

## FULL THREADED SCREW WITH CYLINDRICAL HEAD

### 3 THORNS TIP

Thanks to the 3 THORNS tip, minimum installation distances are reduced. More screws can be used in less space and larger screws in smaller elements. Costs and time for project implementation are reduced.

### STRUCTURAL APPLICATIONS

Approved for structural applications subject to stresses in any direction vs the grain ( $0^\circ \div 90^\circ$ ). Cyclical SEISMIC-REV tests according to EN 12512.

### CYLINDRICAL HEAD

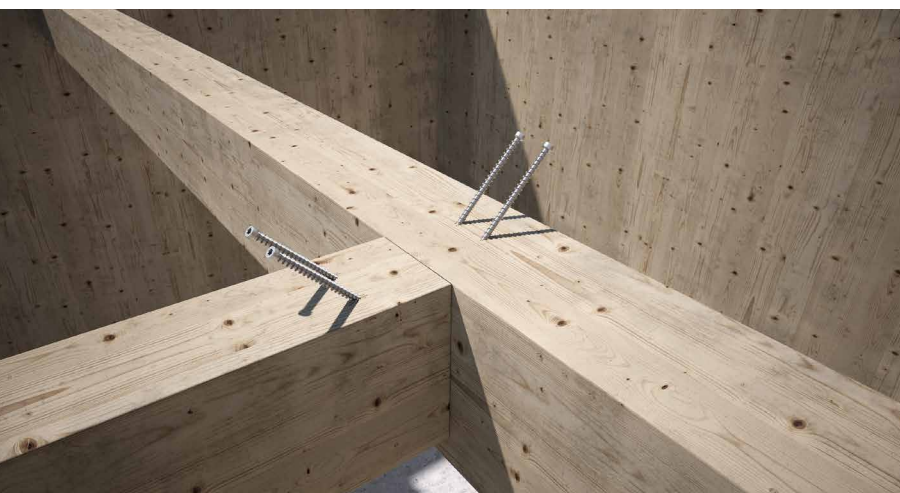
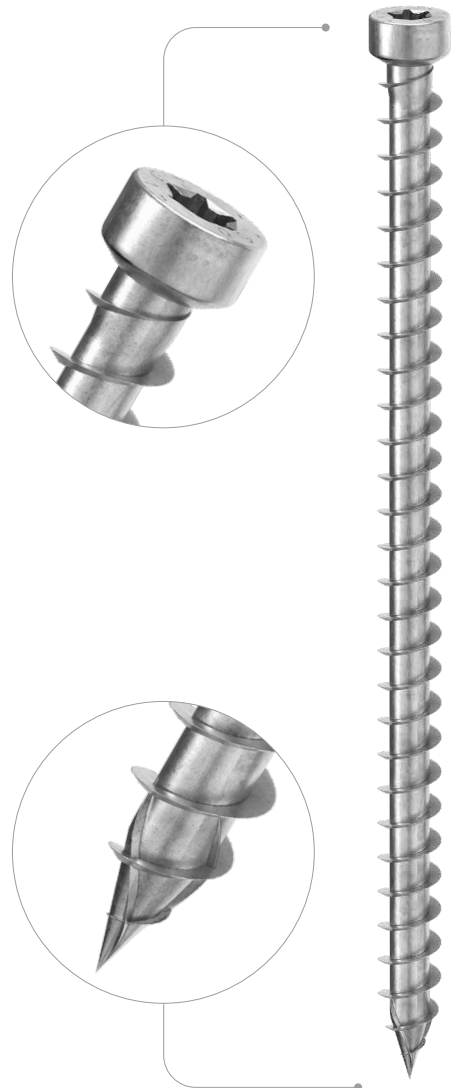
It allows the screw to penetrate and pass through the surface of the wood substrate. Ideal for concealed joints, timber couplings and structural reinforcements. It is the right choice to ensure strength in fire conditions.

### TIMBER FRAME

Also ideal for joining small timber elements such as the crossbeams and uprights of light frame structures.



|                         |                                                                     |     |      |      |
|-------------------------|---------------------------------------------------------------------|-----|------|------|
| DIAMETER [mm]           | 5                                                                   | 7   | 11   | 11   |
| LENGTH [mm]             | 80                                                                  | 80  | 1000 | 1000 |
| SERVICE CLASS           | SC1                                                                 | SC2 |      |      |
| ATMOSPHERIC CORROSIVITY | C1                                                                  | C2  |      |      |
| WOOD CORROSIVITY        | T1                                                                  | T2  |      |      |
| MATERIAL                | <b>Zn</b><br>ELECTRO<br>PLATED<br>electrogalvanized<br>carbon steel |     |      |      |



### FIELDS OF USE

- timber based panels
- solid timber
- glulam (Glued Laminated Timber)
- CLT and LVL
- high density woods

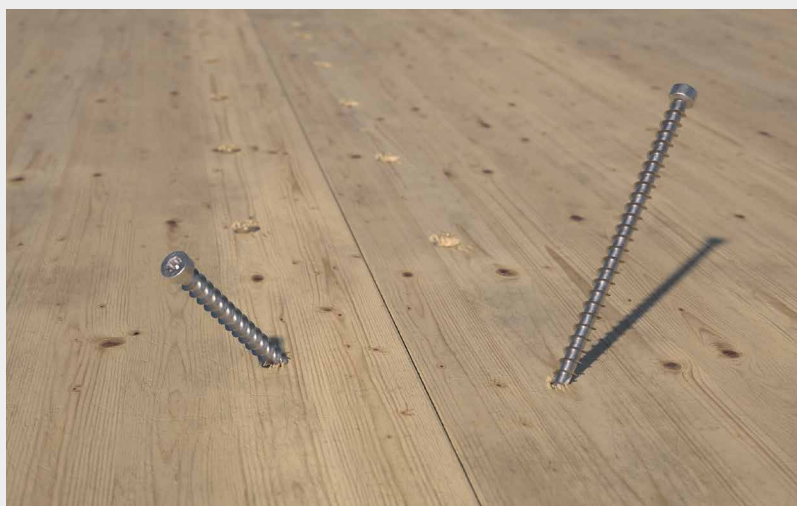


## STRUCTURAL RESTORATION

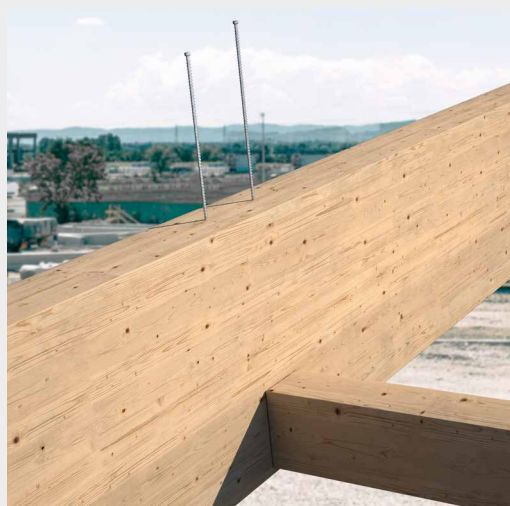
Ideal for coupling beams in structural renovations and new works. Can also be used parallel to the grain thanks to the special approval.

### CLT, LVL

Values also tested, certified and calculated for CLT and high density woods such as Microllam® LVL.

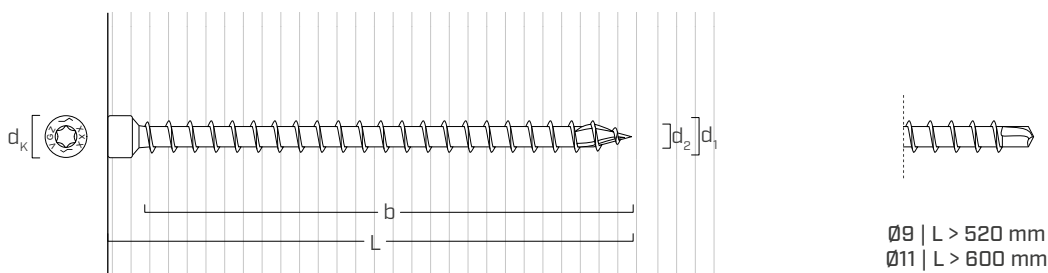


Very high stiffness in side-by-side joining of CLT floors.  
Application with double inclination at 45°, perfect combined with the JIG VGZ template.



Reinforcement orthogonal to grain for hanging load due to joining of main-secondary beams.

## ■ GEOMETRY AND MECHANICAL CHARACTERISTICS



### GEOMETRY

| Nominal diameter                          | $d_1$     | [mm] | 7    | 9     | 11    |
|-------------------------------------------|-----------|------|------|-------|-------|
| Head diameter                             | $d_K$     | [mm] | 9,50 | 11,50 | 13,50 |
| Thread diameter                           | $d_2$     | [mm] | 4,60 | 5,90  | 6,60  |
| Pre-drilling hole diameter <sup>(1)</sup> | $d_{V,S}$ | [mm] | 4,0  | 5,0   | 6,0   |
| Pre-drilling hole diameter <sup>(2)</sup> | $d_{V,H}$ | [mm] | 5,0  | 6,0   | 7,0   |

<sup>(1)</sup> Pre-drilling valid for softwood.

<sup>(2)</sup> Pre-drilling valid for hardwood and beech LVL.

### CHARACTERISTIC MECHANICAL PARAMETERS

| Nominal diameter | $d_1$        | [mm]                 | 7    | 9    | 11   |
|------------------|--------------|----------------------|------|------|------|
| Tensile strength | $f_{tens,k}$ | [kN]                 | 15,4 | 25,4 | 38,0 |
| Yield strength   | $f_{y,k}$    | [N/mm <sup>2</sup> ] | 1000 | 1000 | 1000 |
| Yield moment     | $M_{y,k}$    | [Nm]                 | 14,2 | 27,2 | 45,9 |

|                                 |            |                      | softwood<br>(softwood) | LVL softwood<br>(LVL softwood) | pre-drilled beech LVL<br>(beech LVL predrilled) |
|---------------------------------|------------|----------------------|------------------------|--------------------------------|-------------------------------------------------|
| Withdrawal resistance parameter | $f_{ax,k}$ | [N/mm <sup>2</sup> ] | 11,7                   | 15,0                           | 29,0                                            |
| Associated density              | $\rho_a$   | [kg/m <sup>3</sup> ] | 350                    | 500                            | 730                                             |
| Calculation density             | $\rho_k$   | [kg/m <sup>3</sup> ] | ≤ 440                  | 410 ÷ 550                      | 590 ÷ 750                                       |

For applications with different materials please see ETA-11/0030.



## CODES AND DIMENSIONS

| d <sub>1</sub><br>[mm] | CODE    | L<br>[mm] | b<br>[mm] | pcs |
|------------------------|---------|-----------|-----------|-----|
| 7<br>TX 30             | VGZ780  | 80        | 70        | 25  |
|                        | VGZ7100 | 100       | 90        | 25  |
|                        | VGZ7120 | 120       | 110       | 25  |
|                        | VGZ7140 | 140       | 130       | 25  |
|                        | VGZ7160 | 160       | 150       | 25  |
|                        | VGZ7180 | 180       | 170       | 25  |
|                        | VGZ7200 | 200       | 190       | 25  |
|                        | VGZ7220 | 220       | 210       | 25  |
|                        | VGZ7240 | 240       | 230       | 25  |
|                        | VGZ7260 | 260       | 250       | 25  |
|                        | VGZ7280 | 280       | 270       | 25  |
|                        | VGZ7300 | 300       | 290       | 25  |
|                        | VGZ7320 | 320       | 310       | 25  |
|                        | VGZ7340 | 340       | 330       | 25  |
|                        | VGZ7360 | 360       | 350       | 25  |
|                        | VGZ7380 | 380       | 370       | 25  |
|                        | VGZ7400 | 400       | 390       | 25  |
|                        | VGZ9160 | 160       | 150       | 25  |
|                        | VGZ9180 | 180       | 170       | 25  |
|                        | VGZ9200 | 200       | 190       | 25  |
| 9<br>TX 40             | VGZ9220 | 220       | 210       | 25  |
|                        | VGZ9240 | 240       | 230       | 25  |
|                        | VGZ9260 | 260       | 250       | 25  |
|                        | VGZ9280 | 280       | 270       | 25  |
|                        | VGZ9300 | 300       | 290       | 25  |
|                        | VGZ9320 | 320       | 310       | 25  |
|                        | VGZ9340 | 340       | 330       | 25  |
|                        | VGZ9360 | 360       | 350       | 25  |
|                        | VGZ9380 | 380       | 370       | 25  |
|                        | VGZ9400 | 400       | 390       | 25  |
|                        | VGZ9440 | 440       | 430       | 25  |
|                        | VGZ9480 | 480       | 470       | 25  |
|                        | VGZ9520 | 520       | 510       | 25  |
|                        | VGZ9560 | 560       | 550       | 25  |
|                        | VGZ9600 | 600       | 590       | 25  |

