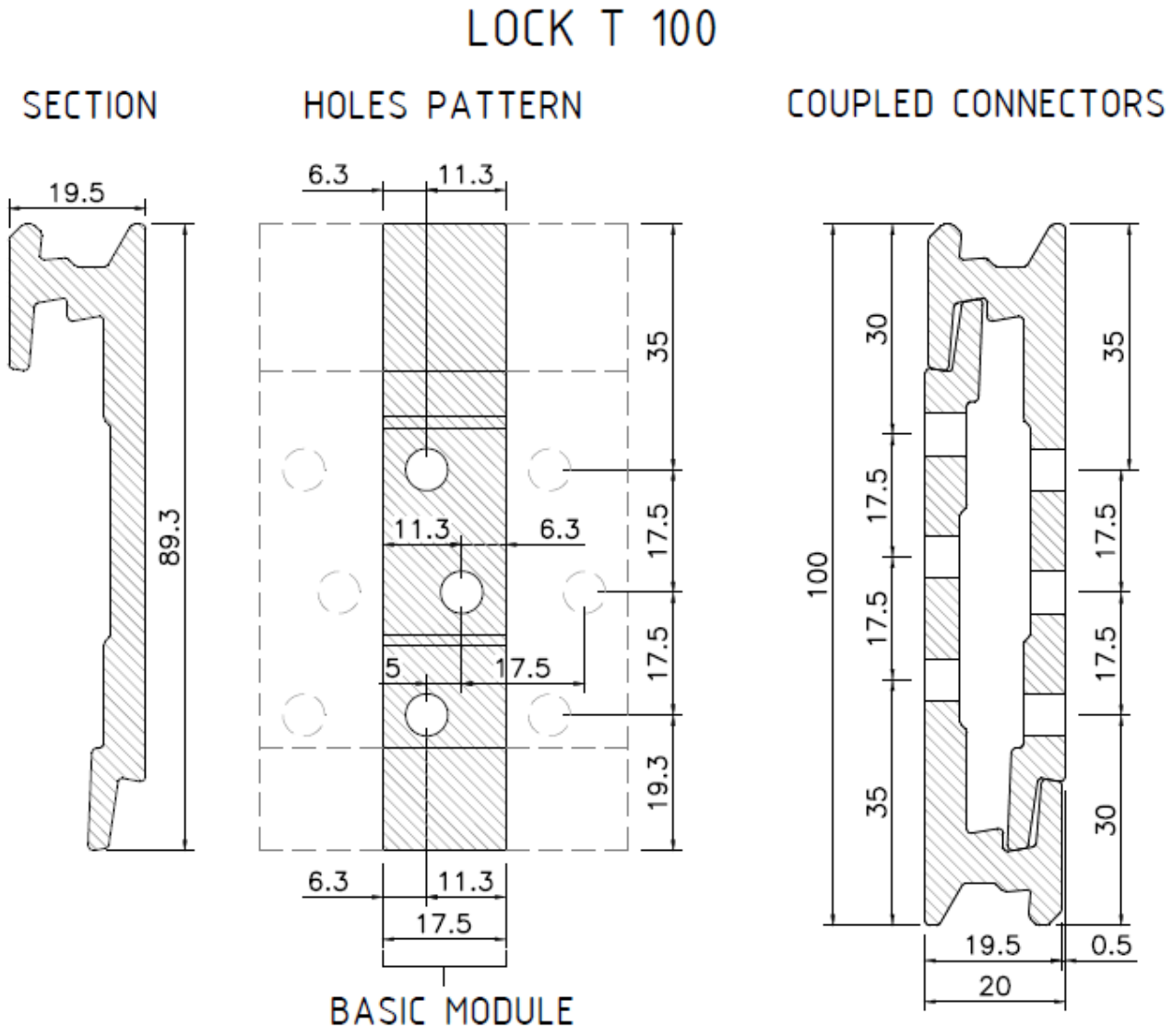
Annex A
Product details and definitions

LOCK T 80 connector

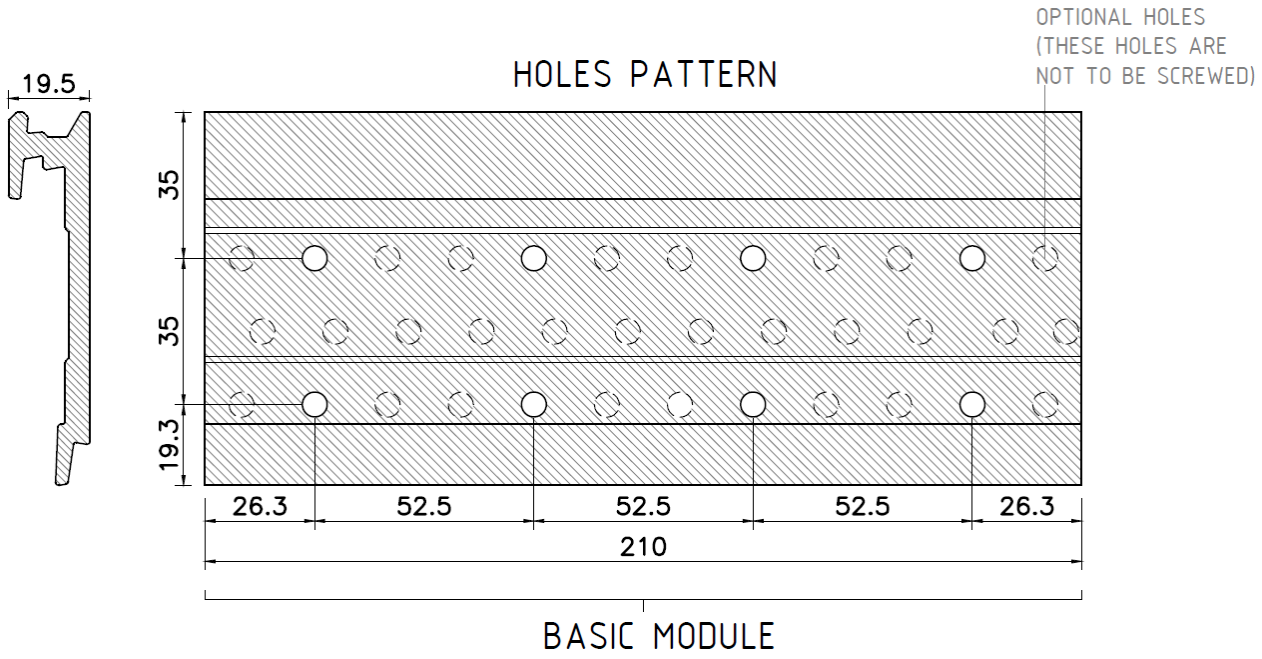
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 5 mm screws.



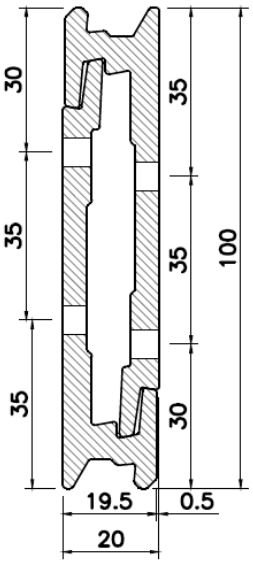
LOCK T 100 and LOCK T 100 FLOOR connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 5 mm screws.



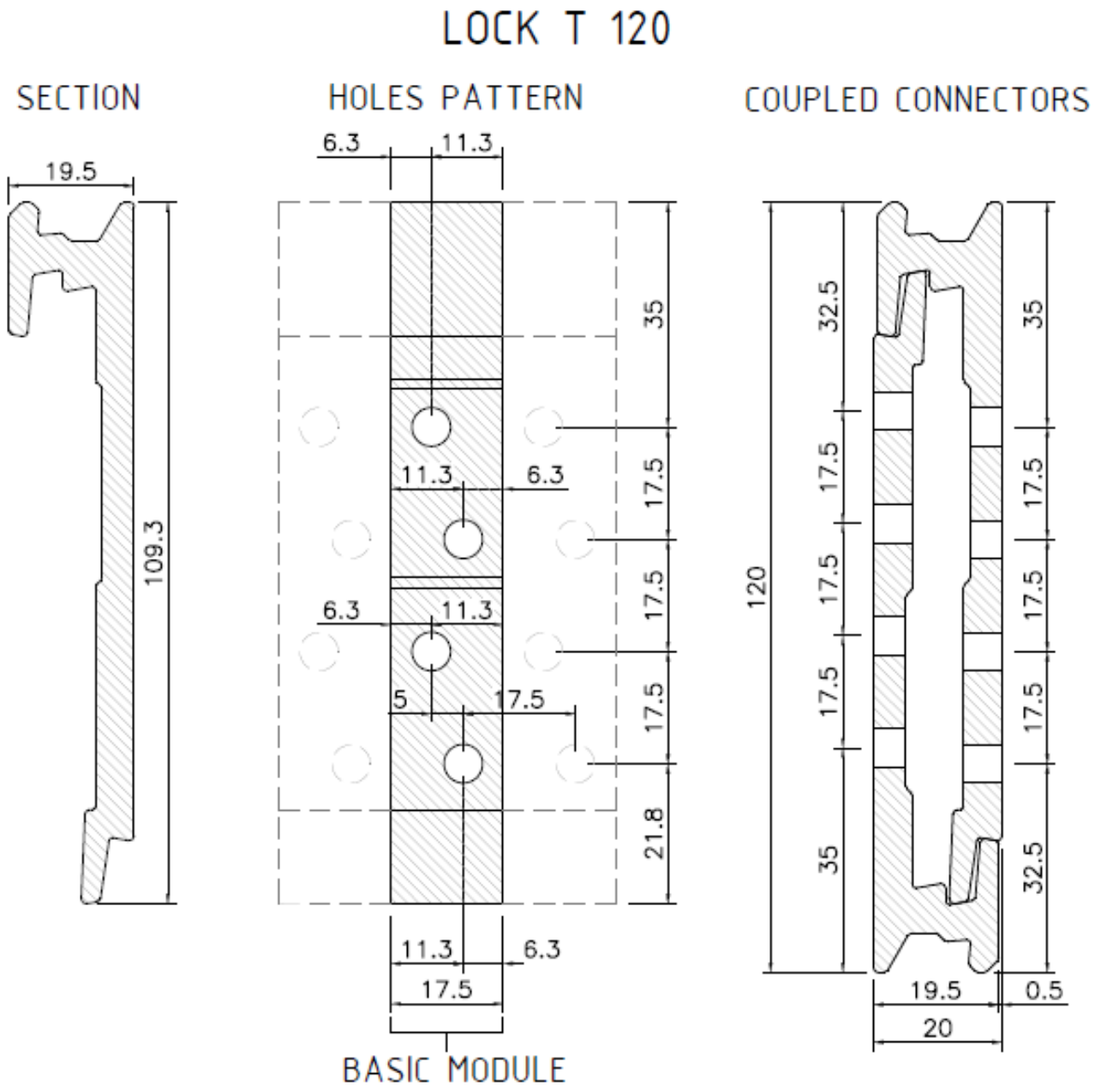
LOCK T 100 FLOOR



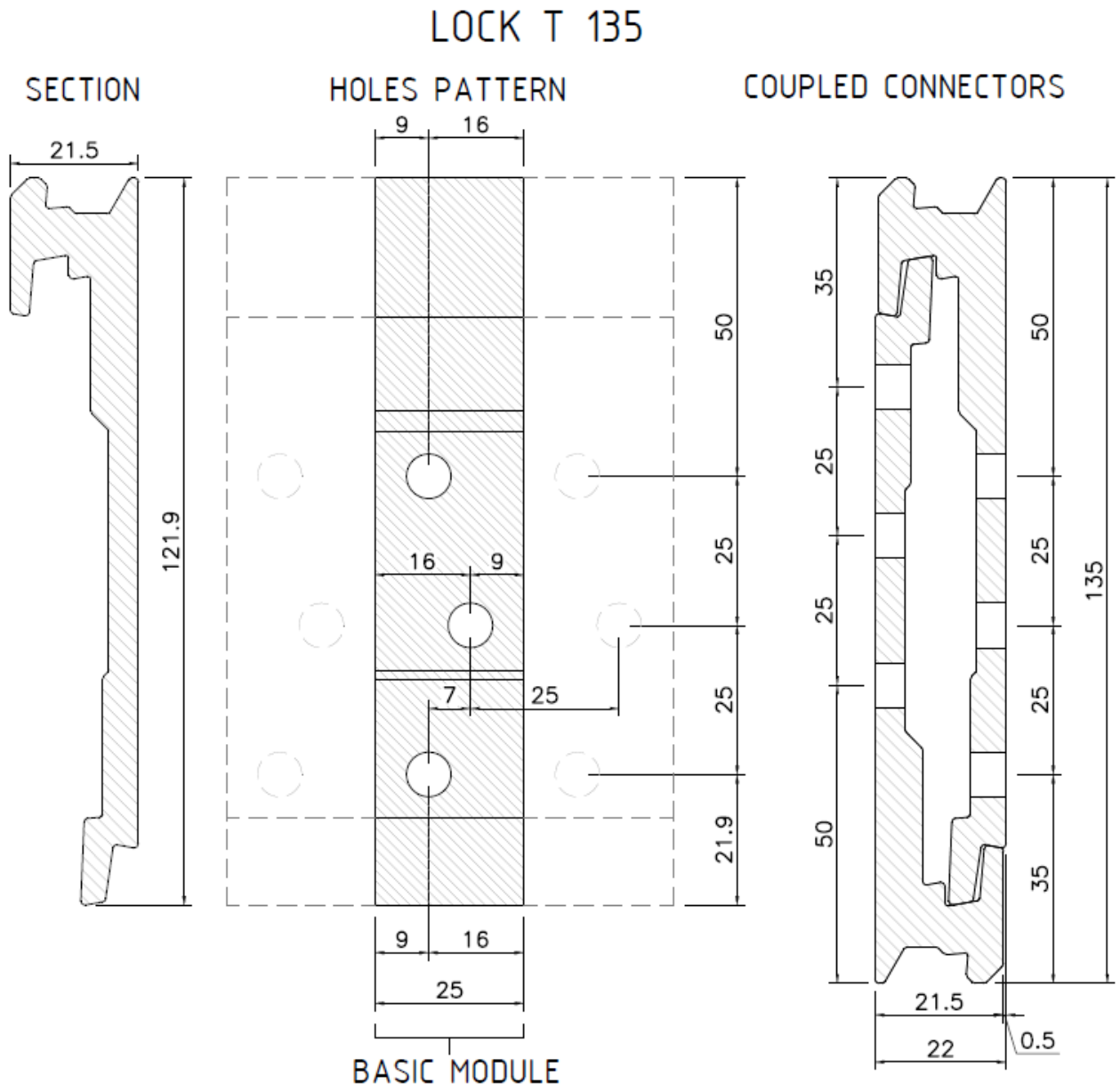
COUPLED CONNECTORS

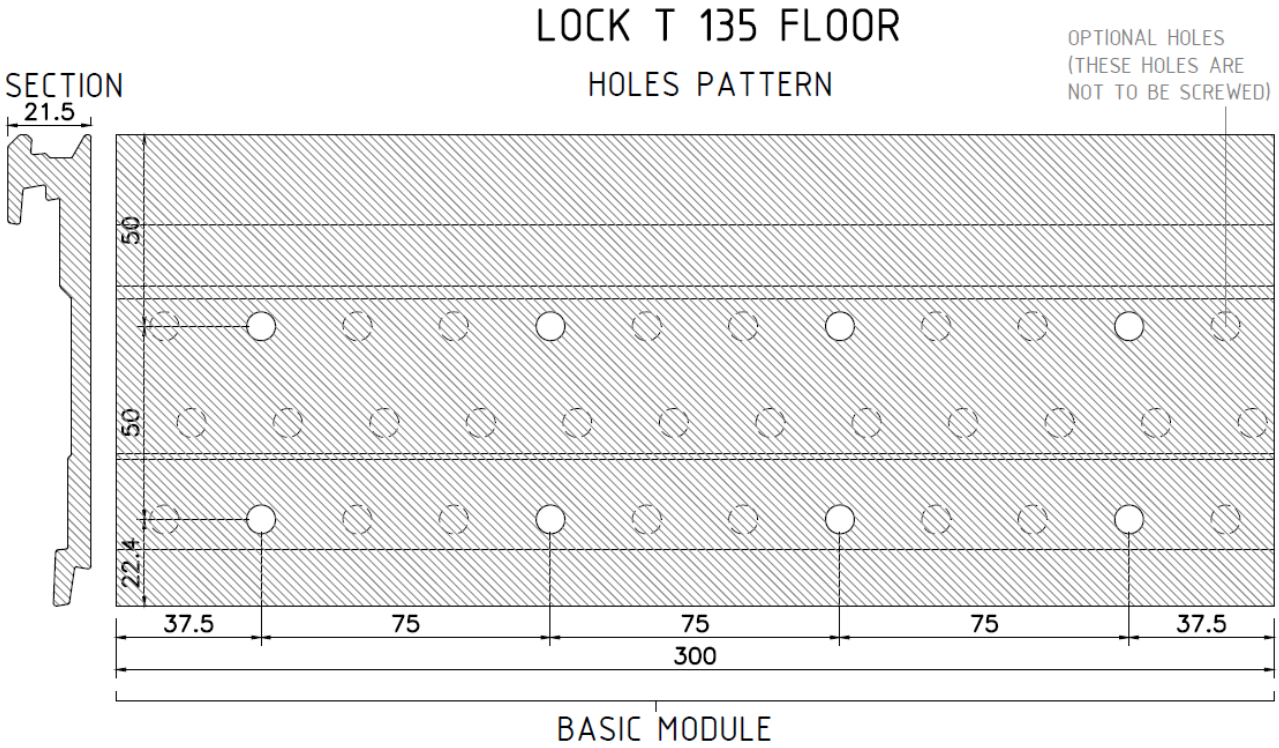


LOCK T 120 connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 5 mm screws.