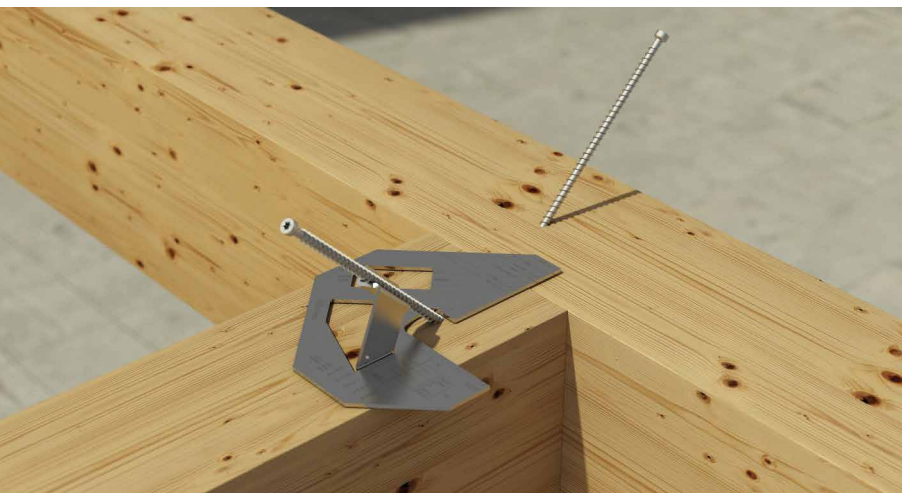
| d <sub>1</sub><br>[mm] | CODE      | L<br>[mm] | b<br>[mm] | pcs |
|------------------------|-----------|-----------|-----------|-----|
| 11<br>TX 50            | VGZ11150  | 150       | 140       | 25  |
|                        | VGZ11200  | 200       | 190       | 25  |
|                        | VGZ11250  | 250       | 240       | 25  |
|                        | VGZ11275  | 275       | 265       | 25  |
|                        | VGZ11300  | 300       | 290       | 25  |
|                        | VGZ11325  | 325       | 315       | 25  |
|                        | VGZ11350  | 350       | 340       | 25  |
|                        | VGZ11375  | 375       | 365       | 25  |
|                        | VGZ11400  | 400       | 390       | 25  |
|                        | VGZ11425  | 425       | 415       | 25  |
|                        | VGZ11450  | 450       | 440       | 25  |
|                        | VGZ11475  | 475       | 465       | 25  |
|                        | VGZ11500  | 500       | 490       | 25  |
|                        | VGZ11525  | 525       | 515       | 25  |
|                        | VGZ11550  | 550       | 540       | 25  |
|                        | VGZ11575  | 575       | 565       | 25  |
|                        | VGZ11600  | 600       | 590       | 25  |
|                        | VGZ11650  | 650       | 640       | 25  |
|                        | VGZ11700  | 700       | 690       | 25  |
|                        | VGZ11750  | 750       | 740       | 25  |
|                        | VGZ11800  | 800       | 790       | 25  |
|                        | VGZ11850  | 850       | 840       | 25  |
|                        | VGZ11900  | 900       | 890       | 25  |
|                        | VGZ11950  | 950       | 940       | 25  |
|                        | VGZ111000 | 1000      | 990       | 25  |

## RELATED PRODUCTS



**JIG VGZ 45°**  
TEMPLATE FOR 45° SCREWS

page 409



### JIG VGZ 45° TEMPLATE

Installation at 45° using the JIG VGZ steel template.



## MINIMUM DISTANCES FOR AXIAL STRESSES | TIMBER



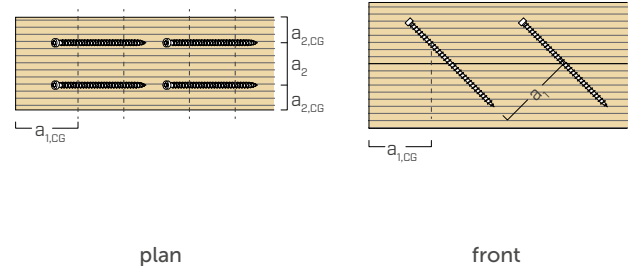
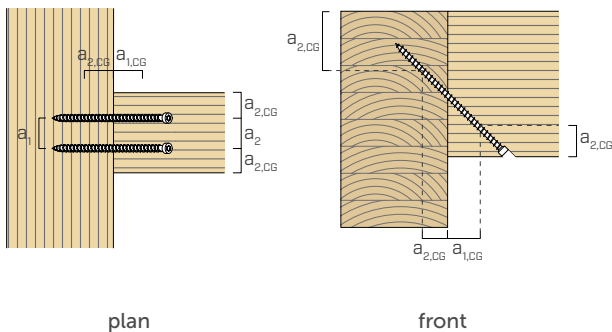
screws inserted **WITH** and **WITHOUT** pre-drilled hole



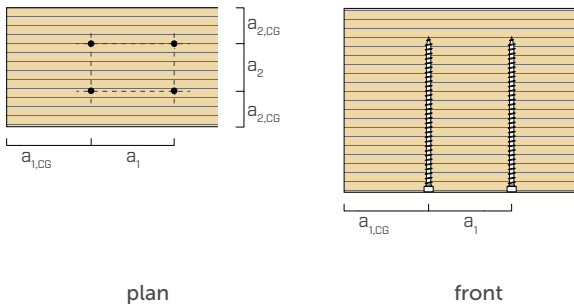
| <b>d<sub>1</sub></b>     | <b>[mm]</b> |              | <b>7</b> | <b>9</b> | <b>11</b> |
|--------------------------|-------------|--------------|----------|----------|-----------|
| <b>a<sub>1</sub></b>     | [mm]        | <b>5·d</b>   | 35       | 45       | 55        |
| <b>a<sub>2</sub></b>     | [mm]        | <b>5·d</b>   | 35       | 45       | 55        |
| <b>a<sub>2,LIM</sub></b> | [mm]        | <b>2,5·d</b> | 18       | 23       | 28        |
| <b>a<sub>1,CG</sub></b>  | [mm]        | <b>8·d</b>   | 56       | 72       | 88        |
| <b>a<sub>2,CG</sub></b>  | [mm]        | <b>3·d</b>   | 21       | 27       | 33        |
| <b>a<sub>CROSS</sub></b> | [mm]        | <b>1,5·d</b> | 11       | 14       | 17        |

| d <sub>1</sub>     | [mm] |       | 9  | 11 |
|--------------------|------|-------|----|----|
| a <sub>1</sub>     | [mm] | 5·d   | 45 | 55 |
| a <sub>2</sub>     | [mm] | 5·d   | 45 | 55 |
| a <sub>2,LIM</sub> | [mm] | 2,5·d | 23 | 28 |
| a <sub>1,CG</sub>  | [mm] | 5·d   | 45 | 55 |
| a <sub>2,CG</sub>  | [mm] | 3·d   | 27 | 33 |
| a <sub>CROSS</sub> | [mm] | 1,5·d | 14 | 17 |

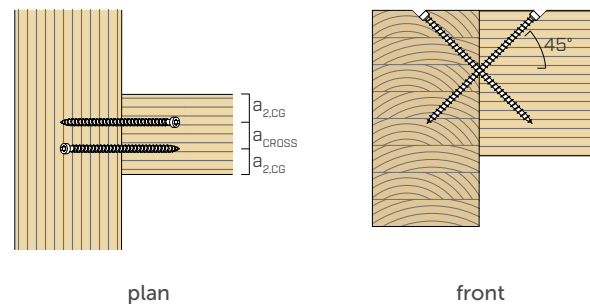
### SCREWS UNDER TENSION INSERTED WITH AN ANGLE $\alpha$ WITH RESPECT TO THE GRAIN



### SCREWS INSERTED WITH $\alpha = 90^\circ$ ANGLE WITH RESPECT TO THE GRAIN



### CROSSED SCREWS INSERTED WITH AN ANGLE $\alpha$ WITH RESPECT TO THE GRAIN

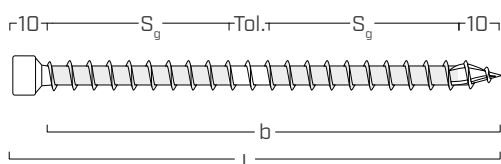


#### NOTES

- Minimum distances according to ETA-11/0030.
- The minimum distances are independent of the insertion angle of the connector and the angle of the force with respect to the grain.
- The axial distance  $a_2$  can be reduced down to  $a_{2,LIM}$  if for each connector a "joint surface"  $a_1 a_2 = 25 d_1^2$  is maintained.
- For main beam-secondary beam joints with VGZ screws  $d = 7$  mm inclined or crossed, inserted at an angle of  $45^\circ$  to the secondary beam head, with a minimum secondary beam height of  $18 d$ , the minimum distance  $a_{1,CG}$  can be taken equal to  $8 \cdot d_1$  and the minimum distance  $a_{2,CG}$  equal to  $3 \cdot d_1$ .

- For 3 THORNS tip and self-drilling tip screws, the minimum distances in the table are derived from experimental tests; alternatively, adopt  $a_{1,CG} = 10 \cdot d$  and  $a_{2,CG} = 4 \cdot d$  in accordance with EN 1995:2014.

## EFFECTIVE THREAD USED IN CALCULATION



$$b = S_{g,tot} = L - 10 \text{ mm}$$

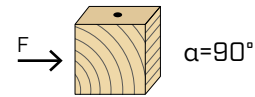
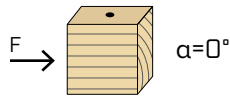
represents the entire length of the threaded part

$$S_g = (L - 10 \text{ mm} - 10 \text{ mm} - \text{Tol.}) / 2$$

represents the partial length of the threaded part net of a laying tolerance (Tol.) of 10 mm

## MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

 screws inserted **WITHOUT** pre-drilled hole  $\rho_k \leq 420 \text{ kg/m}^3$

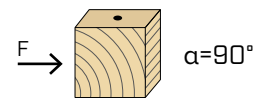
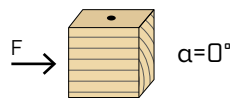


| $d_1$ [mm]     |             | 7   | 9   | 11  |
|----------------|-------------|-----|-----|-----|
| $a_1$ [mm]     | <b>10·d</b> | 70  | 90  | 110 |
| $a_2$ [mm]     | <b>5·d</b>  | 35  | 45  | 55  |
| $a_{3,t}$ [mm] | <b>15·d</b> | 105 | 135 | 165 |
| $a_{3,c}$ [mm] | <b>10·d</b> | 70  | 90  | 110 |
| $a_{4,t}$ [mm] | <b>5·d</b>  | 35  | 45  | 55  |
| $a_{4,c}$ [mm] | <b>5·d</b>  | 35  | 45  | 55  |

| $d_1$ [mm]     |             | 7  | 9  | 11  |
|----------------|-------------|----|----|-----|
| $a_1$ [mm]     | <b>5·d</b>  | 35 | 45 | 55  |
| $a_2$ [mm]     | <b>5·d</b>  | 35 | 45 | 55  |
| $a_{3,t}$ [mm] | <b>10·d</b> | 70 | 90 | 110 |
| $a_{3,c}$ [mm] | <b>10·d</b> | 70 | 90 | 110 |
| $a_{4,t}$ [mm] | <b>10·d</b> | 70 | 90 | 110 |
| $a_{4,c}$ [mm] | <b>5·d</b>  | 35 | 45 | 55  |

$\alpha$  = load-to-grain angle  
 $d = d_1$  = nominal screw diameter

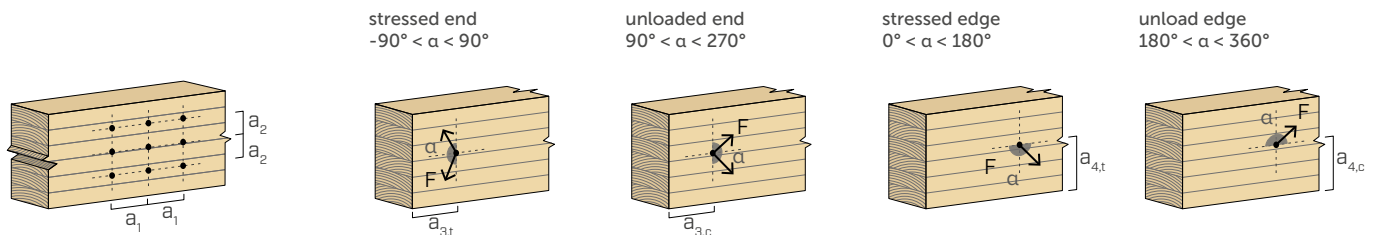
 screws inserted **WITH** pre-drilled hole



| $d_1$ [mm]     |             | 7  | 9   | 11  |
|----------------|-------------|----|-----|-----|
| $a_1$ [mm]     | <b>5·d</b>  | 35 | 45  | 55  |
| $a_2$ [mm]     | <b>3·d</b>  | 21 | 27  | 33  |
| $a_{3,t}$ [mm] | <b>12·d</b> | 84 | 108 | 132 |
| $a_{3,c}$ [mm] | <b>7·d</b>  | 49 | 63  | 77  |
| $a_{4,t}$ [mm] | <b>3·d</b>  | 21 | 27  | 33  |
| $a_{4,c}$ [mm] | <b>3·d</b>  | 21 | 27  | 33  |

| $d_1$ [mm]     |            | 7  | 9  | 11 |
|----------------|------------|----|----|----|
| $a_1$ [mm]     | <b>4·d</b> | 28 | 36 | 44 |
| $a_2$ [mm]     | <b>4·d</b> | 28 | 36 | 44 |
| $a_{3,t}$ [mm] | <b>7·d</b> | 49 | 63 | 77 |
| $a_{3,c}$ [mm] | <b>7·d</b> | 49 | 63 | 77 |
| $a_{4,t}$ [mm] | <b>7·d</b> | 49 | 63 | 77 |
| $a_{4,c}$ [mm] | <b>3·d</b> | 21 | 27 | 33 |

$\alpha$  = load-to-grain angle  
 $d = d_1$  = nominal screw diameter



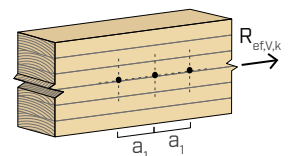
### NOTES

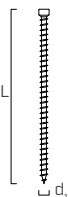
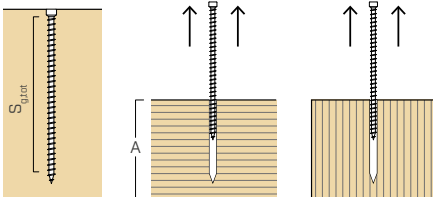
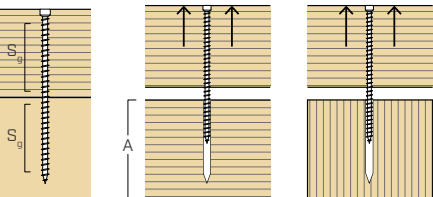
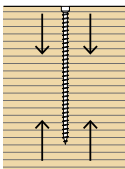
- The minimum distances comply with the EN 1995:2014 standard in accordance with ETA-11/0030.
- The minimum spacing for all panel-to-timber connections ( $a_1$ ,  $a_2$ ) can be multiplied by a coefficient of 0,85.
- The spacing  $a_1$  in the table for screws with 3 THORNS tip inserted without pre-drilling hole in timber elements with density  $\rho_k \leq 420 \text{ kg/m}^3$  and load-to-grain angle  $\alpha = 0^\circ$  was assumed to be 10·d based on experimental tests; alternatively, adopt 12·d in accordance with EN 1995:2014.