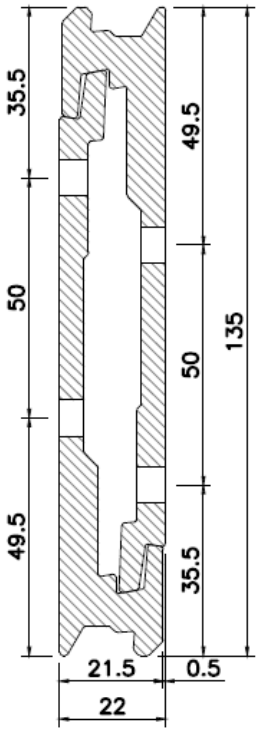


LOCK T 135 and LOCK T 135 FLOOR connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 6 mm or 7 mm screws.

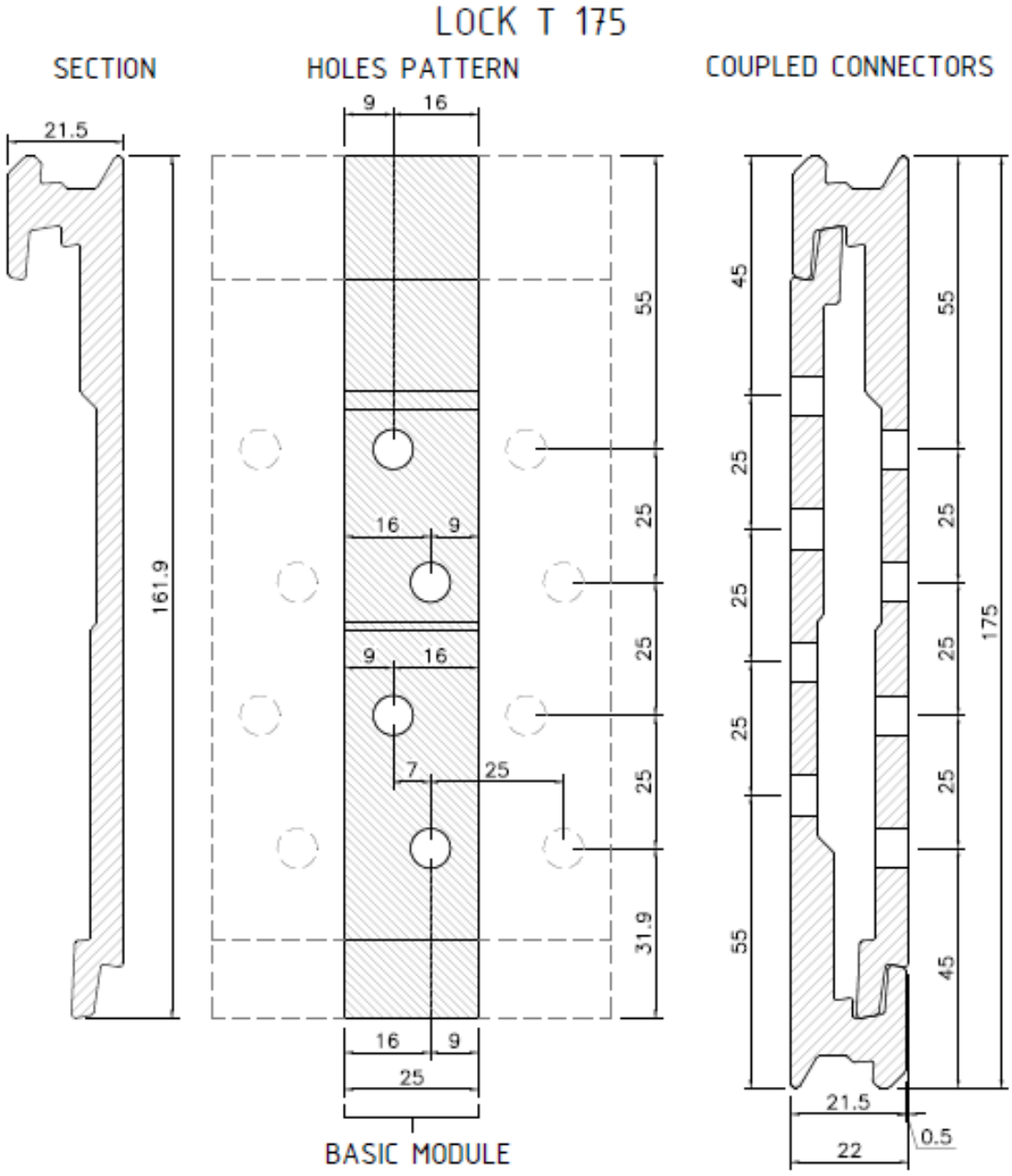




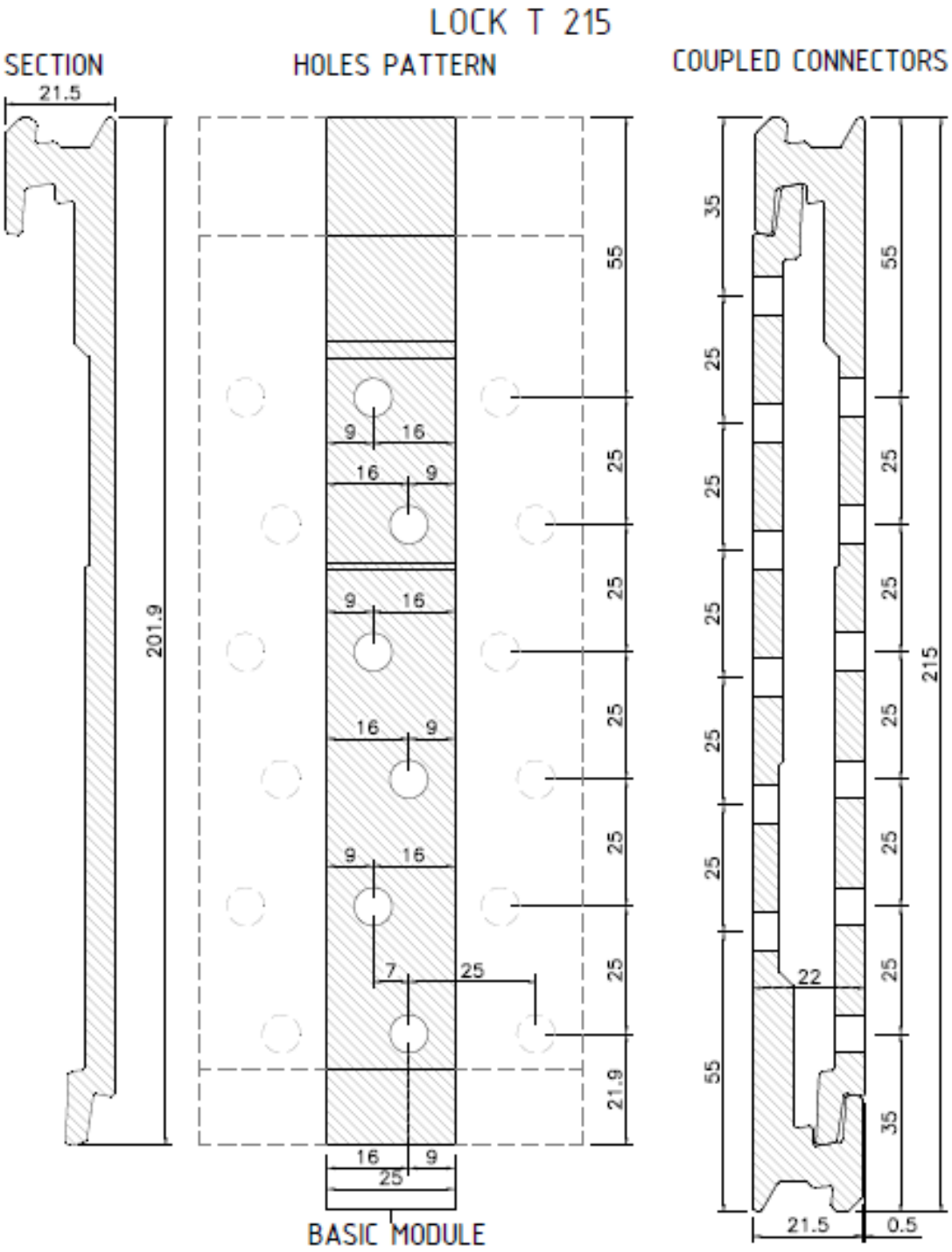
COUPLED CONNECTORS



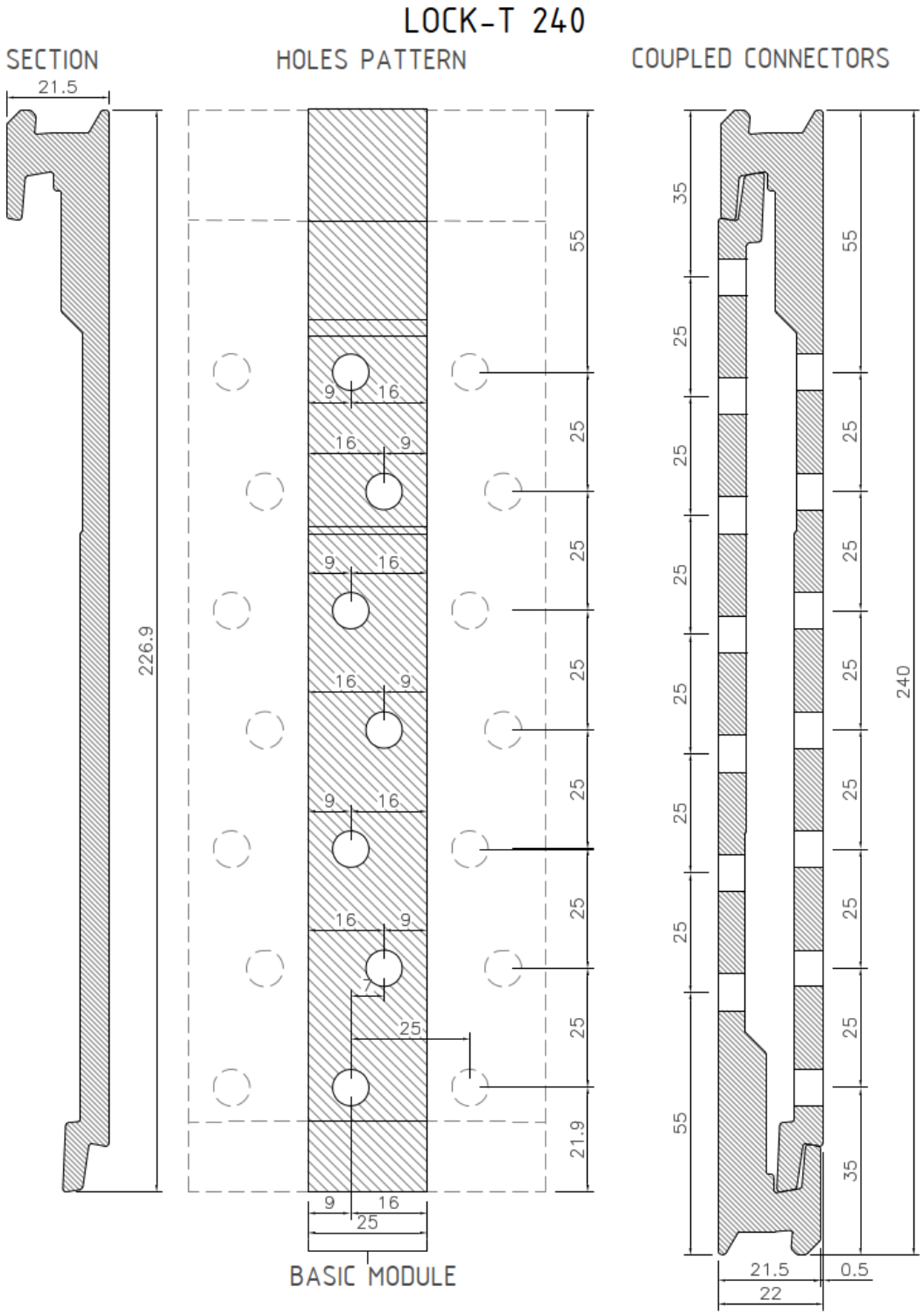
LOCK T 175 connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 6 mm or 7 mm screws.



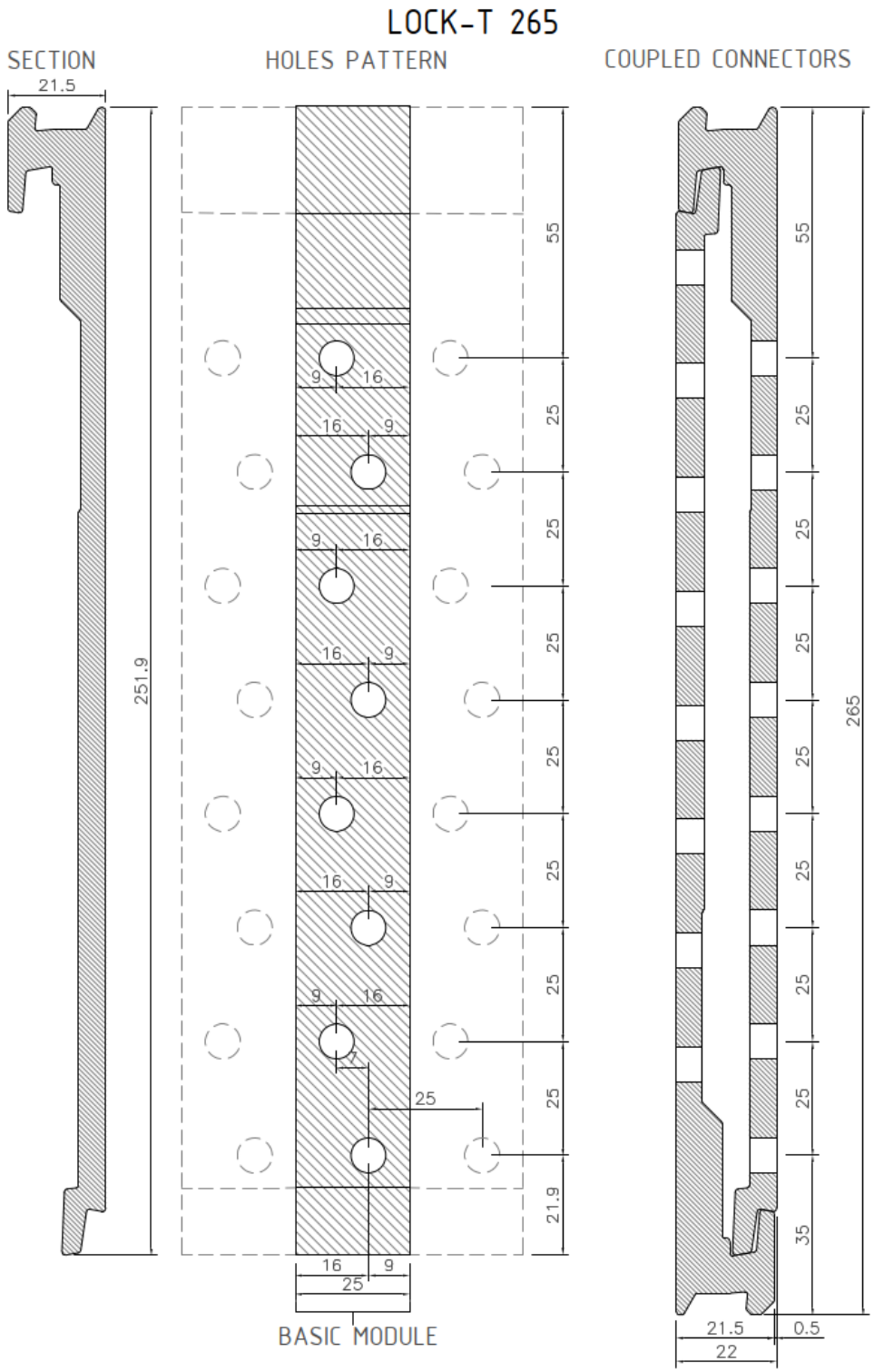
LOCK T 215 connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 6 mm or 7 mm screws.