## EFFECTIVE NUMBER FOR SHEAR LOADS

The load-bearing capacity of a connection made with several screws, all of the same type and size, may be lower than the sum of the load-bearing capacities of the individual connection system.

For a row of  $n$  screws arranged parallel to the direction of the grain at a distance  $a_1$ , the characteristic effective shear bearing capacity  $R_{ef,V,k}$  can be calculated by means of the effective number  $n_{ef}$  (see page 169).



| TENSION / COMPRESSION                                                             |           |                                                                                   |                   |                       |                      |                                                                                    |                   |                       |                      |                                                                                     |                                                                                     |
|-----------------------------------------------------------------------------------|-----------|-----------------------------------------------------------------------------------|-------------------|-----------------------|----------------------|------------------------------------------------------------------------------------|-------------------|-----------------------|----------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| geometry                                                                          |           | total thread withdrawal                                                           |                   |                       |                      | partial thread withdrawal                                                          |                   |                       |                      | steel tension                                                                       | instability<br>$\varepsilon=90^\circ$                                               |
|                                                                                   |           | $\varepsilon=90^\circ$                                                            |                   | $\varepsilon=0^\circ$ |                      | $\varepsilon=90^\circ$                                                             |                   | $\varepsilon=0^\circ$ |                      |                                                                                     |                                                                                     |
|  |           |  |                   |                       |                      |  |                   |                       |                      |  |  |
| $d_1$<br>[mm]                                                                     | L<br>[mm] | $S_{g,tot}$<br>[mm]                                                               | $A_{min}$<br>[mm] | $R_{ax,90,k}$<br>[kN] | $R_{ax,0,k}$<br>[kN] | $S_g$<br>[mm]                                                                      | $A_{min}$<br>[mm] | $R_{ax,90,k}$<br>[kN] | $R_{ax,0,k}$<br>[kN] | $R_{tens,k}$<br>[kN]                                                                | $R_{ki,90,k}$<br>[kN]                                                               |
| 7                                                                                 | 80        | 70                                                                                | 90                | 6,19                  | 1,86                 | -                                                                                  | -                 | -                     | -                    | 15,40                                                                               | 10,30                                                                               |
|                                                                                   | 100       | 90                                                                                | 110               | 7,96                  | 2,39                 | 35                                                                                 | 55                | 3,09                  | 0,93                 |                                                                                     |                                                                                     |
|                                                                                   | 120       | 110                                                                               | 130               | 9,72                  | 2,92                 | 45                                                                                 | 65                | 3,98                  | 1,19                 |                                                                                     |                                                                                     |
|                                                                                   | 140       | 130                                                                               | 150               | 11,49                 | 3,45                 | 55                                                                                 | 75                | 4,86                  | 1,46                 |                                                                                     |                                                                                     |
|                                                                                   | 160       | 150                                                                               | 170               | 13,26                 | 3,98                 | 65                                                                                 | 85                | 5,75                  | 1,72                 |                                                                                     |                                                                                     |
|                                                                                   | 180       | 170                                                                               | 190               | 15,03                 | 4,51                 | 75                                                                                 | 95                | 6,63                  | 1,99                 |                                                                                     |                                                                                     |
|                                                                                   | 200       | 190                                                                               | 210               | 16,79                 | 5,04                 | 85                                                                                 | 105               | 7,51                  | 2,25                 |                                                                                     |                                                                                     |
|                                                                                   | 220       | 210                                                                               | 230               | 18,56                 | 5,57                 | 95                                                                                 | 115               | 8,40                  | 2,52                 |                                                                                     |                                                                                     |
|                                                                                   | 240       | 230                                                                               | 250               | 20,33                 | 6,10                 | 105                                                                                | 125               | 9,28                  | 2,78                 |                                                                                     |                                                                                     |
|                                                                                   | 260       | 250                                                                               | 270               | 22,10                 | 6,63                 | 115                                                                                | 135               | 10,16                 | 3,05                 |                                                                                     |                                                                                     |
|                                                                                   | 280       | 270                                                                               | 290               | 23,87                 | 7,16                 | 125                                                                                | 145               | 11,05                 | 3,31                 |                                                                                     |                                                                                     |
|                                                                                   | 300       | 290                                                                               | 310               | 25,63                 | 7,69                 | 135                                                                                | 155               | 11,93                 | 3,58                 |                                                                                     |                                                                                     |
|                                                                                   | 320       | 310                                                                               | 330               | 27,40                 | 8,22                 | 145                                                                                | 165               | 12,82                 | 3,84                 |                                                                                     |                                                                                     |
|                                                                                   | 340       | 330                                                                               | 350               | 29,17                 | 8,75                 | 155                                                                                | 175               | 13,70                 | 4,11                 |                                                                                     |                                                                                     |
|                                                                                   | 360       | 350                                                                               | 370               | 30,94                 | 9,28                 | 165                                                                                | 185               | 14,58                 | 4,38                 |                                                                                     |                                                                                     |
|                                                                                   | 380       | 370                                                                               | 390               | 32,70                 | 9,81                 | 175                                                                                | 195               | 15,47                 | 4,64                 |                                                                                     |                                                                                     |
|                                                                                   | 400       | 390                                                                               | 410               | 34,47                 | 10,34                | 185                                                                                | 205               | 16,35                 | 4,91                 |                                                                                     |                                                                                     |
| 9                                                                                 | 160       | 150                                                                               | 170               | 17,05                 | 5,11                 | 65                                                                                 | 85                | 7,39                  | 2,22                 | 25,40                                                                               | 17,25                                                                               |
|                                                                                   | 180       | 170                                                                               | 190               | 19,32                 | 5,80                 | 75                                                                                 | 95                | 8,52                  | 2,56                 |                                                                                     |                                                                                     |
|                                                                                   | 200       | 190                                                                               | 210               | 21,59                 | 6,48                 | 85                                                                                 | 105               | 9,66                  | 2,90                 |                                                                                     |                                                                                     |
|                                                                                   | 220       | 210                                                                               | 230               | 23,87                 | 7,16                 | 95                                                                                 | 115               | 10,80                 | 3,24                 |                                                                                     |                                                                                     |
|                                                                                   | 240       | 230                                                                               | 250               | 26,14                 | 7,84                 | 105                                                                                | 125               | 11,93                 | 3,58                 |                                                                                     |                                                                                     |
|                                                                                   | 260       | 250                                                                               | 270               | 28,41                 | 8,52                 | 115                                                                                | 135               | 13,07                 | 3,92                 |                                                                                     |                                                                                     |
|                                                                                   | 280       | 270                                                                               | 290               | 30,68                 | 9,21                 | 125                                                                                | 145               | 14,21                 | 4,26                 |                                                                                     |                                                                                     |
|                                                                                   | 300       | 290                                                                               | 310               | 32,96                 | 9,89                 | 135                                                                                | 155               | 15,34                 | 4,60                 |                                                                                     |                                                                                     |
|                                                                                   | 320       | 310                                                                               | 330               | 35,23                 | 10,57                | 145                                                                                | 165               | 16,48                 | 4,94                 |                                                                                     |                                                                                     |
|                                                                                   | 340       | 330                                                                               | 350               | 37,50                 | 11,25                | 155                                                                                | 175               | 17,61                 | 5,28                 |                                                                                     |                                                                                     |
|                                                                                   | 360       | 350                                                                               | 370               | 39,78                 | 11,93                | 165                                                                                | 185               | 18,75                 | 5,63                 |                                                                                     |                                                                                     |
|                                                                                   | 380       | 370                                                                               | 390               | 42,05                 | 12,61                | 175                                                                                | 195               | 19,89                 | 5,97                 |                                                                                     |                                                                                     |
|                                                                                   | 400       | 390                                                                               | 410               | 44,32                 | 13,30                | 185                                                                                | 205               | 21,02                 | 6,31                 |                                                                                     |                                                                                     |
|                                                                                   | 440       | 430                                                                               | 450               | 48,87                 | 14,66                | 205                                                                                | 225               | 23,30                 | 6,99                 |                                                                                     |                                                                                     |
|                                                                                   | 480       | 470                                                                               | 490               | 53,41                 | 16,02                | 225                                                                                | 245               | 25,57                 | 7,67                 |                                                                                     |                                                                                     |
|                                                                                   | 520       | 510                                                                               | 530               | 57,96                 | 17,39                | 245                                                                                | 265               | 27,84                 | 8,35                 |                                                                                     |                                                                                     |
|                                                                                   | 560       | 550                                                                               | 570               | 62,50                 | 18,75                | 265                                                                                | 285               | 30,12                 | 9,03                 |                                                                                     |                                                                                     |
|                                                                                   | 600       | 590                                                                               | 610               | 67,05                 | 20,11                | 285                                                                                | 305               | 32,39                 | 9,72                 |                                                                                     |                                                                                     |

$\varepsilon$  = screw-to-grain angle



| TENSION / COMPRESSION |             |                         |                   |                       |                      |                           |                   |                       |                      |                      |                        |
|-----------------------|-------------|-------------------------|-------------------|-----------------------|----------------------|---------------------------|-------------------|-----------------------|----------------------|----------------------|------------------------|
| geometry              |             | total thread withdrawal |                   |                       |                      | partial thread withdrawal |                   |                       |                      | steel tension        | instability            |
|                       |             | $\varepsilon=90^\circ$  |                   | $\varepsilon=0^\circ$ |                      | $\varepsilon=90^\circ$    |                   | $\varepsilon=0^\circ$ |                      |                      | $\varepsilon=90^\circ$ |
|                       |             |                         |                   |                       |                      |                           |                   |                       |                      |                      |                        |
| $d_1$<br>[mm]         | $L$<br>[mm] | $S_{g,tot}$<br>[mm]     | $A_{min}$<br>[mm] | $R_{ax,90,k}$<br>[kN] | $R_{ax,0,k}$<br>[kN] | $S_g$<br>[mm]             | $A_{min}$<br>[mm] | $R_{ax,90,k}$<br>[kN] | $R_{ax,0,k}$<br>[kN] | $R_{tens,k}$<br>[kN] | $R_{ki,90,k}$<br>[kN]  |
| 11                    | 150         | 140                     | 160               | 19,45                 | 5,83                 | 60                        | 80                | 8,33                  | 2,50                 | 38,00                | 21,93                  |
|                       | 200         | 190                     | 210               | 26,39                 | 7,92                 | 85                        | 105               | 11,81                 | 3,54                 |                      |                        |
|                       | 250         | 240                     | 260               | 33,34                 | 10,00                | 110                       | 130               | 15,28                 | 4,58                 |                      |                        |
|                       | 275         | 265                     | 285               | 36,81                 | 11,04                | 123                       | 143               | 17,01                 | 5,10                 |                      |                        |
|                       | 300         | 290                     | 310               | 40,28                 | 12,08                | 135                       | 155               | 18,75                 | 5,63                 |                      |                        |
|                       | 325         | 315                     | 335               | 43,75                 | 13,13                | 148                       | 168               | 20,49                 | 6,15                 |                      |                        |
|                       | 350         | 340                     | 360               | 47,22                 | 14,17                | 160                       | 180               | 22,22                 | 6,67                 |                      |                        |
|                       | 375         | 365                     | 385               | 50,70                 | 15,21                | 173                       | 193               | 23,96                 | 7,19                 |                      |                        |
|                       | 400         | 390                     | 410               | 54,17                 | 16,25                | 185                       | 205               | 25,70                 | 7,71                 |                      |                        |
|                       | 425         | 415                     | 435               | 57,64                 | 17,29                | 198                       | 218               | 27,43                 | 8,23                 |                      |                        |
|                       | 450         | 440                     | 460               | 61,11                 | 18,33                | 210                       | 230               | 29,17                 | 8,75                 |                      |                        |
|                       | 475         | 465                     | 485               | 64,59                 | 19,38                | 223                       | 243               | 30,90                 | 9,27                 |                      |                        |
|                       | 500         | 490                     | 510               | 68,06                 | 20,42                | 235                       | 255               | 32,64                 | 9,79                 |                      |                        |
|                       | 525         | 515                     | 535               | 71,53                 | 21,46                | 248                       | 268               | 34,38                 | 10,31                |                      |                        |
|                       | 550         | 540                     | 560               | 75,00                 | 22,50                | 260                       | 280               | 36,11                 | 10,83                |                      |                        |
|                       | 575         | 565                     | 585               | 78,48                 | 23,54                | 273                       | 293               | 37,85                 | 11,35                |                      |                        |
|                       | 600         | 590                     | 610               | 81,95                 | 24,58                | 285                       | 305               | 39,59                 | 11,88                |                      |                        |
|                       | 650         | 640                     | 660               | 88,89                 | 26,67                | 310                       | 330               | 43,06                 | 12,92                |                      |                        |
|                       | 700         | 690                     | 710               | 95,84                 | 28,75                | 335                       | 355               | 46,53                 | 13,96                |                      |                        |
|                       | 750         | 740                     | 760               | 102,78                | 30,84                | 360                       | 380               | 50,00                 | 15,00                |                      |                        |
|                       | 800         | 790                     | 810               | 109,73                | 32,92                | 385                       | 405               | 53,48                 | 16,04                |                      |                        |
|                       | 850         | 840                     | 860               | 116,67                | 35,00                | 410                       | 430               | 56,95                 | 17,08                |                      |                        |
|                       | 900         | 890                     | 910               | 123,62                | 37,09                | 435                       | 455               | 60,42                 | 18,13                |                      |                        |
|                       | 950         | 940                     | 960               | 130,56                | 39,17                | 460                       | 480               | 63,89                 | 19,17                |                      |                        |
|                       | 1000        | 990                     | 1010              | 137,51                | 41,25                | 485                       | 505               | 67,37                 | 20,21                |                      |                        |

$\varepsilon$  = screw-to-grain angle

## NOTES

- The characteristic thread withdrawal resistances were evaluated considering both an  $\varepsilon$  angle of  $90^\circ$  ( $R_{ax,90,k}$ ) and of  $0^\circ$  ( $R_{ax,0,k}$ ) between the grains of the timber element and the connector.
- For the calculation process a timber characteristic density  $\rho_k = 385 \text{ kg/m}^3$  has been considered. For different  $\rho_k$  values, the strength values in the table can be converted by the  $k_{dens}$  coefficient.

$$R'_{ax,k} = k_{dens,ax} \cdot R_{ax,k}$$

$$R'_{ki,k} = k_{dens,ki} \cdot R_{ki,k}$$

| $\rho_k$<br>[kg/m <sup>3</sup> ] | 350  | 380  | 385   | 405   | 425   | 430   | 440   |
|----------------------------------|------|------|-------|-------|-------|-------|-------|
| C-GL                             | C24  | C30  | GL24h | GL26h | GL28h | GL30h | GL32h |
| $k_{dens,ax}$                    | 0,92 | 0,98 | 1,00  | 1,04  | 1,08  | 1,09  | 1,11  |
| $k_{dens,ki}$                    | 0,97 | 0,99 | 1,00  | 1,00  | 1,01  | 1,02  | 1,02  |

Strength values thus determined may differ, for higher safety standards, from those resulting from an exact calculation.

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|               |           | SLIDING          |           |                   |                   |                         | SHEAR            |                                            |                                           |                     |
|---------------|-----------|------------------|-----------|-------------------|-------------------|-------------------------|------------------|--------------------------------------------|-------------------------------------------|---------------------|
| geometry      |           | timber-to-timber |           |                   | steel tension     |                         | timber-to-timber | timber-to-timber<br>$\varepsilon=90^\circ$ | timber-to-timber<br>$\varepsilon=0^\circ$ |                     |
|               |           |                  |           |                   |                   |                         |                  |                                            |                                           |                     |
| $d_1$<br>[mm] | L<br>[mm] | $S_g$<br>[mm]    | A<br>[mm] | $B_{min}$<br>[mm] | $R_{V,k}$<br>[kN] | $R_{tens,45,k}$<br>[kN] | A<br>[mm]        | $S_g$<br>[mm]                              | $R_{V,90,k}$<br>[mm]                      | $R_{V,0,k}$<br>[kN] |
| 7             | 80        | -                | -         | -                 | -                 | 10,89                   | 40               | 25                                         | 2,59                                      | 1,34                |
|               | 100       | 35               | 40        | 55                | 2,19              |                         | 50               | 35                                         | 2,93                                      | 1,53                |
|               | 120       | 45               | 45        | 60                | 2,81              |                         | 60               | 45                                         | 3,15                                      | 1,74                |
|               | 140       | 55               | 55        | 70                | 3,44              |                         | 70               | 55                                         | 3,37                                      | 1,97                |
|               | 160       | 65               | 60        | 75                | 4,06              |                         | 80               | 65                                         | 3,59                                      | 2,06                |
|               | 180       | 75               | 70        | 85                | 4,69              |                         | 90               | 75                                         | 3,81                                      | 2,12                |
|               | 200       | 85               | 75        | 90                | 5,31              |                         | 100              | 85                                         | 4,03                                      | 2,19                |
|               | 220       | 95               | 85        | 100               | 5,94              |                         | 110              | 95                                         | 4,25                                      | 2,26                |
|               | 240       | 105              | 90        | 105               | 6,56              |                         | 120              | 105                                        | 4,30                                      | 2,32                |
|               | 260       | 115              | 95        | 110               | 7,19              |                         | 130              | 115                                        | 4,30                                      | 2,39                |
|               | 280       | 125              | 105       | 120               | 7,81              |                         | 140              | 125                                        | 4,30                                      | 2,46                |
|               | 300       | 135              | 110       | 125               | 8,44              |                         | 150              | 135                                        | 4,30                                      | 2,52                |
|               | 320       | 145              | 120       | 135               | 9,06              |                         | 160              | 145                                        | 4,30                                      | 2,59                |
|               | 340       | 155              | 125       | 140               | 9,69              |                         | 170              | 155                                        | 4,30                                      | 2,65                |
|               | 360       | 165              | 130       | 145               | 10,31             |                         | 180              | 165                                        | 4,30                                      | 2,72                |
|               | 380       | 175              | 140       | 155               | 10,94             |                         | 190              | 175                                        | 4,30                                      | 2,79                |
|               | 400       | 185              | 145       | 160               | 11,56             |                         | 200              | 185                                        | 4,30                                      | 2,85                |
| 9             | 160       | 65               | 60        | 75                | 5,22              | 17,96                   | 80               | 65                                         | 5,10                                      | 2,81                |
|               | 180       | 75               | 70        | 85                | 6,03              |                         | 90               | 75                                         | 5,38                                      | 3,08                |
|               | 200       | 85               | 75        | 90                | 6,83              |                         | 100              | 85                                         | 5,67                                      | 3,18                |
|               | 220       | 95               | 85        | 100               | 7,63              |                         | 110              | 95                                         | 5,95                                      | 3,27                |
|               | 240       | 105              | 90        | 105               | 8,44              |                         | 120              | 105                                        | 6,23                                      | 3,35                |
|               | 260       | 115              | 95        | 110               | 9,24              |                         | 130              | 115                                        | 6,50                                      | 3,44                |
|               | 280       | 125              | 105       | 120               | 10,04             |                         | 140              | 125                                        | 6,50                                      | 3,52                |
|               | 300       | 135              | 110       | 125               | 10,85             |                         | 150              | 135                                        | 6,50                                      | 3,61                |
|               | 320       | 145              | 120       | 135               | 11,65             |                         | 160              | 145                                        | 6,50                                      | 3,69                |
|               | 340       | 155              | 125       | 140               | 12,46             |                         | 170              | 155                                        | 6,50                                      | 3,78                |
|               | 360       | 165              | 130       | 145               | 13,26             |                         | 180              | 165                                        | 6,50                                      | 3,86                |
|               | 380       | 175              | 140       | 155               | 14,06             |                         | 190              | 175                                        | 6,50                                      | 3,95                |
|               | 400       | 185              | 145       | 160               | 14,87             |                         | 200              | 185                                        | 6,50                                      | 4,03                |
|               | 440       | 205              | 160       | 175               | 16,47             |                         | 220              | 205                                        | 6,50                                      | 4,21                |
|               | 480       | 225              | 175       | 190               | 18,08             |                         | 240              | 225                                        | 6,50                                      | 4,38                |
|               | 520       | 245              | 190       | 205               | 19,69             |                         | 260              | 245                                        | 6,50                                      | 4,55                |
|               | 560       | 265              | 205       | 220               | 21,29             |                         | 280              | 265                                        | 6,50                                      | 4,72                |
|               | 600       | 285              | 215       | 230               | 22,90             |                         | 300              | 285                                        | 6,50                                      | 4,89                |

$\varepsilon$  = screw-to-grain angle

|               |           | SLIDING          |           |                   |                   |                         | SHEAR            |                                            |                                           |                     |
|---------------|-----------|------------------|-----------|-------------------|-------------------|-------------------------|------------------|--------------------------------------------|-------------------------------------------|---------------------|
| geometry      |           | timber-to-timber |           |                   | steel tension     |                         | timber-to-timber | timber-to-timber<br>$\varepsilon=90^\circ$ | timber-to-timber<br>$\varepsilon=0^\circ$ |                     |
|               |           |                  |           |                   |                   |                         |                  |                                            |                                           |                     |
| $d_1$<br>[mm] | L<br>[mm] | $S_g$<br>[mm]    | A<br>[mm] | $B_{min}$<br>[mm] | $R_{V,k}$<br>[kN] | $R_{tens,45,k}$<br>[kN] | A<br>[mm]        | $S_g$<br>[mm]                              | $R_{V,90,k}$<br>[kN]                      | $R_{V,0,k}$<br>[kN] |
| 11            | 150       | 60               | 60        | 75                | 5,89              | 26,87                   | 75               | 60                                         | 6,61                                      | 3,33                |
|               | 200       | 85               | 75        | 90                | 8,35              |                         | 100              | 85                                         | 7,48                                      | 4,10                |
|               | 250       | 110              | 95        | 110               | 10,80             |                         | 125              | 110                                        | 8,35                                      | 4,57                |
|               | 275       | 123              | 100       | 115               | 12,03             |                         | 138              | 123                                        | 8,79                                      | 4,70                |
|               | 300       | 135              | 110       | 125               | 13,26             |                         | 150              | 135                                        | 9,06                                      | 4,83                |
|               | 325       | 148              | 120       | 135               | 14,49             |                         | 163              | 148                                        | 9,06                                      | 4,96                |
|               | 350       | 160              | 130       | 145               | 15,71             |                         | 175              | 160                                        | 9,06                                      | 5,09                |
|               | 375       | 173              | 140       | 155               | 16,94             |                         | 188              | 173                                        | 9,06                                      | 5,22                |
|               | 400       | 185              | 145       | 160               | 18,17             |                         | 200              | 185                                        | 9,06                                      | 5,35                |
|               | 425       | 198              | 155       | 170               | 19,40             |                         | 213              | 198                                        | 9,06                                      | 5,48                |
|               | 450       | 210              | 165       | 180               | 20,63             |                         | 225              | 210                                        | 9,06                                      | 5,61                |
|               | 475       | 223              | 175       | 190               | 21,85             |                         | 238              | 223                                        | 9,06                                      | 5,74                |
|               | 500       | 235              | 180       | 195               | 23,08             |                         | 250              | 235                                        | 9,06                                      | 5,87                |
|               | 525       | 248              | 190       | 205               | 24,31             |                         | 263              | 248                                        | 9,06                                      | 6,00                |
|               | 550       | 260              | 200       | 215               | 25,54             |                         | 275              | 260                                        | 9,06                                      | 6,13                |
|               | 575       | 273              | 210       | 225               | 26,76             |                         | 288              | 273                                        | 9,06                                      | 6,26                |
|               | 600       | 285              | 215       | 230               | 27,99             |                         | 300              | 285                                        | 9,06                                      | 6,39                |
|               | 650       | 310              | 235       | 250               | 30,45             |                         | 325              | 310                                        | 9,06                                      | 6,65                |
|               | 700       | 335              | 250       | 265               | 32,90             |                         | 350              | 335                                        | 9,06                                      | 6,85                |
|               | 750       | 360              | 270       | 285               | 35,36             |                         | 375              | 360                                        | 9,06                                      | 6,85                |
|               | 800       | 385              | 290       | 305               | 37,81             |                         | 400              | 385                                        | 9,06                                      | 6,85                |
|               | 850       | 410              | 305       | 320               | 40,27             |                         | 425              | 410                                        | 9,06                                      | 6,85                |
|               | 900       | 435              | 325       | 340               | 42,72             |                         | 450              | 435                                        | 9,06                                      | 6,85                |
|               | 950       | 460              | 340       | 355               | 45,18             |                         | 475              | 460                                        | 9,06                                      | 6,85                |
|               | 1000      | 485              | 360       | 375               | 47,63             |                         | 500              | 485                                        | 9,06                                      | 6,85                |

$\varepsilon$  = screw-to-grain angle

## NOTES

- The characteristic sliding strengths were evaluated by considering an angle  $\varepsilon$  of  $45^\circ$  between the grains of the timber element and the connector.
- The characteristic timber-to-timber shear strengths were evaluated considering both an  $\varepsilon$  angle of  $90^\circ$  ( $R_{V,90,k}$ ) and  $0^\circ$  ( $R_{V,0,k}$ ) between the grains of the second element and the connector.
- For the calculation process a timber characteristic density  $\rho_k = 385 \text{ kg/m}^3$  has been considered. For different  $\rho_k$  values, the strength values in the table can be converted by the  $k_{dens}$  coefficient.

$$R'_{V,k} = k_{dens,ax} \cdot R_{V,k}$$

$$R'_{V,90,k} = k_{dens,v} \cdot R_{V,90,k}$$

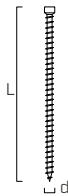
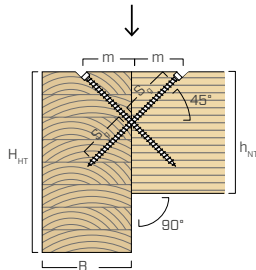
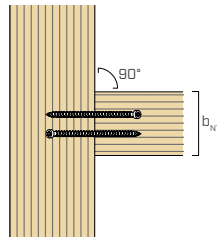
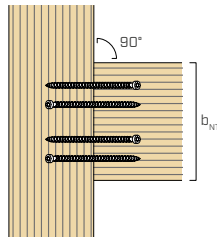
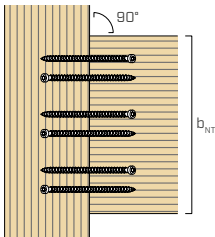
$$R'_{V,0,k} = k_{dens,v} \cdot R_{V,0,k}$$

| $\rho_k$<br>[kg/m <sup>3</sup> ] | 350  | 380  | 385   | 405   | 425   | 430   | 440   |
|----------------------------------|------|------|-------|-------|-------|-------|-------|
| C-GL                             | C24  | C30  | GL24h | GL26h | GL28h | GL30h | GL32h |
| $k_{dens,ax}$                    | 0,92 | 0,98 | 1,00  | 1,04  | 1,08  | 1,09  | 1,11  |
| $k_{dens,v}$                     | 0,90 | 0,98 | 1,00  | 1,02  | 1,05  | 1,05  | 1,07  |

Strength values thus determined may differ, for higher safety standards, from those resulting from an exact calculation.