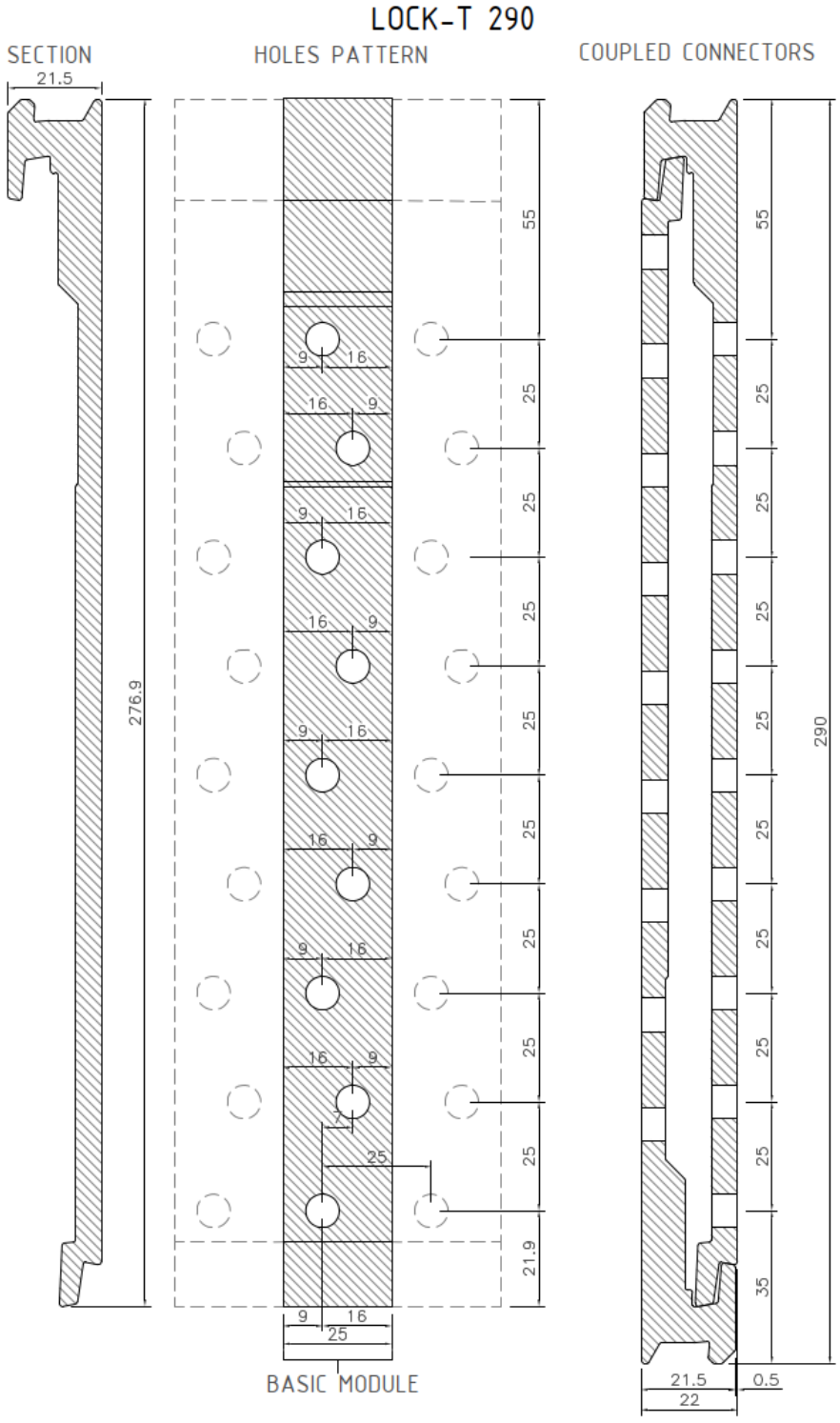
LOCK T 240 connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 6 mm or 7 mm screws.



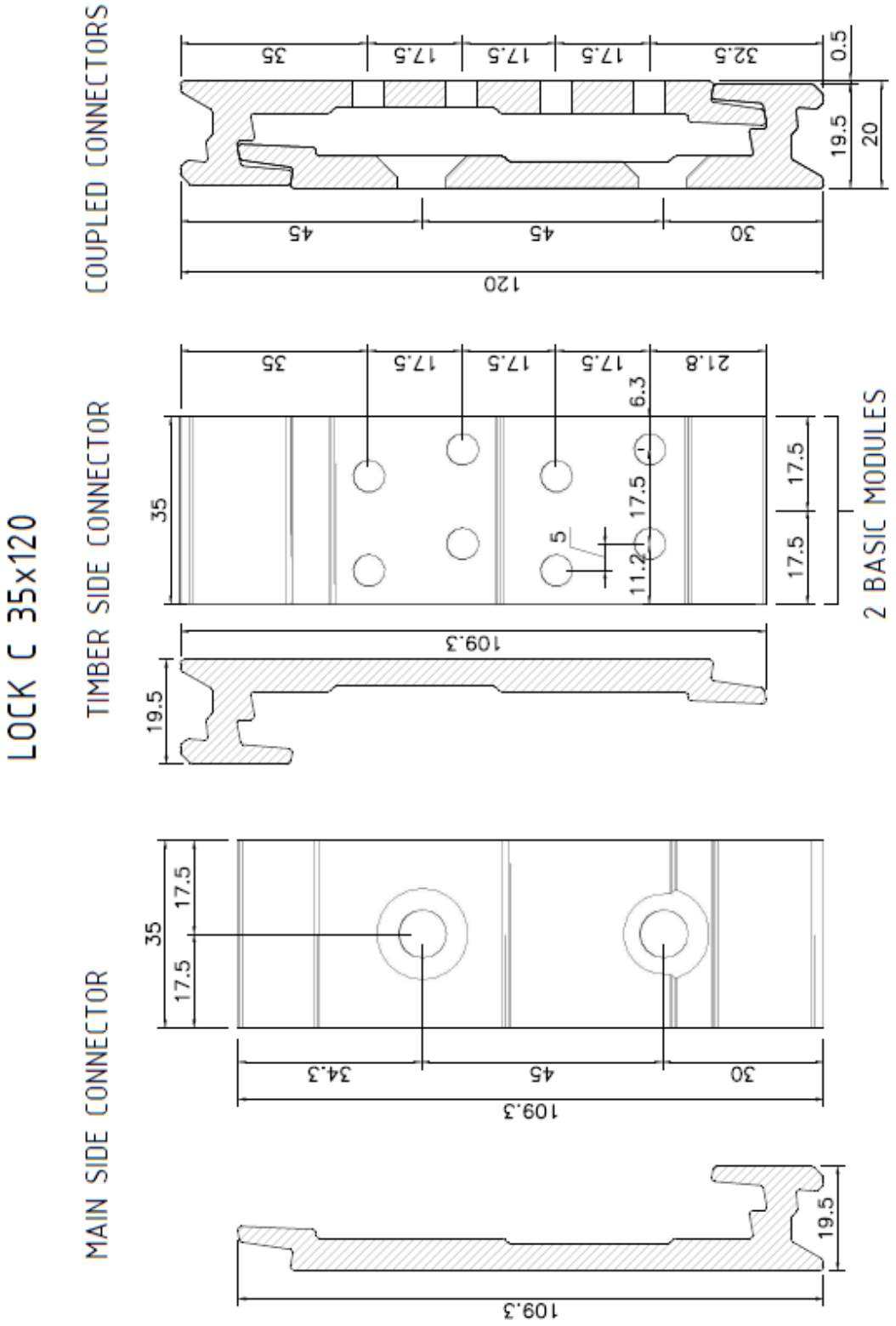
LOCK T 265 connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 6 mm or 7 mm screws.

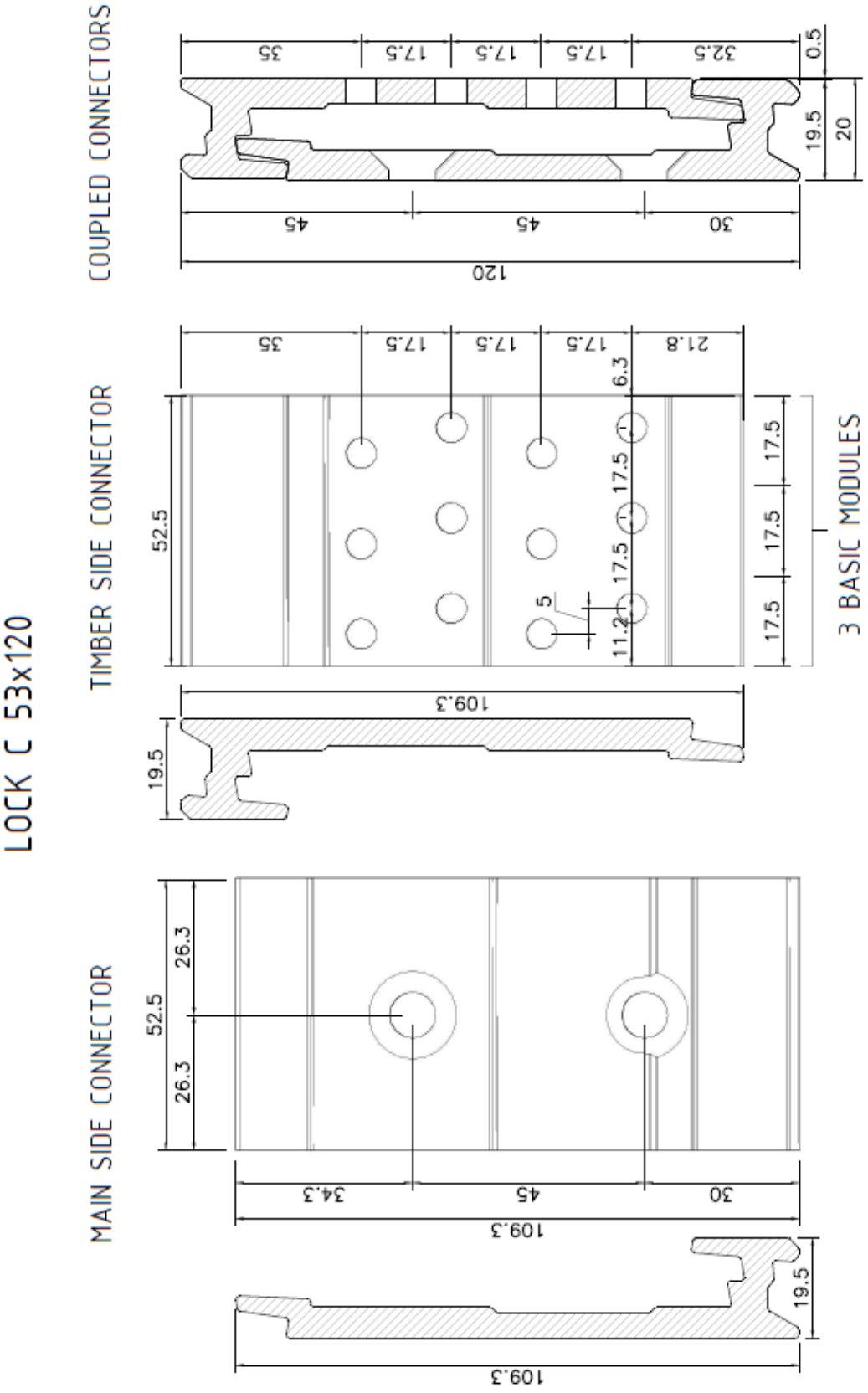


LOCK T 290 connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-timber connections with 6 mm or 7 mm screws.



LOCK C 35x120 or 53x120 connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-concrete or timber to steel connections with 5 mm screws and 8 mm bolts or metal anchors.

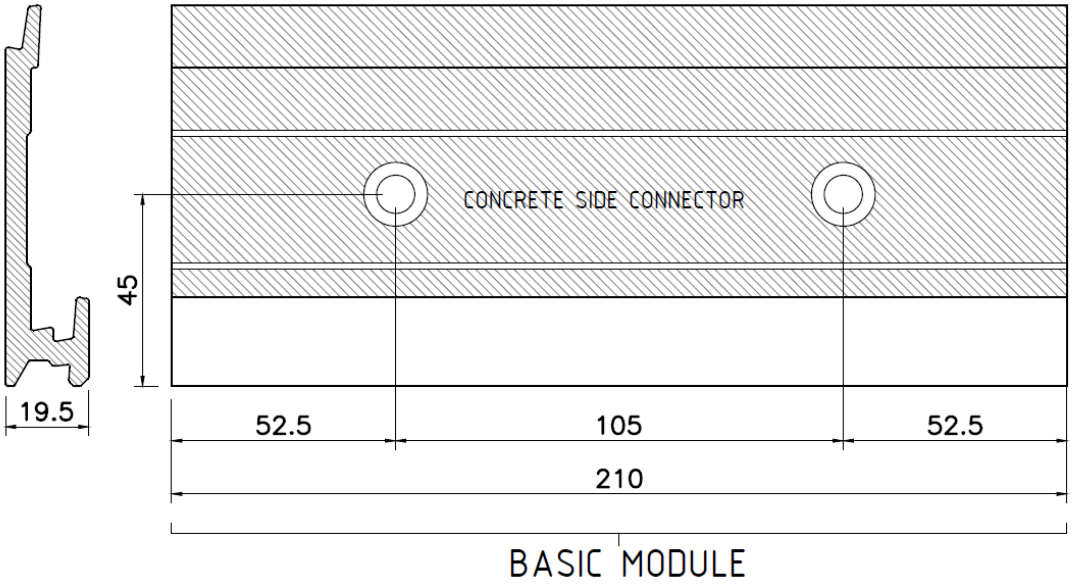



LOCK C 53x120
COUPLED CONNECTORS
35
17.5
17.5
17.5
32.5
0.5
19.5
20
45
45
30
120
TIMBER SIDE CONNECTOR
35
17.5
17.5
17.5
21.8
6.3
52.5
17.5
17.5
17.5
17.5
17.5
5
11.2
3 BASIC MODULES
109.3
19.5
MAIN SIDE CONNECTOR
52.5
26.3
26.3
34.3
45
30
109.3
19.5
109.3

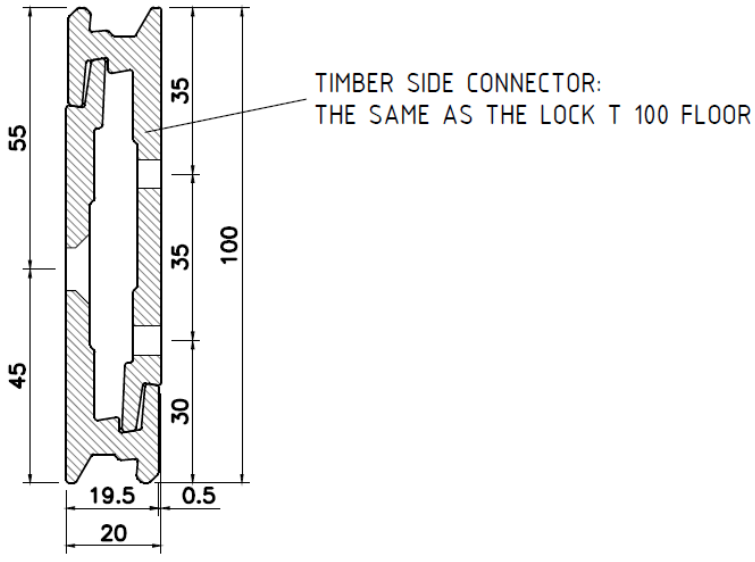
LOCK C 100 FLOOR connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-concrete or timber to steel connections with 5 mm screws and 10 mm bolts or metal anchors.