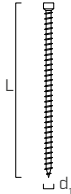
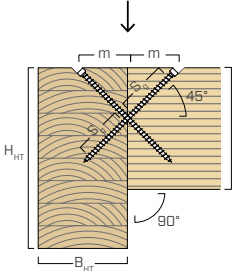
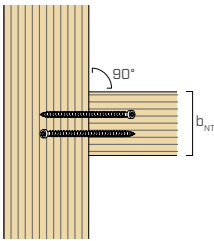
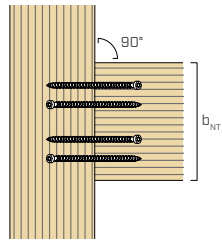
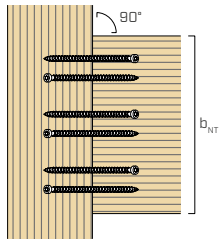
GENERAL PRINCIPLES on page 143.

MAIN BEAM-SECONDARY BEAM SHEAR CONNECTION

| geometry                                                                          |      | main beam<br>secondary beam                                                       |                    |      |      | 1 pair                                                                            |       |       | 2 pairs                                                                            |       |       | 3 pairs                                                                             |       |       |
|-----------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------|--------------------|------|------|-----------------------------------------------------------------------------------|-------|-------|------------------------------------------------------------------------------------|-------|-------|-------------------------------------------------------------------------------------|-------|-------|
|  |      |  |                    |      |      |  |       |       |  |       |       |  |       |       |
| d1                                                                                | L    | BHT,min                                                                           | HHT,min<br>hNT,min | SG   | m    | bNT,min                                                                           | RV1,k | RV2,k | bNT,min                                                                            | RV1,k | RV2,k | bNT,min                                                                             | RV1,k | RV2,k |
| [mm]                                                                              | [mm] | [mm]                                                                              | [mm]               | [mm] | [mm] | [mm]                                                                              | [kN]  | [kN]  | [mm]                                                                               | [kN]  | [kN]  | [mm]                                                                                | [kN]  | [kN]  |
| 7                                                                                 | 160  | 75                                                                                | 130                | 65   | 60   | 53                                                                                | 8,13  | 13,63 | 88                                                                                 | 15,16 | 25,44 | 123                                                                                 | 21,84 | 36,64 |
|                                                                                   | 180  | 80                                                                                | 140                | 75   | 67   | 53                                                                                | 9,38  |       | 88                                                                                 | 17,49 |       | 123                                                                                 | 25,20 |       |
|                                                                                   | 200  | 90                                                                                | 155                | 85   | 74   | 53                                                                                | 10,63 |       | 88                                                                                 | 19,83 |       | 123                                                                                 | 28,56 |       |
|                                                                                   | 220  | 95                                                                                | 170                | 95   | 81   | 53                                                                                | 11,88 |       | 88                                                                                 | 22,16 |       | 123                                                                                 | 31,92 |       |
|                                                                                   | 240  | 100                                                                               | 185                | 105  | 88   | 53                                                                                | 13,13 |       | 88                                                                                 | 24,49 |       | 123                                                                                 | 35,28 |       |
|                                                                                   | 260  | 110                                                                               | 200                | 115  | 95   | 53                                                                                | 14,38 |       | 88                                                                                 | 26,82 |       | 123                                                                                 | 38,64 |       |
|                                                                                   | 280  | 115                                                                               | 210                | 125  | 102  | 53                                                                                | 15,63 |       | 88                                                                                 | 29,16 |       | 123                                                                                 | 42,00 |       |
|                                                                                   | 300  | 125                                                                               | 225                | 135  | 109  | 53                                                                                | 16,88 |       | 88                                                                                 | 31,49 |       | 123                                                                                 | 45,36 |       |
|                                                                                   | 320  | 130                                                                               | 240                | 145  | 116  | 53                                                                                | 18,13 |       | 88                                                                                 | 33,82 |       | 123                                                                                 | 48,72 |       |
|                                                                                   | 340  | 140                                                                               | 255                | 155  | 123  | 53                                                                                | 19,38 |       | 88                                                                                 | 36,16 |       | 123                                                                                 | 52,08 |       |
|                                                                                   | 360  | 145                                                                               | 270                | 165  | 130  | 53                                                                                | 20,63 |       | 88                                                                                 | 38,49 |       | 123                                                                                 | 55,44 |       |
|                                                                                   | 380  | 150                                                                               | 285                | 175  | 137  | 53                                                                                | 21,78 |       | 88                                                                                 | 40,64 |       | 123                                                                                 | 58,54 |       |
| 400                                                                               | 160  | 295                                                                               | 185                | 144  | 53   | 21,78                                                                             | 88    | 40,64 | 123                                                                                | 58,54 |       |                                                                                     |       |       |
| 9                                                                                 | 200  | 90                                                                                | 155                | 85   | 74   | 68                                                                                | 13,66 | 22,88 | 113                                                                                | 25,49 | 42,69 | 158                                                                                 | 36,72 | 61,50 |
|                                                                                   | 220  | 95                                                                                | 170                | 95   | 81   | 68                                                                                | 15,27 |       | 113                                                                                | 28,49 |       | 158                                                                                 | 41,04 |       |
|                                                                                   | 240  | 100                                                                               | 185                | 105  | 88   | 68                                                                                | 16,88 |       | 113                                                                                | 31,49 |       | 158                                                                                 | 45,36 |       |
|                                                                                   | 260  | 110                                                                               | 200                | 115  | 95   | 68                                                                                | 18,48 |       | 113                                                                                | 34,49 |       | 158                                                                                 | 49,68 |       |
|                                                                                   | 280  | 115                                                                               | 210                | 125  | 102  | 68                                                                                | 20,09 |       | 113                                                                                | 37,49 |       | 158                                                                                 | 54,00 |       |
|                                                                                   | 300  | 125                                                                               | 225                | 135  | 109  | 68                                                                                | 21,70 |       | 113                                                                                | 40,49 |       | 158                                                                                 | 58,32 |       |
|                                                                                   | 320  | 130                                                                               | 240                | 145  | 116  | 68                                                                                | 23,30 |       | 113                                                                                | 43,49 |       | 158                                                                                 | 62,64 |       |
|                                                                                   | 340  | 140                                                                               | 255                | 155  | 123  | 68                                                                                | 24,91 |       | 113                                                                                | 46,49 |       | 158                                                                                 | 66,96 |       |
|                                                                                   | 360  | 145                                                                               | 270                | 165  | 130  | 68                                                                                | 26,52 |       | 113                                                                                | 49,48 |       | 158                                                                                 | 71,28 |       |
|                                                                                   | 380  | 150                                                                               | 285                | 175  | 137  | 68                                                                                | 28,13 |       | 113                                                                                | 52,48 |       | 158                                                                                 | 75,60 |       |
|                                                                                   | 400  | 160                                                                               | 295                | 185  | 144  | 68                                                                                | 29,73 |       | 113                                                                                | 55,48 |       | 158                                                                                 | 79,92 |       |
|                                                                                   | 440  | 175                                                                               | 325                | 205  | 159  | 68                                                                                | 32,95 |       | 113                                                                                | 61,48 |       | 158                                                                                 | 88,56 |       |
|                                                                                   | 480  | 185                                                                               | 355                | 225  | 173  | 68                                                                                | 35,92 |       | 113                                                                                | 67,03 |       | 158                                                                                 | 96,55 |       |
|                                                                                   | 520  | 200                                                                               | 380                | 245  | 187  | 68                                                                                | 35,92 |       | 113                                                                                | 67,03 |       | 158                                                                                 | 96,55 |       |
|                                                                                   | 560  | 215                                                                               | 410                | 265  | 201  | 68                                                                                | 35,92 |       | 113                                                                                | 67,03 |       | 158                                                                                 | 96,55 |       |
|                                                                                   | 600  | 230                                                                               | 440                | 285  | 215  | 68                                                                                | 35,92 |       | 113                                                                                | 67,03 |       | 158                                                                                 | 96,55 |       |



MAIN BEAM-SECONDARY BEAM SHEAR CONNECTION

| geometry                                                                          |      | main beam<br>secondary beam                                                       |                                            |                |      | 1 pair                                                                            |                   |                   | 2 pairs                                                                            |                   |                   | 3 pairs                                                                             |                   |                   |
|-----------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------|--------------------------------------------|----------------|------|-----------------------------------------------------------------------------------|-------------------|-------------------|------------------------------------------------------------------------------------|-------------------|-------------------|-------------------------------------------------------------------------------------|-------------------|-------------------|
|  |      |  |                                            |                |      |  |                   |                   |  |                   |                   |  |                   |                   |
| d <sub>1</sub>                                                                    | L    | B <sub>HT,min</sub>                                                               | H <sub>HT,min</sub><br>h <sub>NT,min</sub> | S <sub>g</sub> | m    | b <sub>NT,min</sub>                                                               | R <sub>V1,k</sub> | R <sub>V2,k</sub> | b <sub>NT,min</sub>                                                                | R <sub>V1,k</sub> | R <sub>V2,k</sub> | b <sub>NT,min</sub>                                                                 | R <sub>V1,k</sub> | R <sub>V2,k</sub> |
| [mm]                                                                              | [mm] | [mm]                                                                              | [mm]                                       | [mm]           | [mm] | [mm]                                                                              | [kN]              | [kN]              | [mm]                                                                               | [kN]              | [kN]              | [mm]                                                                                | [kN]              | [kN]              |
| 11                                                                                | 250  | 105                                                                               | 190                                        | 110            | 91   | 83                                                                                | 21,61             | 29,15             | 138                                                                                | 40,32             | 54,40             | 193                                                                                 | 58,08             | 78,35             |
|                                                                                   | 275  | 115                                                                               | 210                                        | 125            | 102  | 83                                                                                | 24,55             |                   | 138                                                                                | 45,82             |                   | 193                                                                                 | 66,00             |                   |
|                                                                                   | 300  | 125                                                                               | 225                                        | 135            | 109  | 83                                                                                | 26,52             |                   | 138                                                                                | 49,48             |                   | 193                                                                                 | 71,28             |                   |
|                                                                                   | 325  | 135                                                                               | 250                                        | 150            | 120  | 83                                                                                | 29,46             |                   | 138                                                                                | 54,98             |                   | 193                                                                                 | 79,20             |                   |
|                                                                                   | 350  | 140                                                                               | 260                                        | 160            | 127  | 83                                                                                | 31,43             |                   | 138                                                                                | 58,65             |                   | 193                                                                                 | 84,48             |                   |
|                                                                                   | 375  | 150                                                                               | 285                                        | 175            | 137  | 83                                                                                | 34,38             |                   | 138                                                                                | 64,15             |                   | 193                                                                                 | 92,40             |                   |
|                                                                                   | 400  | 160                                                                               | 295                                        | 185            | 144  | 83                                                                                | 36,34             |                   | 138                                                                                | 67,81             |                   | 193                                                                                 | 97,68             |                   |
|                                                                                   | 425  | 170                                                                               | 320                                        | 200            | 155  | 83                                                                                | 39,29             |                   | 138                                                                                | 73,31             |                   | 193                                                                                 | 105,60            |                   |
|                                                                                   | 450  | 175                                                                               | 335                                        | 210            | 162  | 83                                                                                | 41,25             |                   | 138                                                                                | 76,98             |                   | 193                                                                                 | 110,88            |                   |
|                                                                                   | 475  | 185                                                                               | 355                                        | 225            | 173  | 83                                                                                | 44,20             |                   | 138                                                                                | 82,47             |                   | 193                                                                                 | 118,80            |                   |
|                                                                                   | 500  | 195                                                                               | 370                                        | 235            | 180  | 83                                                                                | 46,16             |                   | 138                                                                                | 86,14             |                   | 193                                                                                 | 124,08            |                   |
|                                                                                   | 525  | 205                                                                               | 390                                        | 250            | 190  | 83                                                                                | 49,11             |                   | 138                                                                                | 91,64             |                   | 193                                                                                 | 131,99            |                   |
|                                                                                   | 550  | 210                                                                               | 405                                        | 260            | 197  | 83                                                                                | 51,07             |                   | 138                                                                                | 95,30             |                   | 193                                                                                 | 137,27            |                   |
|                                                                                   | 575  | 225                                                                               | 425                                        | 275            | 208  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 600  | 230                                                                               | 440                                        | 285            | 215  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 650  | 245                                                                               | 475                                        | 310            | 233  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 700  | 265                                                                               | 510                                        | 335            | 251  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 750  | 285                                                                               | 545                                        | 360            | 268  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 800  | 300                                                                               | 580                                        | 385            | 286  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 850  | 320                                                                               | 615                                        | 410            | 304  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 900  | 335                                                                               | 650                                        | 435            | 321  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 950  | 355                                                                               | 685                                        | 460            | 339  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |
|                                                                                   | 1000 | 370                                                                               | 720                                        | 485            | 357  | 83                                                                                | 53,74             |                   | 138                                                                                | 100,28            |                   | 193                                                                                 | 144,45            |                   |

NOTES

- The compression design strength of the connectors is the lower between the withdrawal-side design strength ( $R_{V1,d}$ ) and the instability design strength ( $R_{V2,d}$ ).

$$R_{V,d} = \min \left\{ \begin{array}{l} \frac{R_{V1,k} \cdot k_{mod}}{\gamma_M} \\ \frac{R_{V2,k}}{\gamma_{M1}} \end{array} \right.$$

- The values given are calculated considering a distance  $a_{1,CG} \geq 5d$ .
- For the calculation process a timber characteristic density  $\rho_k = 385 \text{ kg/m}^3$  has been considered.  
For different  $\rho_k$  values, the strength values in the table can be converted by the  $k_{dens}$  coefficients previously indicated:

$$R'_{V1,k} = k_{dens,ax} \cdot R_{V1,k}$$

$$R'_{V2,k} = k_{dens,ki} \cdot R_{V2,k}$$

Strength values thus determined may differ, for higher safety standards, from those resulting from an exact calculation.