LOCK C 100 FLOOR

HOLES PATTERN



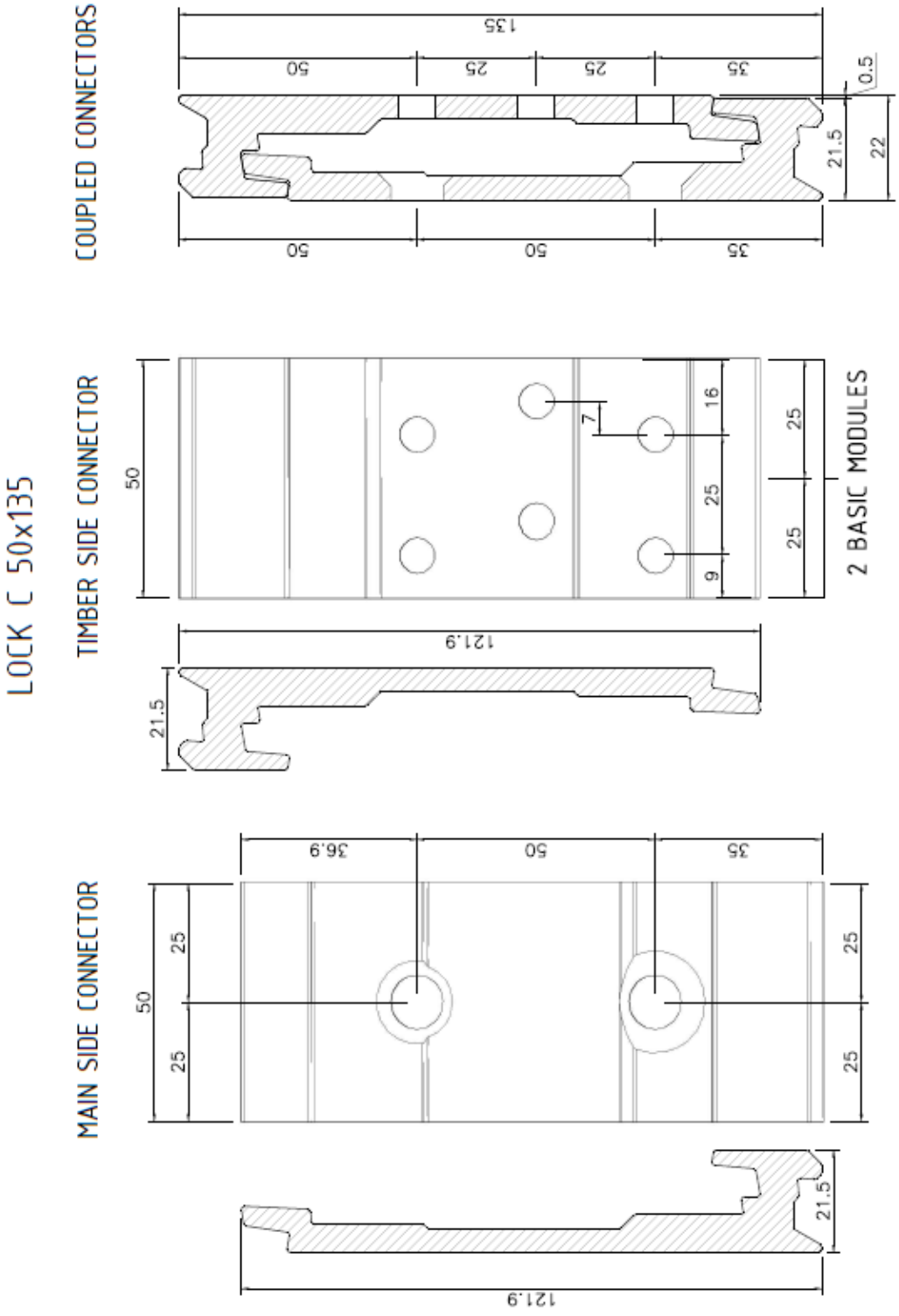
COUPLED CONNECTORS

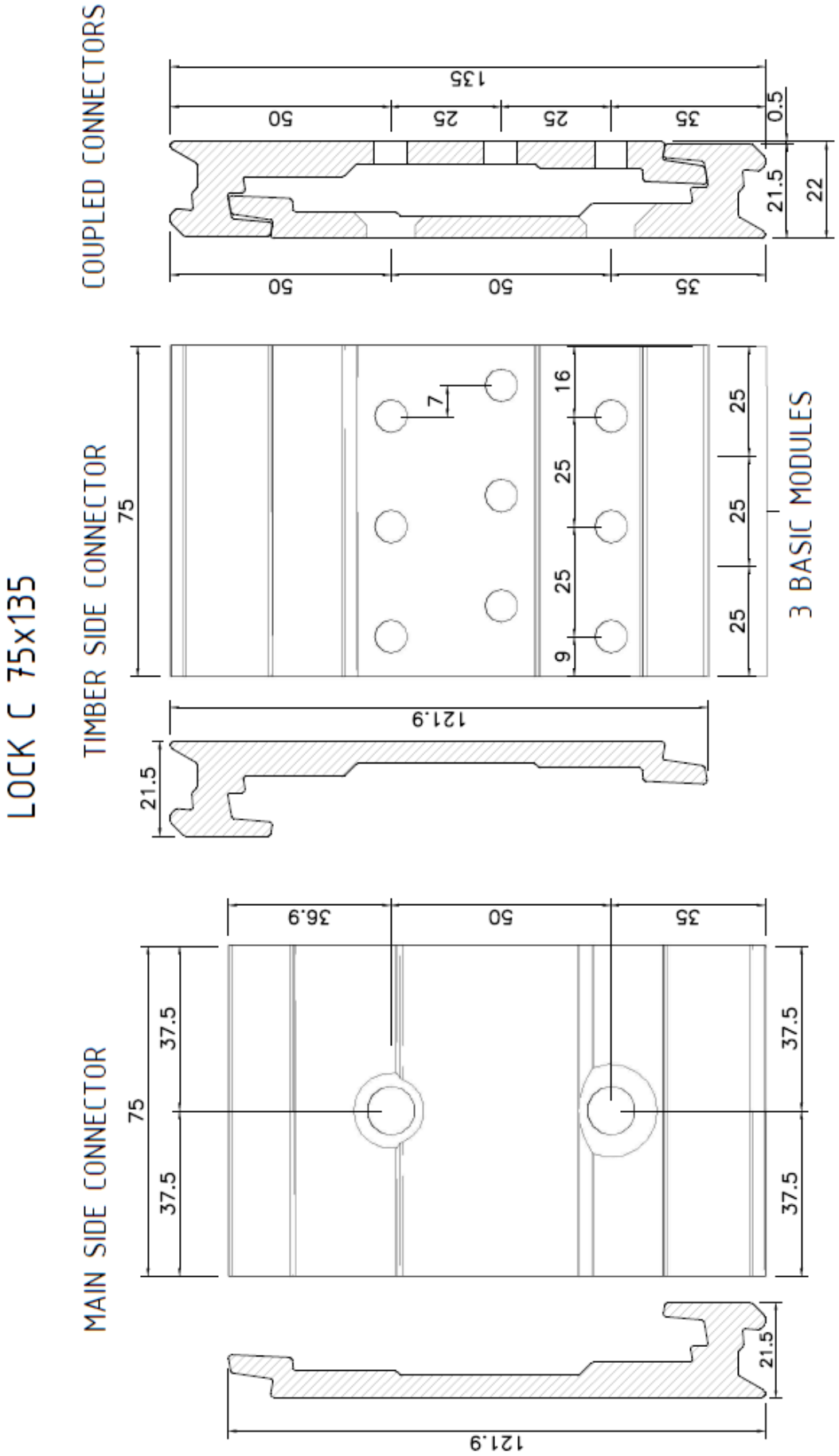


LOCK C 50x135 or 75x135 connector

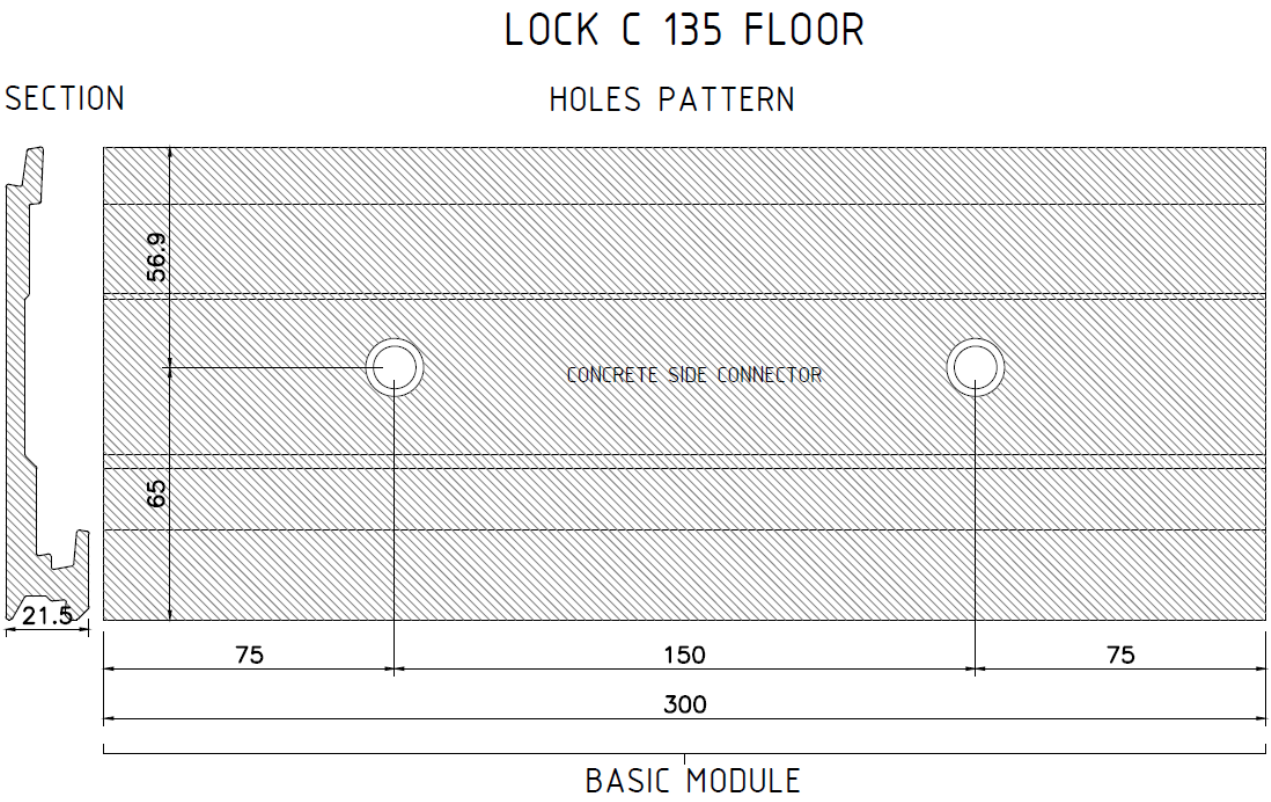
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.

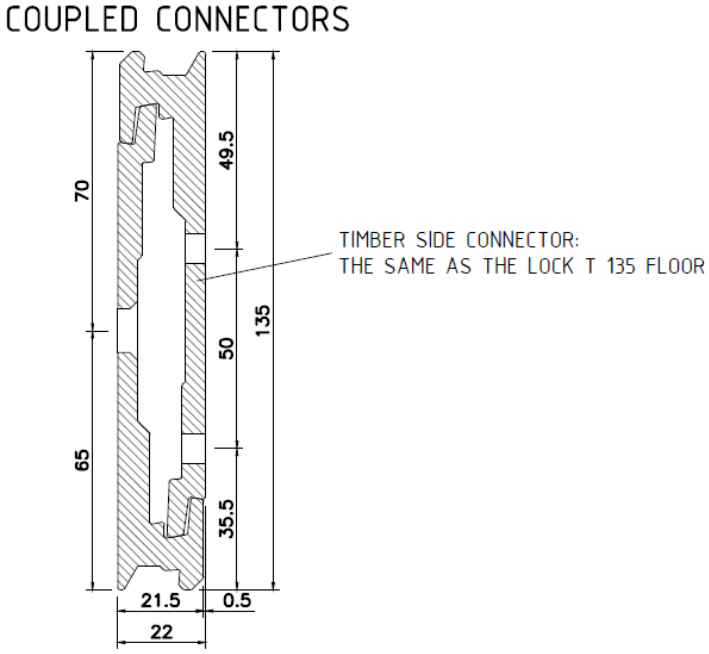
Timber-to-concrete or timber to steel connections with 6 mm or 7 mm screws and 10 mm bolts or metal anchors.




LOCK C 75x135
COUPLED CONNECTORS
135
50
25
25
35
0.5
21.5
22
50
50
35
TIMBER SIDE CONNECTOR
75
7
16
25
25
25
9
25
25
25
3 BASIC MODULES
121.9
21.5
MAIN SIDE CONNECTOR
75
37.5
37.5
36.9
50
35
37.5
37.5
21.5
121.9

LOCK C 135 FLOOR connector
Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.
Timber-to-concrete or timber to steel connections with 6 mm or 7 mm screws and 10 mm bolts or metal anchors.

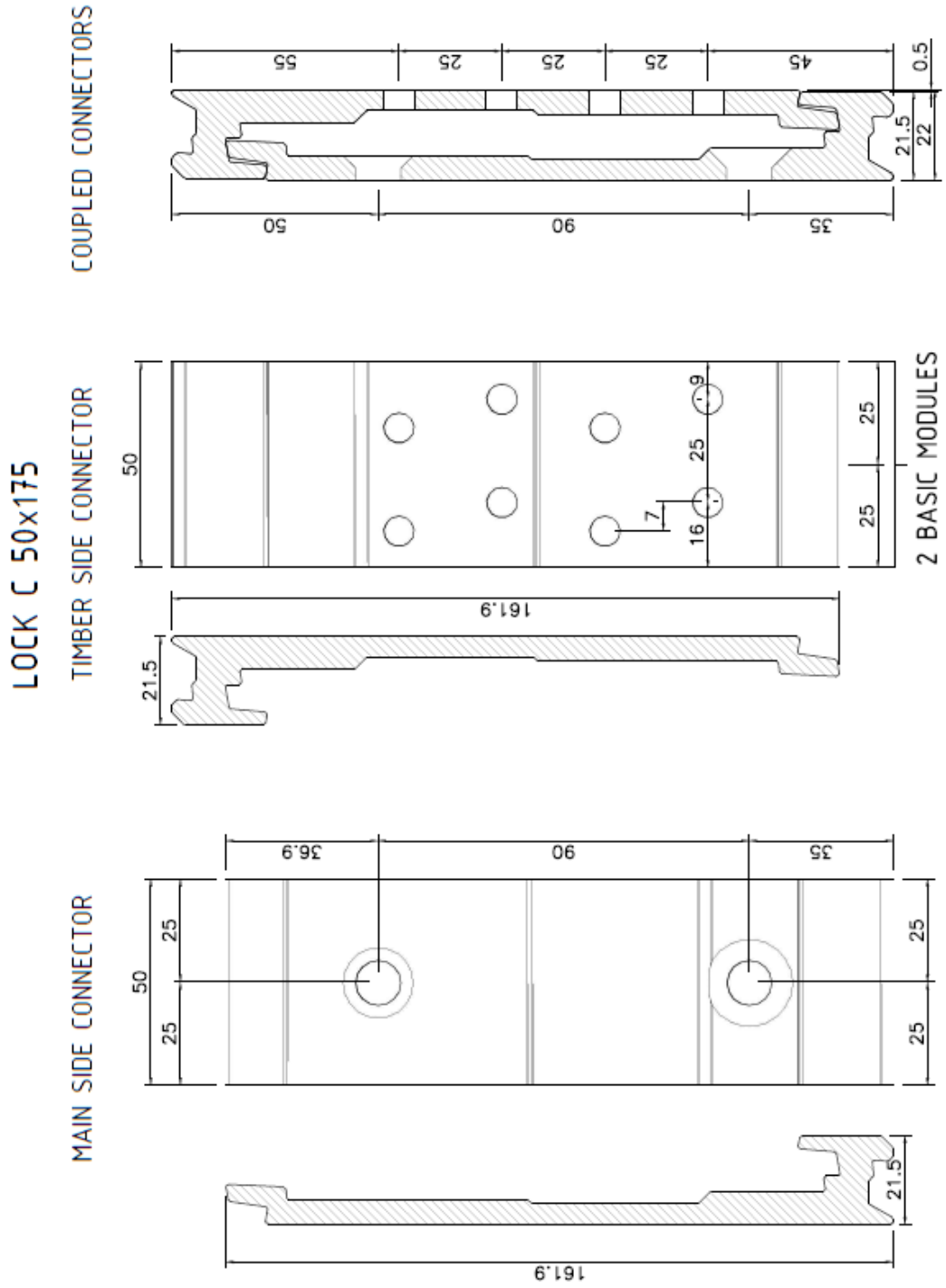


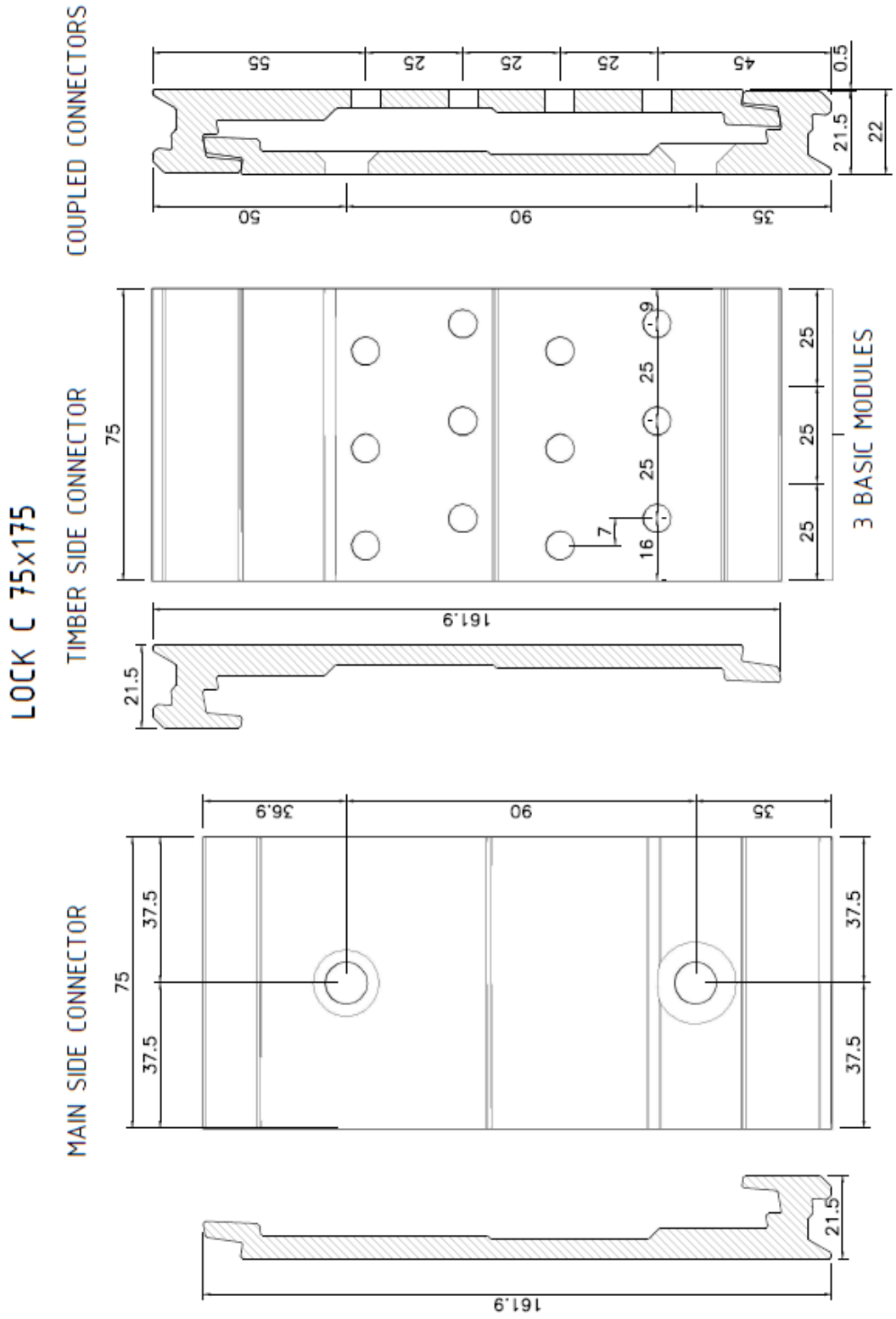


LOCK C 50x175 or 75x175 connector

Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.