- The assembly figure (m) is valid in the case of symmetrical installation of the connectors flush over the elements.
- The connectors must be inserted at 45° with respect to the shear plane.
- The strength values in the table for connections with several pairs of crossed screws are already inclusive of  $n_{ef,ax}$ .

GENERAL PRINCIPLES on page 143.

## MINIMUM DISTANCES FOR CROSSED CONNECTORS

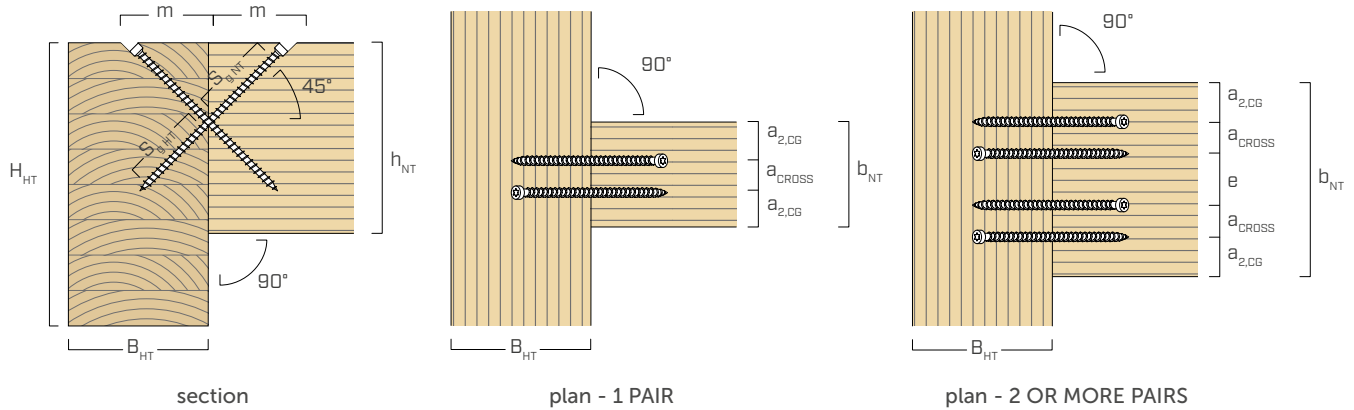
😊 screws inserted **WITH** and **WITHOUT** pre-drilled hole



| $d_1$       | [mm] | 7             | 9  | 11 |
|-------------|------|---------------|----|----|
| $a_{2,CG}$  | [mm] | $3 \cdot d$   | 21 | 27 |
| $a_{CROSS}$ | [mm] | $1,5 \cdot d$ | 11 | 14 |
| $e$         | [mm] | $3,5 \cdot d$ | 25 | 32 |

$d = d_1$  = nominal screw diameter

| $d_1$       | [mm] | 9             | 11 |
|-------------|------|---------------|----|
| $a_{2,CG}$  | [mm] | $3 \cdot d$   | 27 |
| $a_{CROSS}$ | [mm] | $1,5 \cdot d$ | 14 |
| $e$         | [mm] | $3,5 \cdot d$ | 32 |



### NOTES

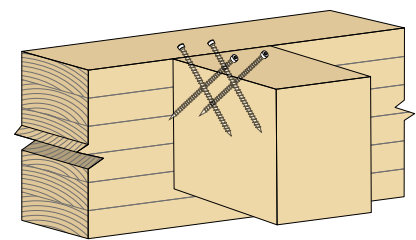
- For main beam-secondary beam joints with VGZ screws  $d = 7$  mm inclined or crossed, inserted at an angle of  $45^\circ$  to the secondary beam head, with a minimum secondary beam height of  $18d$ , the minimum distance  $a_{1,CG}$  can be taken equal to  $8 \cdot d_1$  and the minimum distance  $a_{2,CG}$  equal to  $3 \cdot d_1$ .
- For 3 THORNS tip and self-drilling tip screws, the minimum distances in the table are derived from experimental tests; alternatively, adopt  $a_{1,CG} = 10 \cdot d$  and  $a_{2,CG} = 4 \cdot d$  in accordance with EN1995:2014.

## EFFECTIVE NUMBER FOR AXIALLY STRESSED CONNECTOR PAIRS

The load-bearing capacity of a connection made with several screws, all of the same type and size, may be lower than the sum of the load-bearing capacities of the individual connection system.

For a connection with  $n$  pairs of crossed screws, the characteristic effective load-bearing capacity is equal to:

$$R_{ef,V,k} = n_{ef,ax} \cdot R_{V,k}$$



The  $n_{ef}$  value is given in the table below as a function of  $n$  (number of pairs).

| $n_{PAIRS}$ | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   |
|-------------|------|------|------|------|------|------|------|------|------|
| $n_{ef,ax}$ | 1,87 | 2,70 | 3,60 | 4,50 | 5,40 | 6,30 | 7,20 | 8,10 | 9,00 |



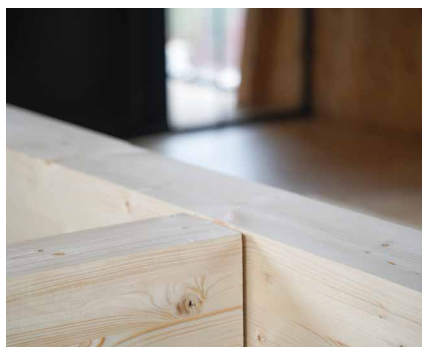
Complete calculation reports for designing in wood?  
Download MyProject and simplify your work!



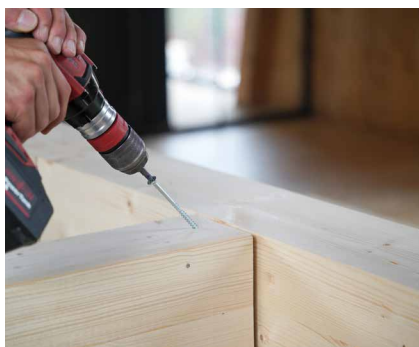
## ■ INSTALLATION SUGGESTIONS

### TIMBER-TO-TIMBER JOINT WITH CROSSED CONNECTORS

#### TIGHTENING THE JOINT



For correct installation of the joint, we recommend tightening the elements before inserting the connectors.

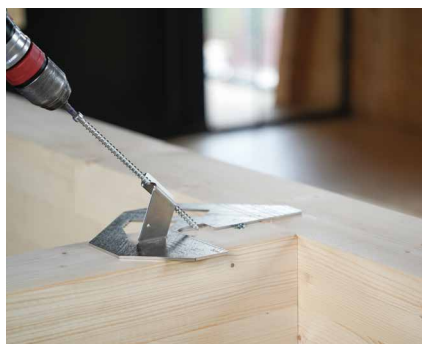


Insert a partially threaded screw (e.g. HBS680) to bring the elements closer together.



The HBS screw eliminated the initial gap between the elements. After positioning the VGZ connectors, it can be removed.

#### INSERTION OF CONNECTORS



To ensure the correct positioning and inclination of the VGZ screws, we recommend using the JIGVGZ45 template.



After tightening about one third of the screw, remove the JIGVGZ45 template and continue with the installation.



Repeat the procedure to install the inserted screw from the main beam to the secondary beam.

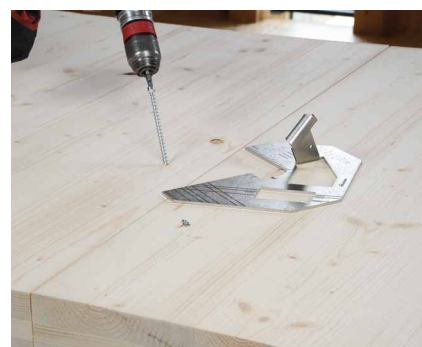
### JOINT BETWEEN CLT PANELS WITH CONNECTORS INCLINED IN BOTH DIRECTIONS [45°-45°]



To ensure the correct positioning and inclination of the VGZ screws, we recommend using the JIGVGZ45 template positioned at 45° to the panel head.



After tightening about one third of the screw, remove the JIGVGZ45 template and continue with the installation.



Repeat the procedure to install the screw in the adjoining panel and continue this alternating sequence according to the distances provided in the design.

## ■ RELATED PRODUCTS



**HBS**  
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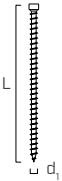
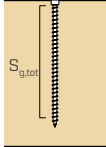
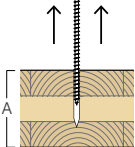
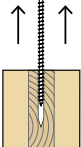
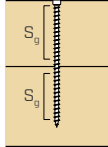
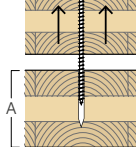
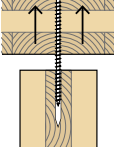
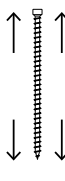
**CATCH**  
page 408

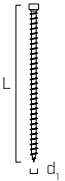
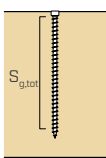
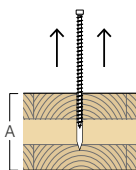
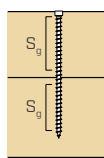
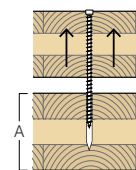
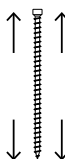


**BIT**  
page 417

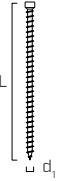
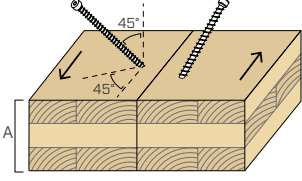
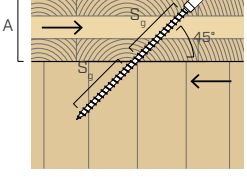
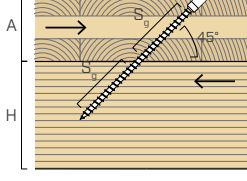