Timber-to-concrete or timber to steel connections with 6 mm or 7 mm screws and 10 mm bolts or metal anchors.

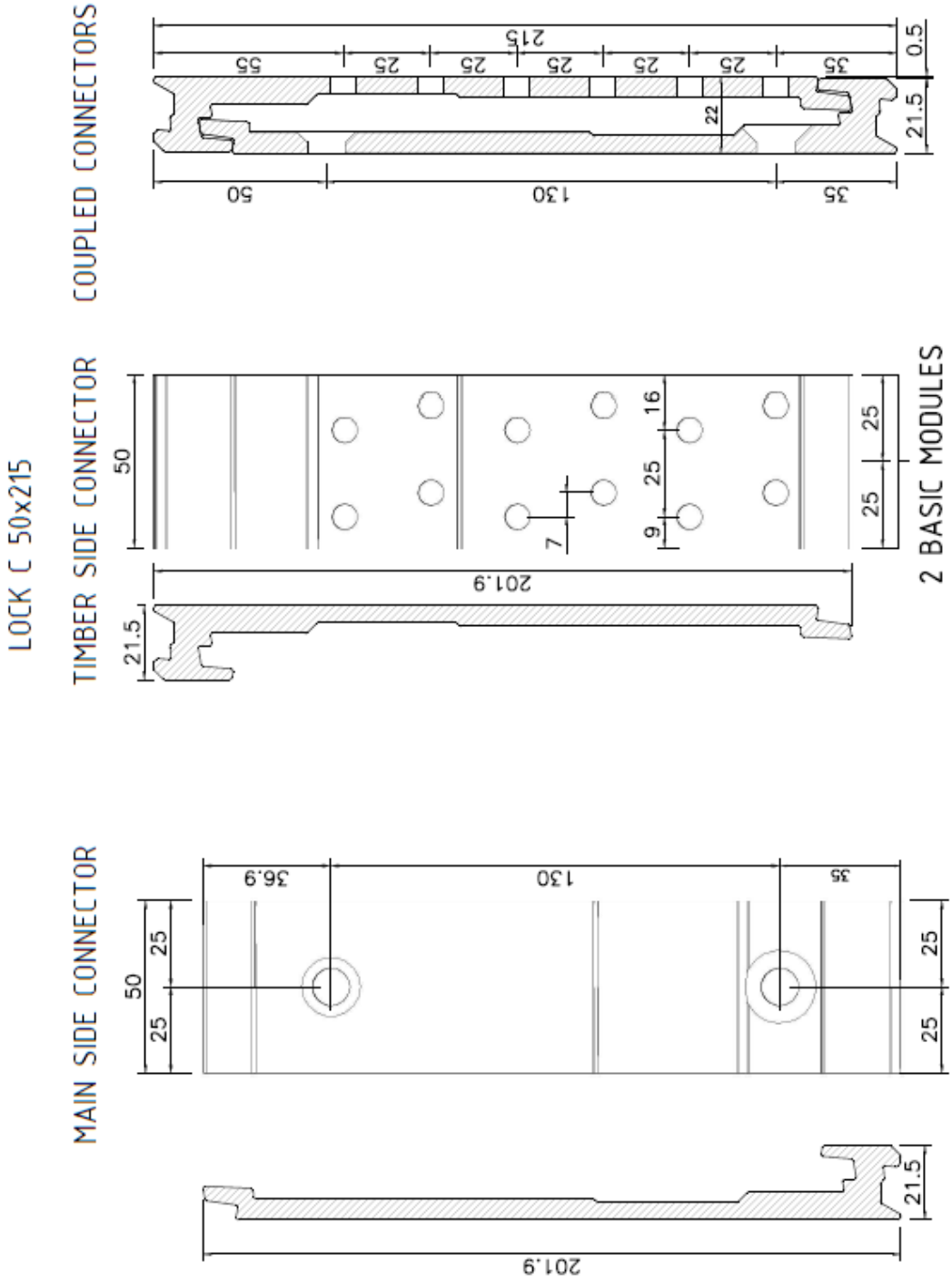


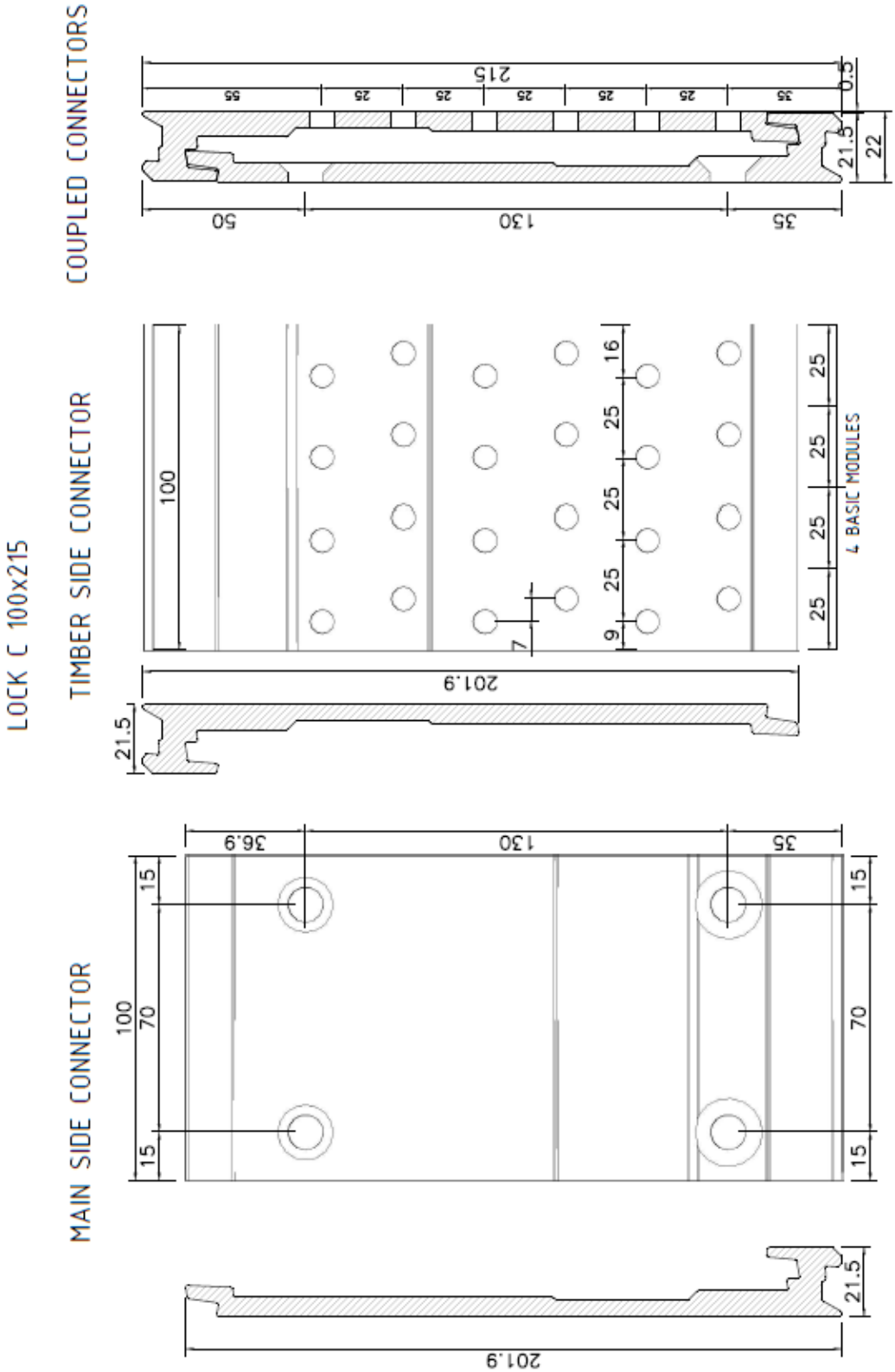

LOCK C 75x175
COUPLED CONNECTORS
55
25
25
25
45
0.5
21.5
22
50
90
35
TIMBER SIDE CONNECTOR
75
25
25
25
25
9
25
7
16
3 BASIC MODULES
161.9
21.5
MAIN SIDE CONNECTOR
36.9
90
35
75
37.5
37.5
37.5
37.5
21.5
161.9

LOCK C 50x215 or 100x215 connector

Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.

Timber-to-concrete or timber to steel connections with 6 mm or 7 mm screws and 10 mm bolts or metal anchors.

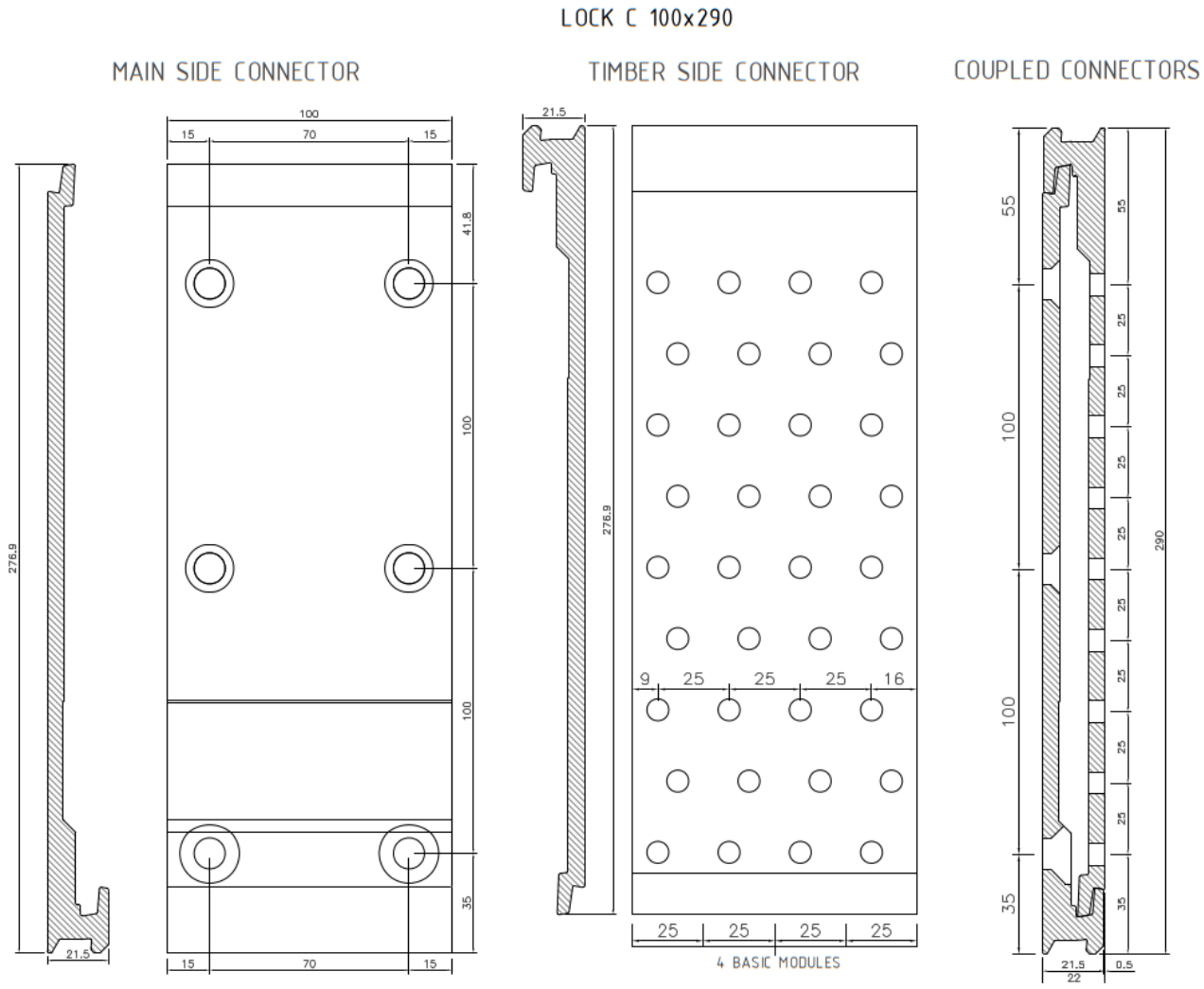



LOCK C 100x215
COUPLED CONNECTORS
215
55
25
25
25
25
25
35
0.5
21.5
22
50
130
35
TIMBER SIDE CONNECTOR
100
16
25
25
25
25
25
25
25
4 BASIC MODULES
7
9
201.9
21.5
MAIN SIDE CONNECTOR
36.9
130
35
15
15
100
70
70
15
15
21.5
201.9

LOCK C 100x290 connector

Face mount two-piece connector. Aluminium grade AW 6005A T6 according to EN 755-2.

Timber-to-concrete or timber to steel connections with 6 mm or 7 mm screws and 10 mm bolts or metal anchors.



Fastener types and sizes

SCREW diameter [mm]	Length [mm]	Screw type
5.0	40 - 100	Rotho Blaas screws according to ETA-11/0030 or EN 14592
6.0	60 - 120	Rotho Blaas screws according to ETA-11/0030 or EN 14592
7.0	60 - 160	Rotho Blaas screws according to ETA-11/0030 or EN 14592

BOLTS diameter [mm]	Length [mm]	Bolt type
8.0 – 10.0	80 - 500	Bolts or threaded rods with metric thread min. 4.6 according to EN ISO 898, EN ISO 4014, EN ISO 4016, EN ISO 4017, EN ISO 4018, EN 15048 or ETA

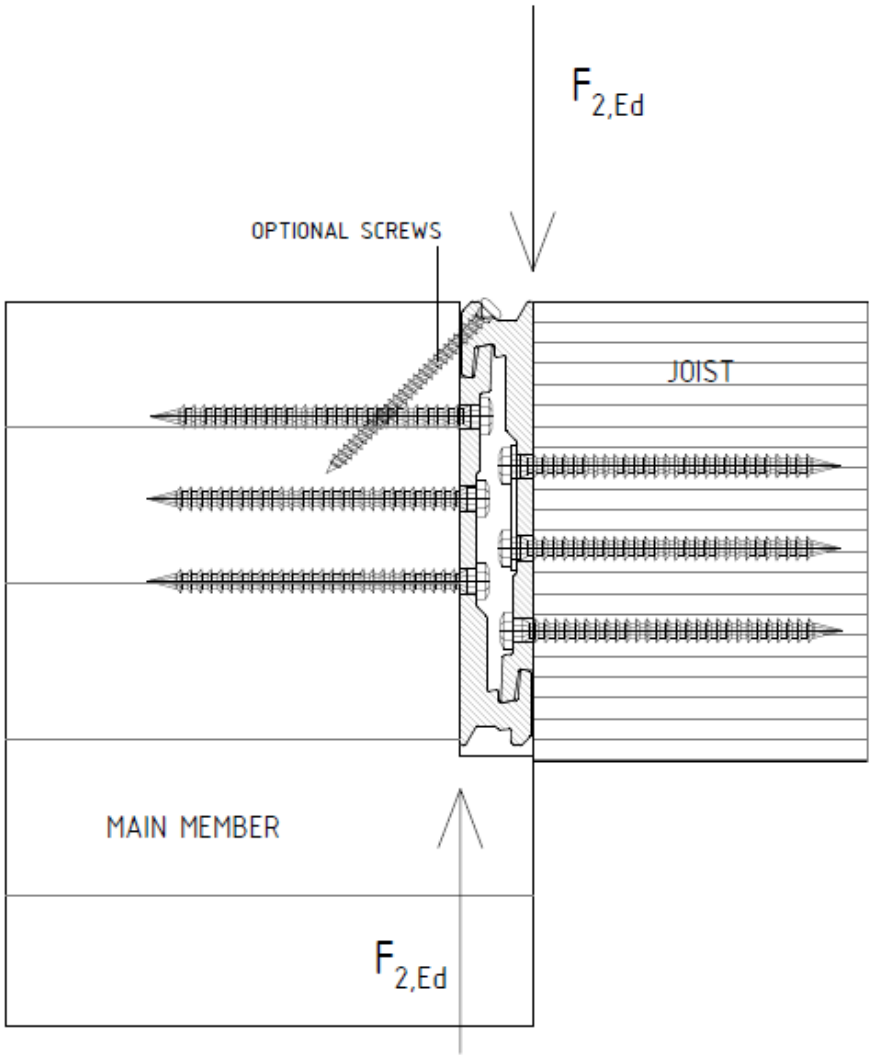
Metal anchors diameter [mm]	Length [mm]	Anchor type
8.0 – 10.0	80 - 500	Metal anchors for use in concrete according to ETA

Annex B
Characteristic values of load-carrying-capacities and slip moduli

Timber-to-timber connections with screws loaded in shear

The forces are assumed to act in or against the direction of insertion. Only a full fastener pattern is specified, where there are screws of equal length in all the holes of each connector part. The screw lengths in the joist and header connector parts, respectively, may be different. The angle between connector plane and grain direction of the secondary member may be between 0° and 90°.

Loading down or up:



Example shown: LOCK T 135 inserted into main member loaded by downward force $F_{2,Ed}$

Loading down:

$$F_{2,Rk} = \min\left\{\sum_{i=1}^{n_J} F_{v,J,Rk}^{i}; \left(\sqrt{\left(\frac{1}{\sum_{i=1}^{n_H} F_{v,H,Rk}^{i}}\right)^2 + \left(\frac{1}{k_{H,2} \cdot F_{ax,H,Rk}}\right)^2}\right)^{-1}; F_{2,alu,Rk}\right\} \quad \text{(B.1)}$$

Loading up:

$$F_{3,Rk} = \min\left\{\sum_{i=1}^{n_J} F_{v,J,Rk}^{i}; \frac{n_{in} \cdot 1,25 \cdot F_{ax,in,Rk}}{\sqrt{2}}; 0,5 \cdot F_{2,alu,Rk}\right\} \quad \text{(B.2)}$$

$F_{v,J,Rk}$ Characteristic load-carrying capacity per shear plane per joist fastener according to EN 1995-1-1 8.2.3 for thin outer steel plates; in equation (8.9a) in EN 1995-1-1 8.2.3 the rope effect may be considered additionally:

$$F_{v,J,Rk} = \min \begin{cases} 0,4 \cdot f_{h,J,k} \cdot t_1 \cdot d + 0,25 \cdot F_{ax,J,Rk} \\ 1,15 \cdot \sqrt{2 \cdot M_{y,Rk} \cdot f_{h,J,k} \cdot d} + 0,25 \cdot F_{ax,J,Rk} \end{cases}$$

$f_{h,J,k}$ Characteristic embedment strength for joist screws according to ETA-11/0030 in Mpa;

d outer thread diameter in mm;

ρ_k characteristic density in kg/m³;

$F_{v,H,Rk}$ Characteristic load-carrying capacity per shear plane per header fastener according to ETA-11/0030 for thin outer steel plates; in equation (8.9a) in EN 1995-1-1 8.2.3 the rope effect may be considered additionally:

$$F_{v,H,Rk} = \min \begin{cases} 0,4 \cdot f_{h,H,k} \cdot t_1 \cdot d + 0,25 \cdot F_{ax,H,Rk} \\ 1,15 \cdot \sqrt{2 \cdot M_{y,Rk} \cdot f_{h,H,k} \cdot d} + 0,25 \cdot F_{ax,H,Rk} \end{cases}$$

$F_{ax,Rk}$ Characteristic axial capacity of a joist or header screw according to ETA-11/0030 for Rotho Blaas LOCK Connectors arranged at angles $0° \leq \alpha \leq 90°$ to the grain. For the rope effect in the joist, the axial withdrawal capacity of screws arranged parallel to grain may be assumed as 5/6 of the withdrawal capacity of screws arranged perpendicular to grain;

n_{in} Number of inclined screws;

$F_{ax,in,Rk}$ Characteristic axial capacity of an inclined screw according to ETA-11/0030 for Rotho Blaas LOCK Connectors arranged at an angles $\alpha = 45°$ to the grain.

$M_{y,Rk}$ Characteristic fastener yield moment;

n_J number of joist screws;

n_H number of header screws;

$k_{H,2}$ form factor, see Table B.1;

$F_{2,alu,Rk}$ characteristic capacity of the Rotho Blaas LOCK Connector, see Table B.1.

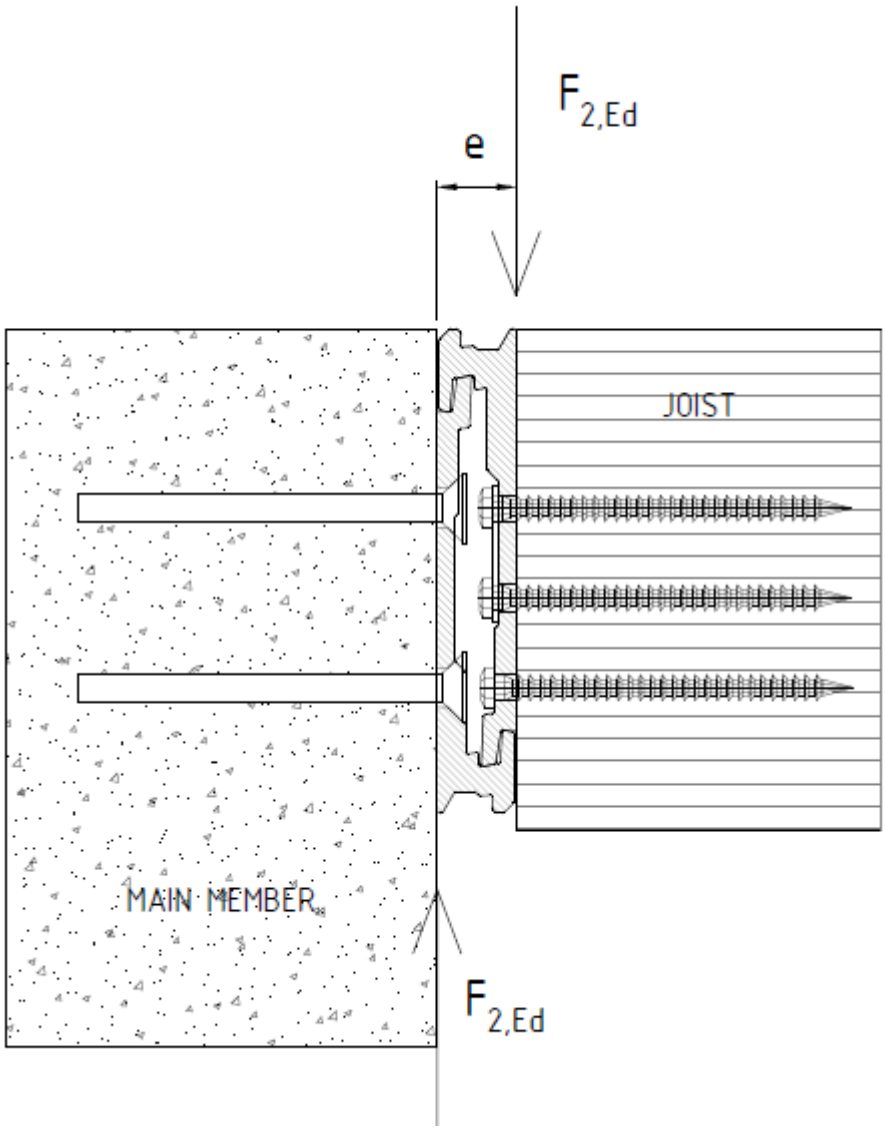
Table B.1: Rotho Blaas LOCK T Connectors: form factor $k_{H,2}$ and connector capacity $F_{2,alu,Rk}$ for load direction F_2 in timber-to-timber connections

Rotho Blaas LOCK Connectors	Module width [mm]	$k_{H,2}$	$F_{2,alu,Rk}$ [kN]
LOCK T 80	17,5	$n_M \cdot 2,19$	$n_M \cdot 10$
LOCK T 100	17,5	$n_M \cdot 4,39$	$n_M \cdot 10$
LOCK T 100FLOOR	210	$n_M \cdot 12,5$	$n_M \cdot 130$
LOCK T 120	17,5	$n_M \cdot 7,36$	$n_M \cdot 10$
LOCK T 135	25,0	$n_M \cdot 5,30$	$n_M \cdot 15$
LOCK T 135FLOOR	300	$n_M \cdot 15,3$	$n_M \cdot 240$
LOCK T 175	25,0	$n_M \cdot 10,0$	$n_M \cdot 20$
LOCK T 215	25,0	$n_M \cdot 17,2$	$n_M \cdot 20$
LOCK T 240	25,0	$n_M \cdot 22,7$	$n_M \cdot 24$
LOCK T 265	25,0	$n_M \cdot 29,0$	$n_M \cdot 24$
LOCK T 290	25,0	$n_M \cdot 36,0$	$n_M \cdot 24$
n_M is the number of basic modules, see product drawings			

Steel-to-timber or concrete-to-timber connections with screws and bolts or metal anchors loaded in shear

The forces are assumed to act in the direction of insertion. Only a full fastener pattern is specified, where there are screws and bolts or metal anchors of equal length in all the holes of the connector. The angle between connector plane and grain direction of the secondary member may be between 0° and 90°.

If bolts or metal anchors according to ETA are used, the calculation methods given in the ETA of the bolts or metal anchors or by national standards have to be applied instead of the second summand in equation (B.3).



Example shown: LOCK C 135 inserted into concrete main member loaded by force $F_{2,Ed}$

$$F_{2,Rk} = \min\left\{\sum_{i=1}^{n_J} F_{v,J,Rk}^{i};\left(\sqrt{\left(\frac{1}{\sum_{i=1}^{n_H} F_{v,bolt,Rk}^{i}}\right)^2+\left(\frac{1}{k_{H,2}\cdot F_{ax,bolt,Rk}}\right)^2}\right)^{-1};F_{2,alu,Rk}\right\} \quad \text{(B.3)}$$

If bolts or metal anchors according to ETA are used, the calculation methods given in the ETA of the bolts or metal anchors or by national standards have to be applied to determine $F_{2,H,Rk}$ instead of the second summand in equation (B.2).

Where:

$F_{v,J,Rk}$	Characteristic load-carrying capacity per shear plane per joist fastener as for LOCK T connectors
$F_{v,bolt,Rk}$	Characteristic load-carrying capacity per shear plane per bolt or metal anchor;
$F_{ax,bolt,Rk}$	Axial capacity of a bolt or metal anchor;
n_J	Number of joist screws;
n_H	Number of bolts or metal anchors in the header;
$k_{H,2}$	Form factor, see Table B.2;
$F_{2,alu,Rk}$	Characteristic capacity of the Rotho Blaas LOCK Connector, see Table B.2.

Table B.2: Rotho Blaas LOCK C Connectors: form factor $k_{H,2}$ and connector capacity $F_{2,alu,Rk}$ for load direction F_2 in timber-to-concrete or timber-to-steel connections

Rotho Blaas LOCK Connectors	Connector width [mm]	$k_{H,2}$	$F_{2,alu,Rk}$ [kN]
LOCK C 35x120	35,0	3,56	20
LOCK C 53x120	52,5	3,56	30
LOCK C 50x135	50,0	3,79	30
LOCK C 75x135	75,0	5,68	45
LOCK C 50x175	50,0	5,47	40
LOCK C 75x175	75,0	8,20	60
LOCK C 50x215	50,0	7,75	40
LOCK C 100x215	100	15,5	80
LOCK C 100FLOOR	$n_M \cdot 210$	$n_M \cdot 3,50$	$n_M \cdot 130$
LOCK C 135FLOOR	$n_M \cdot 300$	$n_M \cdot 5,91$	$n_M \cdot 240$
LOCK C 100x290	100	18,6	96
n_M is the number of basic modules, see product drawings			

The slip modulus per LOCK connector may be assumed as:

$$K_{23,ser} = \frac{n \cdot \rho_m^{1,5} \cdot d^{0,8}}{30}$$ N/mm for LOCK connectors with laterally loaded joist screws

Where:

d Outer thread diameter of joist screws in mm,

ρ_m Mean density of the secondary timber member (joist) in kg/m³

n Number of screws in the joist connection;

Loading laterally, notch in header beam or column:

$$F_{45,Rk} = \min\left\{\frac{n_{ef}\cdot F_{v,J,Rk}}{\sqrt{1+\left(\frac{n_{ef}\cdot F_{v,J,Rk}}{k_{lat}\cdot F_{ax,J,Rk}}\right)^2}};\ f_{c,0,k}\cdot A_{LOCK}\right\} \text{ for notch in header beam} \qquad (B.4)$$

$$F_{45,Rk} = \min\left\{\frac{n_{ef}\cdot F_{v,J,Rk}}{\sqrt{1+\left(\frac{n_{ef}\cdot F_{v,J,Rk}}{k_{lat}\cdot F_{ax,J,Rk}}\right)^2}};\ k_{c,90}\cdot f_{c,90,k}\cdot A_{LOCK};\ \frac{(b_C - B)\cdot \ell_{LOCK}\cdot f_{r,k}}{2}\right\} \text{ for notch in column} \qquad (B.5)$$

n_{ef} Effective number of joist screws, see Table B.3;

$F_{v,J,Rk}$ Characteristic load-carrying capacity per shear plane per joist fastener according to EN 1995-1-1 8.2.3 for thin outer steel plates; in equation (8.9a) in EN 1995-1-1 8.2.3 the rope effect may be considered additionally.

k_{lat} form factor, see Table B.3;

$F_{ax,J,Rk}$ Characteristic axial capacity of a joist screw according to ETA-11/0030 for Rotho Blaas LOCK Connectors arranged at angles $0° \le \alpha \le 90°$ to the grain. For the rope effect in the joist, the axial withdrawal capacity of screws arranged parallel to grain may be assumed as 5/6 of the withdrawal capacity of screws arranged perpendicular to grain;

A_{LOCK} Contact area between LOCK T Connector and header or column, see Table B.3;

$f_{c,0,k}$ Characteristic header compressive strength parallel to grain in N/mm²;

$f_{c,90,k}$ Characteristic column compressive strength perpendicular to grain in N/mm²;

$k_{c,90}$ Factor according to EN 1995-1-1, 6.1.5;

ℓ_{LOCK} Length of LOCK T Connector, see Table B.3;

$f_{r,k}$ Characteristic column rolling shear strength in N/mm²;

b_C Column width in mm;

B LOCK T Connector width in mm.

Table B.3: Rotho Blaas LOCK T Connectors: effective number of joist fasteners n_{ef}, form factor k_{lat} and contact area A_{LOCK} for load direction F_{45} in timber-to-timber connections

	Rotho Blaas LOCK T Connectors										
ℓ_{LOCK} [mm]	80	100	100 Floor	120	135	135 Floor	175	215	240	265	290
A_{LOCK} [mm²]	492	614	614	734	924	924	1174	1414	1645	1795	1945
n_{ef}, n_M =1	0,7	1,3	7,1	2,0	1,2	5,9	1,8	2,9	3,5	4,2	4,9
n_{ef}, n_M =2	1,8	2,8	15,4	4,2	2,7	15,2	4,0	6,1	7,1	8,5	10,0
n_{ef}, n_M =3	3,1	4,8	23,6	6,9	4,5	23,5	6,5	9,6	11,1	13,1	15,3
n_{ef}, n_M =4	4,8	7,1	31,7	9,9	6,7	31,6	9,3	13,4	15,4	18,1	20,9
n_{ef}, n_M =5	6,6	9,7	39,7	13,3	9,2	39,7	12,6	17,7	20,1	23,4	26,9
n_{ef}, n_M =6	8,7	12,6	47,8	17,0	12,1	47,7	16,2	22,4	25,3	29,3	33,4
k_{lat}, n_M =1	1,0	1,1	10,7	2,3	2,1	15,1	4,2	6,8	7,1	9,4	10
k_{lat}, n_M =2	6,1	8,9	117	14	13	160	21	35	39	48	54
k_{lat}, n_M =3	15	22	313	34	32	428	50	80	92	111	126
k_{lat}, n_M =4	27	41	600	61	58	820	89	144	166	199	227
k_{lat}, n_M =5	42	66	978	97	92	1335	140	226	261	312	357
k_{lat}, n_M =6	62	96	1447	141	134	1973	202	326	378	450	516
n_M is the number of basic modules, see product drawings											

Loading laterally, notch in joist:

$$F_{45,Rk} = \min\left\{\frac{n_{ef}\cdot F_{v,H,Rk}}{\sqrt{1+\left(\frac{n_{ef}\cdot F_{v,H,Rk}}{k_{lat}\cdot F_{ax,H,Rk}}\right)^2}};\ 2\cdot k_{c,90}\cdot f_{c,90,k}\cdot A_{LOCK};\ \frac{k_v\cdot f_{v,k}\cdot \ell_{LOCK}\cdot (b_J - B)}{3}\right\} \text{ for notch in joist} \quad (B.6)$$

n_{ef} Effective number of header fasteners, see Table B.3 or Table B.4.

$F_{v,H,Rk}$ Characteristic load-carrying capacity per shear plane per header fastener or header bolt or metal anchor according to ETA. For screws according to EN 1995-1-1 8.2.3 for thin outer steel plates; in equation (8.9a) in EN 1995-1-1 8.2.3 the rope effect may be considered additionally.

k_{lat} form factor, see Table B.3 for LOCK-T and Table B.4 for LOCK-C.