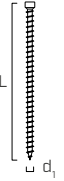
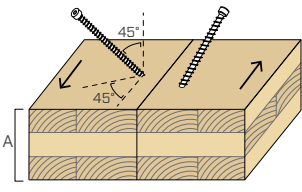
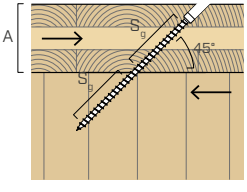
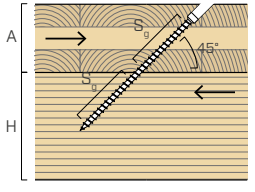
**JIG VGZ 45°**  
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| TENSION                                                                           |                                                                                   |                                                                                   |                                                                                   |                              |                             |                                                                                   |                                                                                    |                                                                                     |                                                                                     |                             |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------|-----------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------|
| geometry                                                                          | total thread withdrawal                                                           |                                                                                   |                                                                                   |                              |                             | partial thread withdrawal                                                         |                                                                                    |                                                                                     |                                                                                     | steel tension               |
|                                                                                   | lateral                                                                           |                                                                                   | narrow                                                                            |                              |                             | lateral                                                                           |                                                                                    | narrow                                                                              |                                                                                     |                             |
|  |  |  |  |                              |                             |  |  |  |  |                             |
| d <sub>1</sub><br>[mm]                                                            | L<br>[mm]                                                                         | S <sub>g,tot</sub><br>[mm]                                                        | A <sub>min</sub><br>[mm]                                                          | R <sub>ax,90,k</sub><br>[kN] | R <sub>ax,0,k</sub><br>[kN] | S <sub>g</sub><br>[mm]                                                            | A <sub>min</sub><br>[mm]                                                           | R <sub>ax,90,k</sub><br>[kN]                                                        | R <sub>ax,0,k</sub><br>[kN]                                                         | R <sub>tens,k</sub><br>[kN] |
| 7                                                                                 | 80                                                                                | 70                                                                                | 90                                                                                | 5,73                         | 4,34                        | -                                                                                 | -                                                                                  | -                                                                                   | -                                                                                   | 15,40                       |
|                                                                                   | 100                                                                               | 90                                                                                | 110                                                                               | 7,37                         | 5,44                        | 35                                                                                | 55                                                                                 | 2,87                                                                                | 2,33                                                                                |                             |
|                                                                                   | 120                                                                               | 110                                                                               | 130                                                                               | 9,01                         | 6,52                        | 45                                                                                | 65                                                                                 | 3,69                                                                                | 2,92                                                                                |                             |
|                                                                                   | 140                                                                               | 130                                                                               | 150                                                                               | 10,65                        | 7,58                        | 55                                                                                | 75                                                                                 | 4,50                                                                                | 3,49                                                                                |                             |
|                                                                                   | 160                                                                               | 150                                                                               | 170                                                                               | 12,29                        | 8,62                        | 65                                                                                | 85                                                                                 | 5,32                                                                                | 4,06                                                                                |                             |
|                                                                                   | 180                                                                               | 170                                                                               | 190                                                                               | 13,92                        | 9,65                        | 75                                                                                | 95                                                                                 | 6,14                                                                                | 4,62                                                                                |                             |
|                                                                                   | 200                                                                               | 190                                                                               | 210                                                                               | 15,56                        | 10,67                       | 85                                                                                | 105                                                                                | 6,96                                                                                | 5,17                                                                                |                             |
|                                                                                   | 220                                                                               | 210                                                                               | 230                                                                               | 17,20                        | 11,67                       | 95                                                                                | 115                                                                                | 7,78                                                                                | 5,72                                                                                |                             |
|                                                                                   | 240                                                                               | 230                                                                               | 250                                                                               | 18,84                        | 12,67                       | 105                                                                               | 125                                                                                | 8,60                                                                                | 6,25                                                                                |                             |
|                                                                                   | 260                                                                               | 250                                                                               | 270                                                                               | 20,48                        | 13,65                       | 115                                                                               | 135                                                                                | 9,42                                                                                | 6,79                                                                                |                             |
|                                                                                   | 280                                                                               | 270                                                                               | 290                                                                               | 22,11                        | 14,63                       | 125                                                                               | 145                                                                                | 10,24                                                                               | 7,32                                                                                |                             |
|                                                                                   | 300                                                                               | 290                                                                               | 310                                                                               | 23,75                        | 15,61                       | 135                                                                               | 155                                                                                | 11,06                                                                               | 7,84                                                                                |                             |
|                                                                                   | 320                                                                               | 310                                                                               | 330                                                                               | 25,39                        | 16,57                       | 145                                                                               | 165                                                                                | 11,88                                                                               | 8,36                                                                                |                             |
|                                                                                   | 340                                                                               | 330                                                                               | 350                                                                               | 27,03                        | 17,53                       | 155                                                                               | 175                                                                                | 12,69                                                                               | 8,88                                                                                |                             |
|                                                                                   | 360                                                                               | 350                                                                               | 370                                                                               | 28,67                        | 18,48                       | 165                                                                               | 185                                                                                | 13,51                                                                               | 9,39                                                                                |                             |
|                                                                                   | 380                                                                               | 370                                                                               | 390                                                                               | 30,30                        | 19,43                       | 175                                                                               | 195                                                                                | 14,33                                                                               | 9,90                                                                                |                             |
|                                                                                   | 400                                                                               | 390                                                                               | 410                                                                               | 31,94                        | 20,37                       | 185                                                                               | 205                                                                                | 15,15                                                                               | 10,41                                                                               |                             |
| 9                                                                                 | 160                                                                               | 150                                                                               | 170                                                                               | 15,80                        | 10,54                       | 65                                                                                | 85                                                                                 | 6,84                                                                                | 4,97                                                                                | 25,40                       |
|                                                                                   | 180                                                                               | 170                                                                               | 190                                                                               | 17,90                        | 11,80                       | 75                                                                                | 95                                                                                 | 7,90                                                                                | 5,65                                                                                |                             |
|                                                                                   | 200                                                                               | 190                                                                               | 210                                                                               | 20,01                        | 13,04                       | 85                                                                                | 105                                                                                | 8,95                                                                                | 6,32                                                                                |                             |
|                                                                                   | 220                                                                               | 210                                                                               | 230                                                                               | 22,11                        | 14,27                       | 95                                                                                | 115                                                                                | 10,00                                                                               | 6,99                                                                                |                             |
|                                                                                   | 240                                                                               | 230                                                                               | 250                                                                               | 24,22                        | 15,49                       | 105                                                                               | 125                                                                                | 11,06                                                                               | 7,65                                                                                |                             |
|                                                                                   | 260                                                                               | 250                                                                               | 270                                                                               | 26,33                        | 16,69                       | 115                                                                               | 135                                                                                | 12,11                                                                               | 8,30                                                                                |                             |
|                                                                                   | 280                                                                               | 270                                                                               | 290                                                                               | 28,43                        | 17,89                       | 125                                                                               | 145                                                                                | 13,16                                                                               | 8,95                                                                                |                             |
|                                                                                   | 300                                                                               | 290                                                                               | 310                                                                               | 30,54                        | 19,08                       | 135                                                                               | 155                                                                                | 14,22                                                                               | 9,59                                                                                |                             |
|                                                                                   | 320                                                                               | 310                                                                               | 330                                                                               | 32,64                        | 20,26                       | 145                                                                               | 165                                                                                | 15,27                                                                               | 10,22                                                                               |                             |
|                                                                                   | 340                                                                               | 330                                                                               | 350                                                                               | 34,75                        | 21,43                       | 155                                                                               | 175                                                                                | 16,32                                                                               | 10,86                                                                               |                             |
|                                                                                   | 360                                                                               | 350                                                                               | 370                                                                               | 36,86                        | 22,60                       | 165                                                                               | 185                                                                                | 17,37                                                                               | 11,49                                                                               |                             |
|                                                                                   | 380                                                                               | 370                                                                               | 390                                                                               | 38,96                        | 23,76                       | 175                                                                               | 195                                                                                | 18,43                                                                               | 12,11                                                                               |                             |
|                                                                                   | 400                                                                               | 390                                                                               | 410                                                                               | 41,07                        | 24,91                       | 185                                                                               | 205                                                                                | 19,48                                                                               | 12,73                                                                               |                             |
|                                                                                   | 440                                                                               | 430                                                                               | 450                                                                               | 45,28                        | 27,20                       | 205                                                                               | 225                                                                                | 21,59                                                                               | 13,96                                                                               |                             |
|                                                                                   | 480                                                                               | 470                                                                               | 490                                                                               | 49,49                        | 29,47                       | 225                                                                               | 245                                                                                | 23,69                                                                               | 15,18                                                                               |                             |
|                                                                                   | 520                                                                               | 510                                                                               | 530                                                                               | 53,70                        | 31,71                       | 245                                                                               | 265                                                                                | 25,80                                                                               | 16,39                                                                               |                             |
|                                                                                   | 560                                                                               | 550                                                                               | 570                                                                               | 57,92                        | 33,94                       | 265                                                                               | 285                                                                                | 27,90                                                                               | 17,59                                                                               |                             |
|                                                                                   | 600                                                                               | 590                                                                               | 610                                                                               | 62,13                        | 36,16                       | 285                                                                               | 305                                                                                | 30,01                                                                               | 18,78                                                                               |                             |

|                                                                                   |           | TENSION                                                                           |              |                                                                                   |                 |                                                                                   |              |                                                                                    |                 |                                                                                     |
|-----------------------------------------------------------------------------------|-----------|-----------------------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| geometry                                                                          |           | total thread withdrawal                                                           |              |                                                                                   |                 | partial thread withdrawal                                                         |              |                                                                                    |                 | steel tension                                                                       |
|                                                                                   |           | lateral                                                                           |              | narrow                                                                            |                 | lateral                                                                           |              | narrow                                                                             |                 |                                                                                     |
|  |           |  |              |  |                 |  |              |  |                 |  |
| d1<br>[mm]                                                                        | L<br>[mm] | Sg,tot<br>[mm]                                                                    | Amin<br>[mm] | Rax,90,k<br>[kN]                                                                  | Rax,0,k<br>[kN] | Sg<br>[mm]                                                                        | Amin<br>[mm] | Rax,90,k<br>[kN]                                                                   | Rax,0,k<br>[kN] | Rtens,k<br>[kN]                                                                     |
| 11                                                                                | 150       | 140                                                                               | 160          | 18,02                                                                             | 11,63           | 60                                                                                | 80           | 7,72                                                                               | 5,43            | 38,00                                                                               |
|                                                                                   | 200       | 190                                                                               | 210          | 24,45                                                                             | 15,31           | 85                                                                                | 105          | 10,94                                                                              | 7,42            |                                                                                     |
|                                                                                   | 250       | 240                                                                               | 260          | 30,89                                                                             | 18,89           | 110                                                                               | 130          | 14,16                                                                              | 9,36            |                                                                                     |
|                                                                                   | 275       | 265                                                                               | 285          | 34,11                                                                             | 20,66           | 123                                                                               | 143          | 15,77                                                                              | 10,31           |                                                                                     |
|                                                                                   | 300       | 290                                                                               | 310          | 37,32                                                                             | 22,40           | 135                                                                               | 155          | 17,37                                                                              | 11,26           |                                                                                     |
|                                                                                   | 325       | 315                                                                               | 335          | 40,54                                                                             | 24,13           | 148                                                                               | 168          | 18,98                                                                              | 12,19           |                                                                                     |
|                                                                                   | 350       | 340                                                                               | 360          | 43,76                                                                             | 25,85           | 160                                                                               | 180          | 20,59                                                                              | 13,12           |                                                                                     |
|                                                                                   | 375       | 365                                                                               | 385          | 46,98                                                                             | 27,56           | 173                                                                               | 193          | 22,20                                                                              | 14,04           |                                                                                     |
|                                                                                   | 400       | 390                                                                               | 410          | 50,19                                                                             | 29,25           | 185                                                                               | 205          | 23,81                                                                              | 14,95           |                                                                                     |
|                                                                                   | 425       | 415                                                                               | 435          | 53,41                                                                             | 30,93           | 198                                                                               | 218          | 25,42                                                                              | 15,85           |                                                                                     |
|                                                                                   | 450       | 440                                                                               | 460          | 56,63                                                                             | 32,60           | 210                                                                               | 230          | 27,03                                                                              | 16,75           |                                                                                     |
|                                                                                   | 475       | 465                                                                               | 485          | 59,85                                                                             | 34,27           | 223                                                                               | 243          | 28,64                                                                              | 17,65           |                                                                                     |
|                                                                                   | 500       | 490                                                                               | 510          | 63,06                                                                             | 35,92           | 235                                                                               | 255          | 30,24                                                                              | 18,54           |                                                                                     |
|                                                                                   | 525       | 515                                                                               | 535          | 66,28                                                                             | 37,56           | 248                                                                               | 268          | 31,85                                                                              | 19,43           |                                                                                     |
|                                                                                   | 550       | 540                                                                               | 560          | 69,50                                                                             | 39,20           | 260                                                                               | 280          | 33,46                                                                              | 20,31           |                                                                                     |
|                                                                                   | 575       | 565                                                                               | 585          | 72,72                                                                             | 40,83           | 273                                                                               | 293          | 35,07                                                                              | 21,18           |                                                                                     |
|                                                                                   | 600       | 590                                                                               | 610          | 75,93                                                                             | 42,45           | 285                                                                               | 305          | 36,68                                                                              | 22,05           |                                                                                     |
|                                                                                   | 650       | 640                                                                               | 660          | 82,37                                                                             | 45,68           | 310                                                                               | 330          | 39,90                                                                              | 23,79           |                                                                                     |
|                                                                                   | 700       | 690                                                                               | 710          | 88,80                                                                             | 48,88           | 335                                                                               | 355          | 43,11                                                                              | 25,51           |                                                                                     |
|                                                                                   | 750       | 740                                                                               | 760          | 95,24                                                                             | 52,05           | 360                                                                               | 380          | 46,33                                                                              | 27,22           |                                                                                     |
|                                                                                   | 800       | 790                                                                               | 810          | 101,67                                                                            | 55,21           | 385                                                                               | 405          | 49,55                                                                              | 28,91           |                                                                                     |
|                                                                                   | 850       | 840                                                                               | 860          | 108,11                                                                            | 58,34           | 410                                                                               | 430          | 52,77                                                                              | 30,59           |                                                                                     |
|                                                                                   | 900       | 890                                                                               | 910          | 114,54                                                                            | 61,46           | 435                                                                               | 455          | 55,98                                                                              | 32,27           |                                                                                     |
|                                                                                   | 950       | 940                                                                               | 960          | 120,98                                                                            | 64,56           | 460                                                                               | 480          | 59,20                                                                              | 33,93           |                                                                                     |
|                                                                                   | 1000      | 990                                                                               | 1010         | 127,41                                                                            | 67,64           | 485                                                                               | 505          | 62,42                                                                              | 35,59           |                                                                                     |