$F_{ax,H,Rk}$ Characteristic axial capacity of a header screw according to ETA-11/0030 for Rotho Blaas LOCK Connectors arranged at angles $0° \le \alpha \le 90°$ to the grain or a header bolt or metal anchor according to ETA.

A_{LOCK} Contact area between LOCK T Connector and header or column, see Table B.3 or Table B.4.

$f_{c,90,k}$ Characteristic joist compressive strength perpendicular to grain in N/mm²;

$k_{c,90}$ Factor according to EN 1995-1-1, 6.1.5;

ℓ_{LOCK} Length of LOCK T Connector, see Table B.3;

$f_{v,k}$ Characteristic joist shear strength in N/mm²;

k_v Factor according to EN 1995-1-1, equation (6.62) where

$\alpha = 0{,}5 \cdot (b_J\text{-}B)/b_J$

b_J = joist width

B = LOCK-T connector width

h = b_J

x = 20 mm;

b_J Joist width in mm;

B LOCK T Connector width in mm.

Table B.4: Rotho Blaas LOCK C Connectors: effective number of joist fasteners n_{ef}, form factor k_{lat} and contact area A_{LOCK} for load direction F_{45} in concrete-to-timber or steel-to-timber connections

	Rotho Blaas LOCK C Connectors										
	35x120	53x120	100 Floor	50x135	75x135	135 Floor	50x175	75x175	50x215	100x215	100x290
A_{LOCK} [mm²]	734	734	614	924	924	924	1174	1174	1414	1414	1945
n_{ef}	4,4	7,4	27,1	6,2	10,0	37,4	6,8	11,1	7,3	29,7	47,4
k_{lat}	1,19	1,19	1,91	0,98	0,98	1,89	1,29	1,29	1,36	2,91	4,14

Loading laterally, inclined screw:

$$F_{45,Rk} = \min\left\{ n_{in} \cdot F_{v,in,Rk}; \frac{n_{ef} \cdot F_{v,J,Rk}}{\sqrt{1+\left(\frac{n_{ef} \cdot F_{v,J,Rk}}{k_{lat} \cdot F_{ax,J,Rk}}\right)^2}} \right\} \text{ for inclined screw} \qquad (B.7)$$

n_{ef} Effective number of joist screws, see Table B.5;

$F_{v,J,Rk}$ Characteristic load-carrying capacity per shear plane per joist fastener according to EN 1995-1-1 8.2.3 for thin outer steel plates; in equation (8.9a) in EN 1995-1-1 8.2.3 the rope effect may be considered additionally.

k_{lat} form factor, see Table B.5;

$F_{ax,J,Rk}$ Characteristic axial capacity of a joist screw according to ETA-11/0030 for Rotho Blaas LOCK Connectors arranged at angles $0° \le \alpha \le 90°$ to the grain. For the rope effect in the joist, the axial withdrawal capacity of screws arranged parallel to grain may be assumed as 5/6 of the withdrawal capacity of screws arranged perpendicular to grain;

n_{in} Number of inclined screws;

$F_{v,in,Rk}$ Characteristic lateral load-carrying capacity of an inclined screw according to ETA-11/0030 for Rotho Blaas LOCK Connectors arranged at an angle $\alpha = 45°$ to the grain.

Table B.5: Rotho Blaas LOCK T Connectors: effective number of joist fasteners n_{ef}, form factor k_{lat}, connector length ℓ_{LOCK} and contact area A_{LOCK} for load direction F_{45} in timber-to-timber connections

	Rotho Blaas LOCK T Connectors										
ℓ_{LOCK} [mm]	80	100	100 Floor	120	135	135 Floor	175	215	240	265	290
A_{LOCK} [mm²]	492	614	614	734	924	924	1174	1414	1645	1795	1945
n_{ef}, n_M =1	0,4	0,7	5,4	0,9	0,6	3,6	0,8	1,3	1,5	1,8	2,0
n_{ef}, n_M =2	1,1	1,5	13,7	2,0	1,4	13,2	1,8	2,7	3,2	3,7	4,1
n_{ef}, n_M =3	2,0	2,6	22,1	3,3	2,5	21,9	3,0	4,3	5,0	5,7	6,4
n_{ef}, n_M =4	3,1	3,9	30,5	4,9	3,7	30,3	4,4	6,1	7,0	7,9	8,8
n_{ef}, n_M =5	4,4	5,6	38,7	6,7	5,3	38,5	6,1	8,2	9,3	10,4	11,5
n_{ef}, n_M =6	6,0	7,5	46,9	9,0	7,1	46,8	8,2	10,7	11,9	13,2	14,5
k_{lat}, n_M =1	0,3	0,3	3,3	0,7	0,6	4,5	1,1	1,7	1,8	2,3	2,3
k_{lat}, n_M =2	2,0	2,8	36	4,0	4,0	47	5,7	8,6	10	11	13
k_{lat}, n_M =3	4,8	6,8	97	10	9,5	126	13	20	23	27	29
k_{lat}, n_M =4	8,8	13	185	18	17	241	24	36	41	48	53
k_{lat}, n_M =5	14	20	302	28	27	393	37	56	65	75	83
k_{lat}, n_M =6	20	30	446	40	40	581	54	81	94	108	121
n_M is the number of basic modules, see product drawings											

Loading laterally, LOCK STOP:

$$F_{45,Rk} = \min\left\{F_{LOCKSTOP,Rk}; \frac{n_{ef} \cdot F_{v,J,Rk}}{\sqrt{1+\left(\frac{n_{ef} \cdot F_{v,J,Rk}}{k_{lat} \cdot F_{ax,J,Rk}}\right)^2}}; \frac{n_{ef} \cdot F_{v,H,Rk}}{\sqrt{1+\left(\frac{n_{ef} \cdot F_{v,H,Rk}}{k_{lat} \cdot F_{ax,H,Rk}}\right)^2}}\right\} \text{ for LOCK STOP} \quad (B.8)$$

n_{ef} Effective number of joist or header screws, see Table B.6 for LOCK-T and Table B.4 for LOCK-C.

$F_{v,J/H,Rk}$ Characteristic load-carrying capacity per shear plane per joist or header fastener according to EN 1995-1-1 8.2.3 for thin outer steel plates; in equation (8.9a) in EN 1995-1-1 8.2.3 the rope effect may be considered additionally.
For steel or concrete headers, characteristic load-carrying capacity per shear plane per header bolt or metal anchor.

k_{lat} form factor, see Table B.6 for LOCK-T and Table B.4 for LOCK-C.

$F_{ax,J/H,Rk}$ Characteristic axial capacity of a joist or header screw according to ETA-11/0030 for Rotho Blaas LOCK Connectors arranged at angles $0° \le \alpha \le 90°$ to the grain. For the rope effect in the joist, the axial withdrawal capacity of screws arranged parallel to grain may be assumed as 5/6 of the withdrawal capacity of screws arranged perpendicular to grain.
For steel or concrete headers, characteristic axial load-carrying capacity per header bolt or metal anchor.

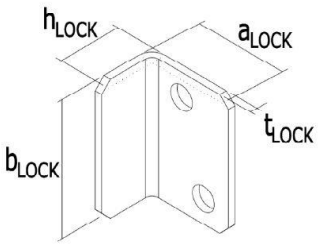
$F_{LOCKSTOP,Rk}$ Characteristic lateral load-carrying capacity of a LOCK STOP bracket, see Table B.7.

Table B.6: Rotho Blaas LOCK T Connectors: effective number of joist or header fasteners n_{ef}, form factor k_{lat}, connector length ℓ_{LOCK} and contact area A_{LOCK} for load direction F_{45} in timber-to-timber connections

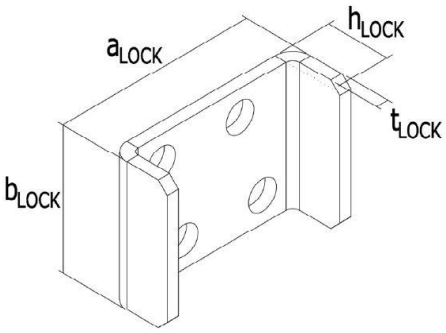
	Rotho Blaas LOCK T Connectors										
ℓ_{LOCK} [mm]	80	100	100 Floor	120	135	135 Floor	175	215	240	265	290
A_{LOCK} [mm²]	492	614	614	734	924	924	1174	1414	1645	1795	1945
n_{ef}, n_M =1	2,0	1,7	7,6	1,8	1,7	7,1	1,8	2,2	2,4	2,7	2,9
n_{ef}, n_M =2	4,0	3,8	15,7	3,9	3,8	15,7	3,9	4,6	5,0	5,5	5,9
n_{ef}, n_M =3	6,0	6,3	23,8	6,4	6,3	23,8	6,4	7,3	7,9	8,5	9,1
n_{ef}, n_M =4	8,0	9,0	31,9	9,3	9,0	31,9	9,3	10,3	11,0	11,8	12,6
n_{ef}, n_M =5	10,0	12,0	39,9	12,5	12,0	39,9	12,5	13,7	14,5	15,4	16,4
n_{ef}, n_M =6	12,0	15,1	47,9	16,2	15,1	47,9	16,2	17,6	18,5	19,5	20,6
k_{lat}, n_M =1	0,4	0,4	3,9	0,8	0,7	5,2	1,3	2,0	2,0	2,6	2,7
k_{lat}, n_M =2	2,4	3,2	42	4,7	4,6	55	6,6	10	11	13	15
k_{lat}, n_M =3	5,7	8,0	114	11	11	146	15	23	26	31	34
k_{lat}, n_M =4	10,3	15	218	21	20	280	28	41	48	55	61
k_{lat}, n_M =5	16	24	355	33	32	455	43	65	75	87	97
k_{lat}, n_M =6	24	35	525	48	46	673	63	94	108	125	140
n_M is the number of basic modules, see product drawings											

Table B.7: LOCK STOP bracket dimensions and $F_{LOCKSTOP,Rk}$

PRODUCT	h_{LOCK} [mm]	t_{LOCK} [mm]	a_{LOCK} [mm]	b_{LOCK} [mm]	$F_{LOCKSTOP,Rk}$ [N]
LOCK STOP 5	13	1,5	19,0	27,5	$1{,}11 \cdot f_{y,k}$
LOCK STOP 7	15	1,5	26,5	38	$1{,}27 \cdot f_{y,k}$
LOCK STOP 18	13	1,5	21,5	27,5	$1{,}11 \cdot f_{y,k}$
LOCK STOP 35	13	2,5	41,0	28,5	$3{,}39 \cdot f_{y,k}$
LOCK STOP 50	15,5	2,5	56,0	40	$3{,}70 \cdot f_{y,k}$
LOCK STOP 75	15,5	2,5	81,0	40	$3{,}70 \cdot f_{y,k}$
LOCK STOP 100	15,5	2,5	106,0	40	$3{,}70 \cdot f_{y,k}$
LOCK STOP 125	15,5	2,5	131,0	40	$3{,}70 \cdot f_{y,k}$
$f_{y,k}$ is the characteristic yield strength of the steel plate to produce the LOCK STOP Bracket					



LOCK STOP 5 or 7



LOCK STOP bracket 18 to 125

Loading axially:

$$F_{1,Rk} = n_M \cdot \min\left\{F_{1,ALU,Rk}; F_{ax,Rk} / k_{LOCK}\right\} \quad (B.9)$$

n_M Number of basic modules;

$F_{1,alu,Rk}$ Characteristic capacity of the Rotho Blaas LOCK Connector, see Table B.8.

k_{LOCK} Form factor, see Table B.8;

$F_{ax,Rk}$ Lower characteristic axial capacity of a joist or header screw according to ETA-11/0030 for Rotho Blaas LOCK T Connectors arranged at angles $0° \le \alpha \le 90°$ to the grain. For the rope effect in the joist, the axial withdrawal capacity of screws arranged parallel to grain may be assumed as 5/6 of the withdrawal capacity of screws arranged perpendicular to grain.

$F_{ax,Rk}$ Characteristic axial capacity of a bolt or metal anchor according to ETA for Rotho Blaas LOCK C Connectors. When using Rotho Blaas LOCK C connectors, equation (B.9) must be checked both, for the LOCK T and the LOCK C connector part.

Table B.8: Rotho Blaas LOCK T Connectors: form factor k_{LOCK} and characteristic capacity $F_{1,alu,Rk}$ for load direction F_1 in timber-to-timber connections

	Rotho Blaas LOCK T Connectors										
ℓ_{LOCK} [mm]	80	100	100 Floor	120	135	135 Floor	175	215	240	265	290
$F_{1,alu,Rk}$ [kN]	2,7	2,9	34,5	3,1	2,7	32,3	2,7	2,3	2,8	2,8	2,8
k_{LOCK}	0,71	0,57	0,14	0,52	0,65	0,16	0,57	0,58	0,57	0,56	0,55
Module width [mm]	17,5	17,5	210	17,5	25	300	25	25	25	25	25
	Rotho Blaas LOCK C Connectors										
ℓ_{LOCK} [mm]	120	120	100 Floor	135	135	135 Floor	175	175	215	215	290
$F_{1,alu,Rk}$ [kN]	4,0	6,9	23,5	6,0	9,8	25,3	6,0	9,8	6,0	12,0	12,6
k_{LOCK}	0,67	0,67	0,58	0,65	0,65	0,52	0,58	0,58	0,56	0,28	0,28
Module width [mm]	35	52,5	210	50	75	300	50	75	50	100	100

Combined forces

If the forces F_1, F_2, F_3 or $F_{4/5}$ act at the same time, the following inequality shall be fulfilled:

$$\left(\frac{F_{1,Ed}}{F_{1,Rd}}\right)^2 + \left(\frac{F_{2,Ed}}{F_{2,Rd}}\right)^2 + \left(\frac{F_{3,Ed}}{F_{3,Rd}}\right)^2 + \left(\frac{F_{45,Ed}}{F_{45,Rd}}\right)^2 \le 1 \quad (B.10)$$

The forces F_2 and F_3 are forces with opposite direction. Therefore, only one force F_2 or F_3 is able to act simultaneously with F_1 or F_{45}, while the other shall be set to zero.

Installation:

Table B.9: Required screw hole predrilling for combinations of timber materials and LOCK connectors

Timber, glulam, CLT or LVL member	LOCK T80 to T290 LOCK C120 to C290	LOCK T120 FLOOR LOCK C120 FLOOR	LOCK T135 FLOOR LOCK C135 FLOOR
Joist or header, $\rho_k \leq 420$ kg/m³	No predrilling	No predrilling	No predrilling
Joist or header, $420 < \rho_k < 500$ kg/m³	Predrilling	No predrilling	No predrilling
Column, $\rho_k \leq 420$ kg/m³	Predrilling	No predrilling	No predrilling
Column, $420 < \rho_k < 500$ kg/m³	Predrilling	No predrilling	Predrilling

The required end and edge distances are given in EN 1995-1-1 Table 8.2. For timber joists with screws oriented parallel to grain, the edge distances in both directions should fulfil the required minimum values for $a_{4,t}$ or $a_{4,c}$, respectively.

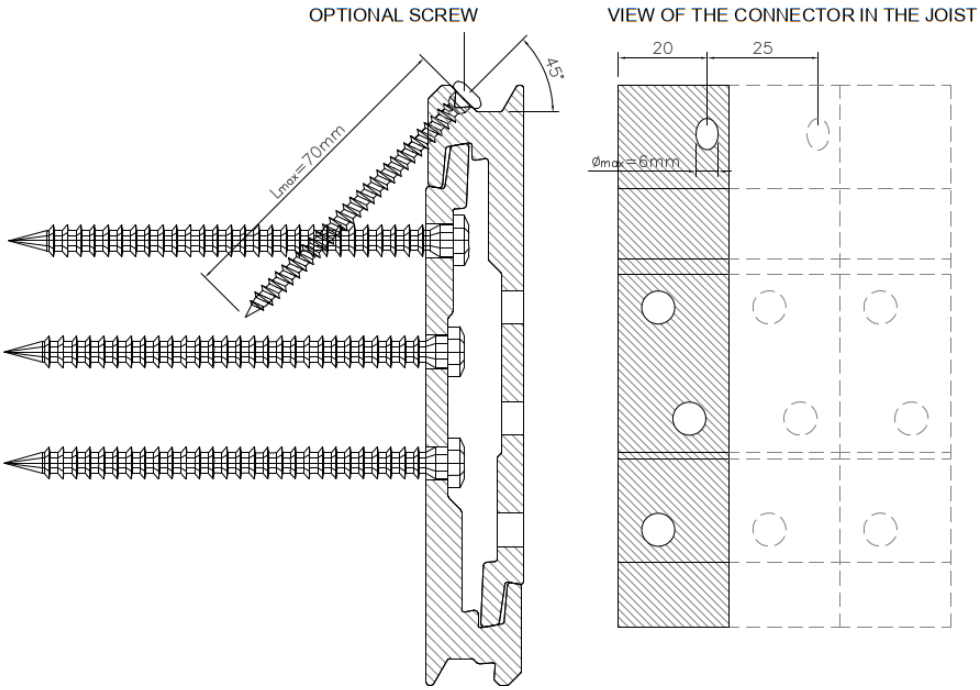
For LOCK T connectors in joists from softwood with $\rho_k \leq 420$ kg/m³, the minimum edge distances for screws arranged parallel to grain without pre-drilling may be reduced to:

LOCK T 80, LOCK T 100, LOCK T 120: $a_{4,t} = 35$ mm $a_{4,c} = 19$ mm
LOCK T 135, LOCK T 175, LOCK T 215, LOCK T 240, LOCK T 265, LOCK T 290: $a_{4,t} = 55$ mm $a_{4,c} = 24$ mm

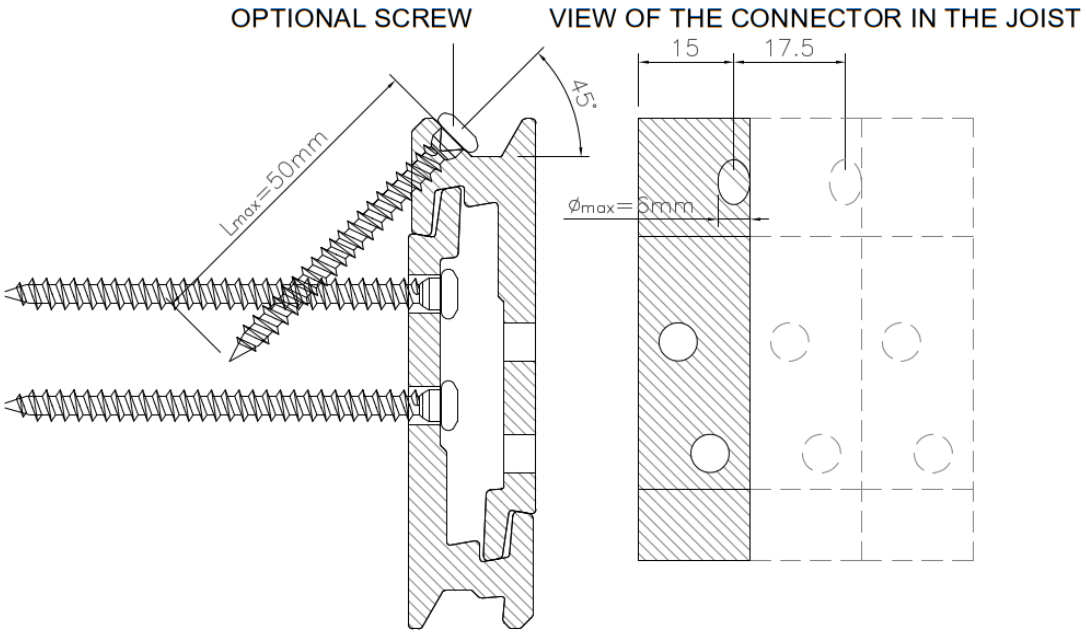
Inclined screws

The holes for the inclined screws of the optional locking system may be pre-positioned on the LOCK connectors or may be drilled on site according to the configuration shown.

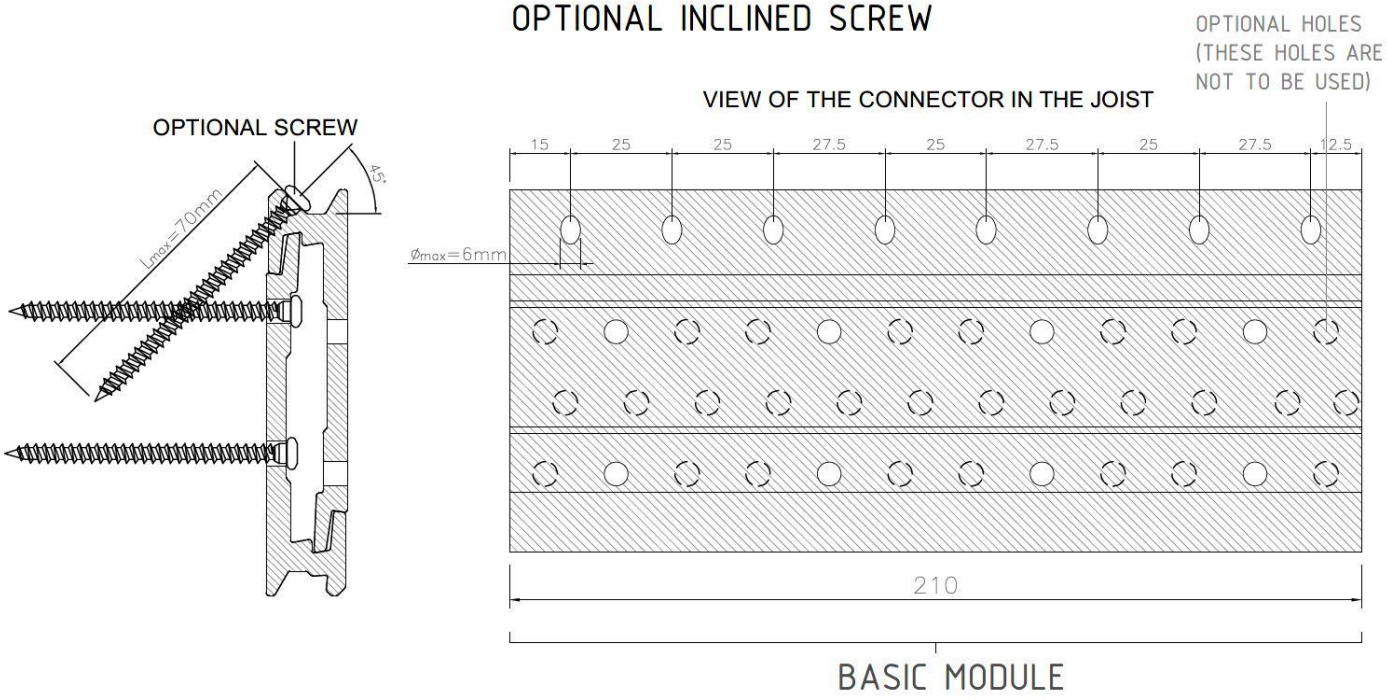
LOCK-T 135, 175, 215, 240, 265 and 290
OPTIONAL INCLINED SCREW



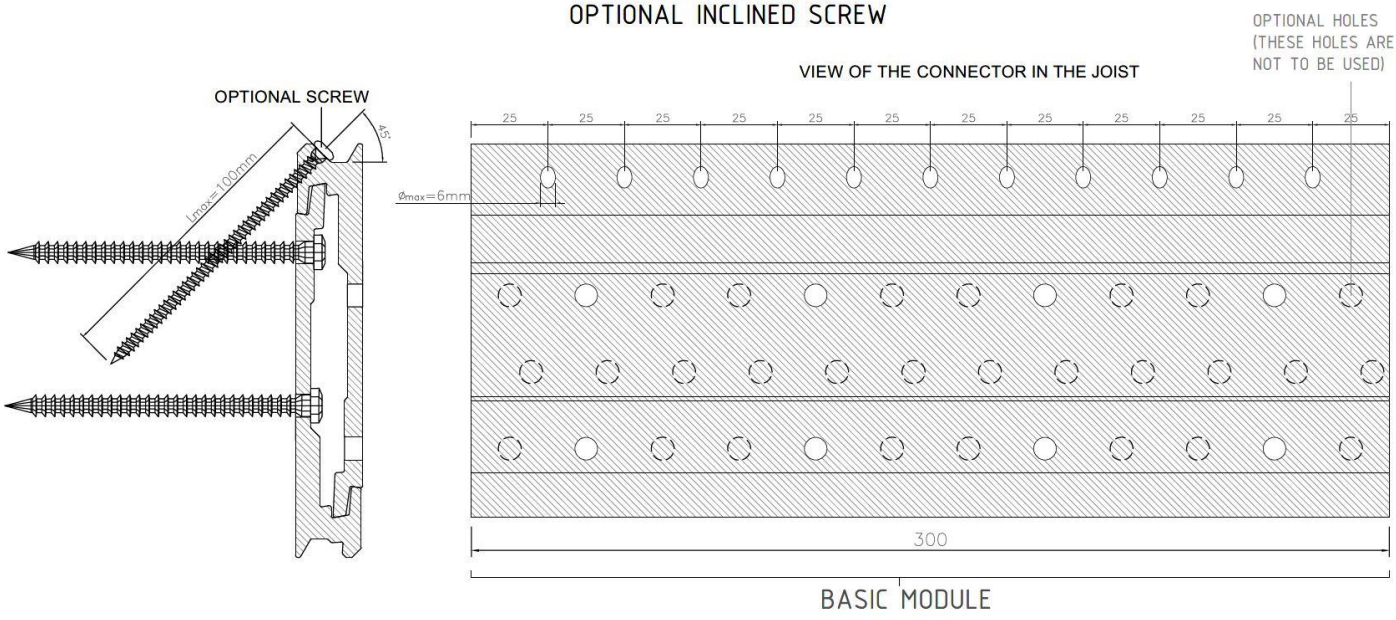
LOCK-T 80, 100 and 120
OPTIONAL INCLINED SCREW



LOCK-T 100 FLOOR
OPTIONAL INCLINED SCREW



LOCK-T 135 FLOOR
OPTIONAL INCLINED SCREW



Lateral locking system
The lateral locking system LOCK STOP can be obtained using one “U-shaped” plate (LOCKSTOP 18) for LOCK connectors made of one basic module, and LOCKSTOP 35 to 125 for LOCK connectors made of multiple basic modules, while two “L-shaped” plates (LOCKSTOP 5 and LOCKSTOP 7) can be used for LOCK connectors made of multiple basic modules.
The lateral locking system LOCK STOP can be only used on the timber side for LOCK C connectors.
The lateral locking system LOCK STOP can be used on both timber members, joist and header, for LOCK T 120, LOCK T 175 and LOCK T 215, LOCK T 240, LOCK T 265 and LOCK T 290. The lateral locking system LOCK STOP can be only used on one timber member, joist or header, for LOCK T 80, LOCK T 100 and LOCK T 135.

LOCK STOP
Face mount one or two-piece connector. Steel-to-aluminium connections with 5 mm or 6 mm or 7 mm screws.
Steel grades

- S235 / Z 275 or FeZn12c according to EN 10025
- S275 / Z 275 or FeZn12c according to EN 10025
- S355 / Z 275 or FeZn12c according to EN 10025
- DX51D / Z275 according to EN 10346
- S250GD / Z275 according to EN 10346
- Stainless steel 1.4301 according to EN10088-2 or equivalent or better.

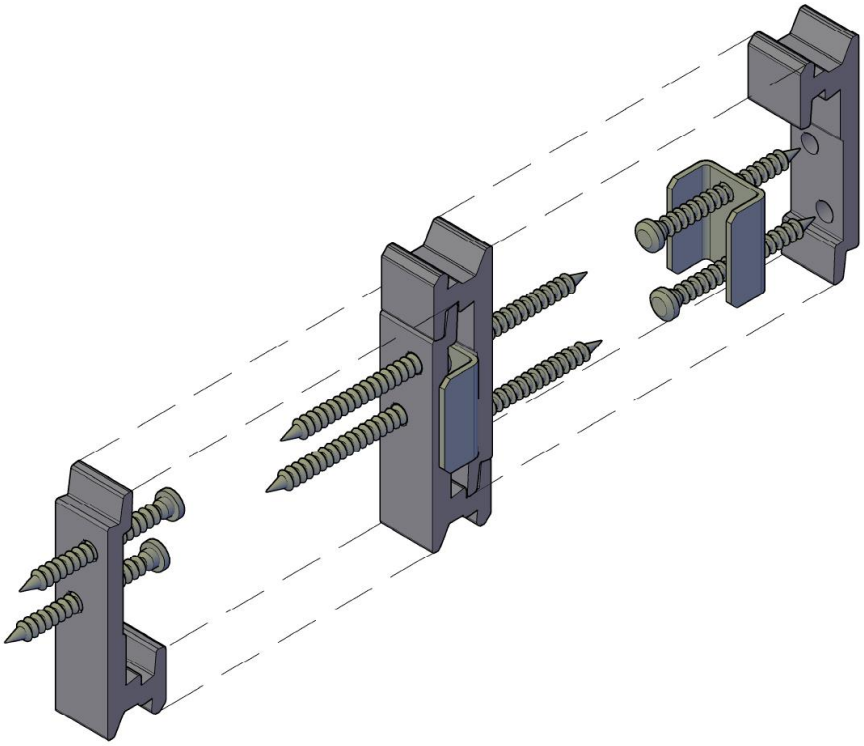


Figure 1: 1 module LOCK T connector

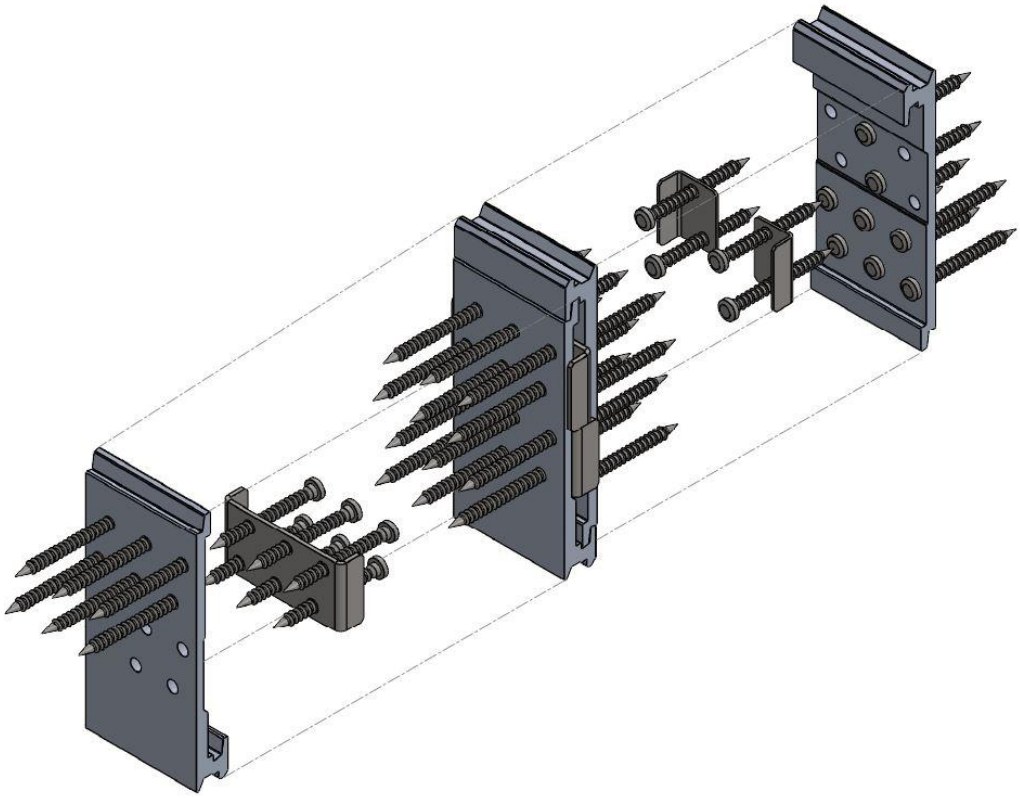


Figure 2 LOCK T connector with lateral locking system on both sides

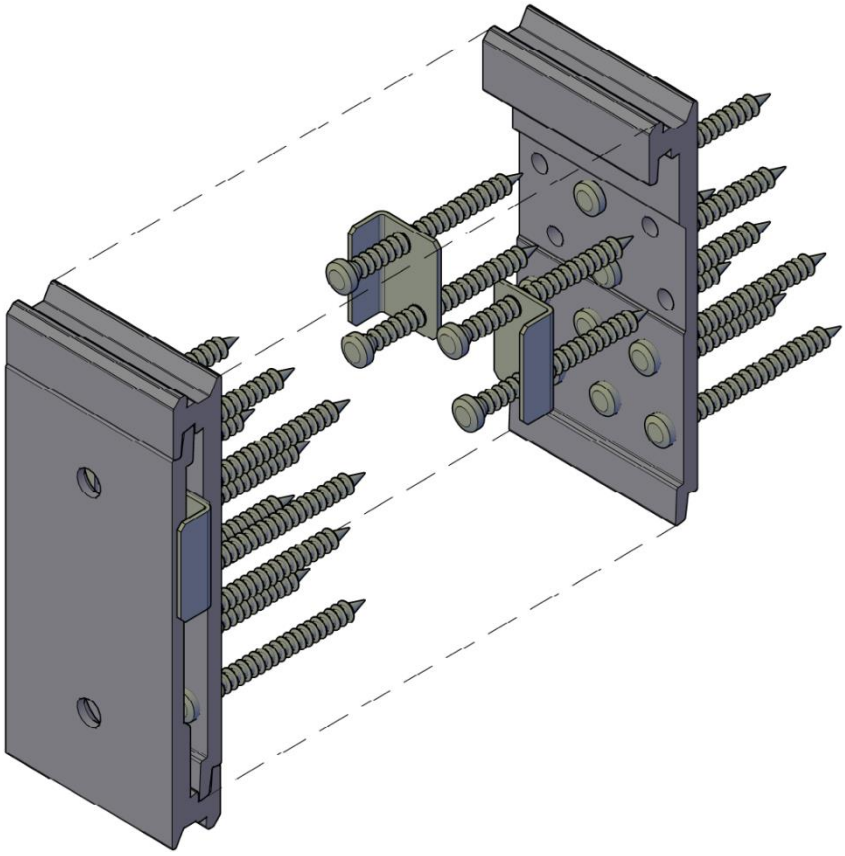


Figure 3 LOCK C connector with lateral locking system