|                                                                                   |      |                | SLIDING                                                                           |                  |                           |                                                                                   |                  |                        |                                                                                     |                  |                  |                        |
|-----------------------------------------------------------------------------------|------|----------------|-----------------------------------------------------------------------------------|------------------|---------------------------|-----------------------------------------------------------------------------------|------------------|------------------------|-------------------------------------------------------------------------------------|------------------|------------------|------------------------|
| geometry                                                                          |      |                | CLT - CLT 45° + 45°                                                               |                  |                           | CLT - CLT                                                                         |                  |                        | CLT - timber                                                                        |                  |                  |                        |
|  |      |                |  |                  |                           |  |                  |                        |  |                  |                  |                        |
| d <sub>1</sub>                                                                    | L    | S <sub>g</sub> | A <sub>min</sub>                                                                  | R <sub>V,k</sub> | R <sub>tens,45+45,k</sub> | A                                                                                 | R <sub>V,k</sub> | R <sub>tens,45,k</sub> | A                                                                                   | H <sub>min</sub> | R <sub>V,k</sub> | R <sub>tens,45,k</sub> |
| [mm]                                                                              | [mm] | [mm]           | [mm]                                                                              | [kN]             | [kN]                      | [mm]                                                                              | [kN]             | [kN]                   | [mm]                                                                                | [mm]             | [kN]             | [kN]                   |
| 7                                                                                 | 80   | 25             | 65                                                                                | 0,86             | 7,70                      | 35                                                                                | 1,22             | 10,89                  | 35                                                                                  | 50               | 1,45             | 10,89                  |
|                                                                                   | 100  | 35             | 80                                                                                | 1,16             |                           | 40                                                                                | 1,65             |                        | 40                                                                                  | 55               | 2,03             |                        |
|                                                                                   | 120  | 45             | 95                                                                                | 1,46             |                           | 45                                                                                | 2,06             |                        | 45                                                                                  | 60               | 2,61             |                        |
|                                                                                   | 140  | 55             | 110                                                                               | 1,75             |                           | 55                                                                                | 2,47             |                        | 55                                                                                  | 70               | 3,19             |                        |
|                                                                                   | 160  | 65             | 125                                                                               | 2,03             |                           | 60                                                                                | 2,87             |                        | 60                                                                                  | 75               | 3,76             |                        |
|                                                                                   | 180  | 75             | 135                                                                               | 2,31             |                           | 70                                                                                | 3,27             |                        | 70                                                                                  | 85               | 4,34             |                        |
|                                                                                   | 200  | 85             | 150                                                                               | 2,59             |                           | 75                                                                                | 3,66             |                        | 75                                                                                  | 90               | 4,92             |                        |
|                                                                                   | 220  | 95             | 165                                                                               | 2,86             |                           | 85                                                                                | 4,04             |                        | 85                                                                                  | 100              | 5,50             |                        |
|                                                                                   | 240  | 105            | 180                                                                               | 3,13             |                           | 90                                                                                | 4,42             |                        | 90                                                                                  | 105              | 6,08             |                        |
|                                                                                   | 260  | 115            | 195                                                                               | 3,39             |                           | 95                                                                                | 4,80             |                        | 95                                                                                  | 110              | 6,66             |                        |
|                                                                                   | 280  | 125            | 210                                                                               | 3,66             |                           | 105                                                                               | 5,17             |                        | 105                                                                                 | 120              | 7,24             |                        |
|                                                                                   | 300  | 135            | 220                                                                               | 3,92             |                           | 110                                                                               | 5,54             |                        | 110                                                                                 | 125              | 7,82             |                        |
|                                                                                   | 320  | 145            | 235                                                                               | 4,18             |                           | 120                                                                               | 5,91             |                        | 120                                                                                 | 135              | 8,40             |                        |
|                                                                                   | 340  | 155            | 250                                                                               | 4,44             |                           | 125                                                                               | 6,28             |                        | 125                                                                                 | 140              | 8,98             |                        |
|                                                                                   | 360  | 165            | 265                                                                               | 4,70             |                           | 130                                                                               | 6,64             |                        | 130                                                                                 | 145              | 9,56             |                        |
|                                                                                   | 380  | 175            | 280                                                                               | 4,95             |                           | 140                                                                               | 7,00             |                        | 140                                                                                 | 155              | 10,13            |                        |
|                                                                                   | 400  | 185            | 295                                                                               | 5,21             |                           | 145                                                                               | 7,36             |                        | 145                                                                                 | 160              | 10,71            |                        |
| 9                                                                                 | 160  | 65             | 125                                                                               | 2,48             | 12,70                     | 60                                                                                | 3,51             | 17,96                  | 60                                                                                  | 75               | 4,84             | 17,96                  |
|                                                                                   | 180  | 75             | 135                                                                               | 2,82             |                           | 70                                                                                | 3,99             |                        | 70                                                                                  | 85               | 5,58             |                        |
|                                                                                   | 200  | 85             | 150                                                                               | 3,16             |                           | 75                                                                                | 4,47             |                        | 75                                                                                  | 90               | 6,33             |                        |
|                                                                                   | 220  | 95             | 165                                                                               | 3,49             |                           | 85                                                                                | 4,94             |                        | 85                                                                                  | 100              | 7,07             |                        |
|                                                                                   | 240  | 105            | 180                                                                               | 3,82             |                           | 90                                                                                | 5,41             |                        | 90                                                                                  | 105              | 7,82             |                        |
|                                                                                   | 260  | 115            | 195                                                                               | 4,15             |                           | 95                                                                                | 5,87             |                        | 95                                                                                  | 110              | 8,56             |                        |
|                                                                                   | 280  | 125            | 210                                                                               | 4,47             |                           | 105                                                                               | 6,33             |                        | 105                                                                                 | 120              | 9,31             |                        |
|                                                                                   | 300  | 135            | 220                                                                               | 4,79             |                           | 110                                                                               | 6,78             |                        | 110                                                                                 | 125              | 10,05            |                        |
|                                                                                   | 320  | 145            | 235                                                                               | 5,11             |                           | 120                                                                               | 7,23             |                        | 120                                                                                 | 135              | 10,80            |                        |
|                                                                                   | 340  | 155            | 250                                                                               | 5,43             |                           | 125                                                                               | 7,68             |                        | 125                                                                                 | 140              | 11,54            |                        |
|                                                                                   | 360  | 165            | 265                                                                               | 5,74             |                           | 130                                                                               | 8,12             |                        | 130                                                                                 | 145              | 12,29            |                        |
|                                                                                   | 380  | 175            | 280                                                                               | 6,06             |                           | 140                                                                               | 8,56             |                        | 140                                                                                 | 155              | 13,03            |                        |
|                                                                                   | 400  | 185            | 295                                                                               | 6,37             |                           | 145                                                                               | 9,00             |                        | 145                                                                                 | 160              | 13,77            |                        |
|                                                                                   | 440  | 205            | 320                                                                               | 6,98             |                           | 160                                                                               | 9,87             |                        | 160                                                                                 | 175              | 15,26            |                        |
|                                                                                   | 480  | 225            | 350                                                                               | 7,59             |                           | 175                                                                               | 10,74            |                        | 175                                                                                 | 190              | 16,75            |                        |
|                                                                                   | 520  | 245            | 380                                                                               | 8,20             |                           | 190                                                                               | 11,59            |                        | 190                                                                                 | 205              | 18,24            |                        |
|                                                                                   | 560  | 265            | 405                                                                               | 8,80             |                           | 205                                                                               | 12,44            |                        | 205                                                                                 | 220              | 19,73            |                        |
|                                                                                   | 600  | 285            | 435                                                                               | 9,39             |                           | 215                                                                               | 13,28            |                        | 215                                                                                 | 230              | 21,22            |                        |

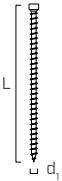
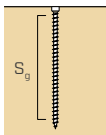
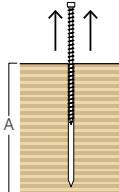
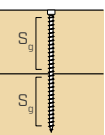
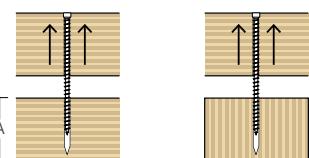
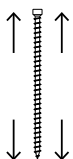
|                                                                                   |      | SLIDING                                                                           |           |           |                    |                                                                                   |           |                 |      |                                                                                     |           |                 |  |
|-----------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------|-----------|-----------|--------------------|-----------------------------------------------------------------------------------|-----------|-----------------|------|-------------------------------------------------------------------------------------|-----------|-----------------|--|
| geometry                                                                          |      | CLT - CLT 45° + 45°                                                               |           |           |                    | CLT - CLT                                                                         |           |                 |      | CLT - timber                                                                        |           |                 |  |
|  |      |  |           |           |                    |  |           |                 |      |  |           |                 |  |
| $d_1$                                                                             | L    | $S_g$                                                                             | $A_{min}$ | $R_{V,k}$ | $R_{tens,45+45,k}$ | A                                                                                 | $R_{V,k}$ | $R_{tens,45,k}$ | A    | $H_{min}$                                                                           | $R_{V,k}$ | $R_{tens,45,k}$ |  |
| [mm]                                                                              | [mm] | [mm]                                                                              | [mm]      | [kN]      | [kN]               | [mm]                                                                              | [kN]      | [kN]            | [mm] | [mm]                                                                                | [kN]      | [kN]            |  |
| 11                                                                                | 150  | 60                                                                                | 115       | 2,71      | 19,00              | 60                                                                                | 3,84      | 26,87           | 60   | 75                                                                                  | 5,46      | 26,87           |  |
|                                                                                   | 200  | 85                                                                                | 150       | 3,71      |                    | 75                                                                                | 5,25      |                 | 75   | 90                                                                                  | 7,74      |                 |  |
|                                                                                   | 250  | 110                                                                               | 185       | 4,68      |                    | 95                                                                                | 6,62      |                 | 95   | 110                                                                                 | 10,01     |                 |  |
|                                                                                   | 275  | 123                                                                               | 205       | 5,16      |                    | 100                                                                               | 7,29      |                 | 100  | 115                                                                                 | 11,15     |                 |  |
|                                                                                   | 300  | 135                                                                               | 220       | 5,63      |                    | 110                                                                               | 7,96      |                 | 110  | 125                                                                                 | 12,29     |                 |  |
|                                                                                   | 325  | 148                                                                               | 240       | 6,10      |                    | 120                                                                               | 8,62      |                 | 120  | 135                                                                                 | 13,42     |                 |  |
|                                                                                   | 350  | 160                                                                               | 255       | 6,56      |                    | 130                                                                               | 9,28      |                 | 130  | 145                                                                                 | 14,56     |                 |  |
|                                                                                   | 375  | 173                                                                               | 275       | 7,02      |                    | 140                                                                               | 9,93      |                 | 140  | 155                                                                                 | 15,70     |                 |  |
|                                                                                   | 400  | 185                                                                               | 295       | 7,47      |                    | 145                                                                               | 10,57     |                 | 145  | 160                                                                                 | 16,84     |                 |  |
|                                                                                   | 425  | 198                                                                               | 310       | 7,93      |                    | 155                                                                               | 11,21     |                 | 155  | 170                                                                                 | 17,97     |                 |  |
|                                                                                   | 450  | 210                                                                               | 330       | 8,38      |                    | 165                                                                               | 11,85     |                 | 165  | 180                                                                                 | 19,11     |                 |  |
|                                                                                   | 475  | 223                                                                               | 345       | 8,82      |                    | 175                                                                               | 12,48     |                 | 175  | 190                                                                                 | 20,25     |                 |  |
|                                                                                   | 500  | 235                                                                               | 365       | 9,27      |                    | 180                                                                               | 13,11     |                 | 180  | 195                                                                                 | 21,39     |                 |  |
|                                                                                   | 525  | 248                                                                               | 380       | 9,71      |                    | 190                                                                               | 13,74     |                 | 190  | 205                                                                                 | 22,52     |                 |  |
|                                                                                   | 550  | 260                                                                               | 400       | 10,15     |                    | 200                                                                               | 14,36     |                 | 200  | 215                                                                                 | 23,66     |                 |  |
|                                                                                   | 575  | 273                                                                               | 415       | 10,59     |                    | 210                                                                               | 14,98     |                 | 210  | 225                                                                                 | 24,80     |                 |  |
|                                                                                   | 600  | 285                                                                               | 435       | 11,03     |                    | 215                                                                               | 15,60     |                 | 215  | 230                                                                                 | 25,94     |                 |  |
|                                                                                   | 650  | 310                                                                               | 470       | 11,89     |                    | 235                                                                               | 16,82     |                 | 235  | 250                                                                                 | 28,21     |                 |  |
|                                                                                   | 700  | 335                                                                               | 505       | 12,75     |                    | 250                                                                               | 18,04     |                 | 250  | 265                                                                                 | 30,49     |                 |  |
|                                                                                   | 750  | 360                                                                               | 540       | 13,61     |                    | 270                                                                               | 19,24     |                 | 270  | 285                                                                                 | 32,76     |                 |  |
|                                                                                   | 800  | 385                                                                               | 575       | 14,46     |                    | 290                                                                               | 20,44     |                 | 290  | 305                                                                                 | 35,04     |                 |  |
|                                                                                   | 850  | 410                                                                               | 610       | 15,30     |                    | 305                                                                               | 21,63     |                 | 305  | 320                                                                                 | 37,31     |                 |  |
|                                                                                   | 900  | 435                                                                               | 645       | 16,13     |                    | 325                                                                               | 22,82     |                 | 325  | 340                                                                                 | 39,59     |                 |  |
|                                                                                   | 950  | 460                                                                               | 680       | 16,97     |                    | 340                                                                               | 23,99     |                 | 340  | 355                                                                                 | 41,86     |                 |  |
|                                                                                   | 1000 | 485                                                                               | 715       | 17,79     |                    | 360                                                                               | 25,16     |                 | 360  | 375                                                                                 | 44,14     |                 |  |

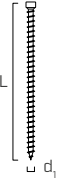
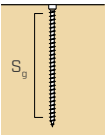
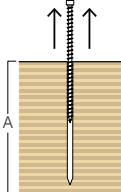
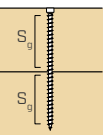
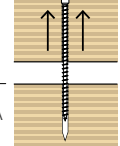
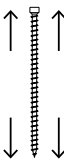
## NOTES | CLT

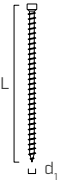
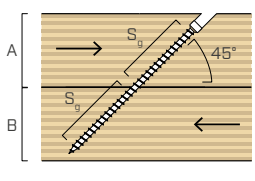
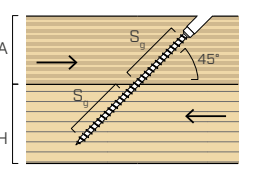
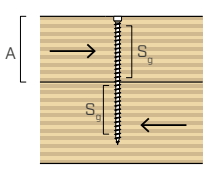
- The characteristic values are according to the national specifications ÖNORM EN 1995 - Annex K.
- For the calculation process, a mass density of  $\rho_k = 350 \text{ kg/m}^3$  has been considered for CLT elements and a mass density of  $\rho_k = 385 \text{ kg/m}^3$  has been considered for timber elements.
- The axial thread withdrawal resistance in the narrow face is valid for minimum CLT thickness  $t_{CLT,min} = 10 \cdot d_1$  and minimum screw pull-through depth  $t_{pen} = 10 \cdot d_1$ .
- The characteristic sliding strengths of the connectors inserted in the lateral face of the CLT panel were evaluated considering an angle  $\varepsilon$  of 45° between the grains and the connector, since it was not possible to define the thickness and orientation of the individual layers in advance.

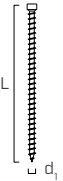
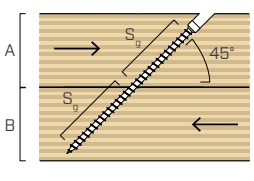
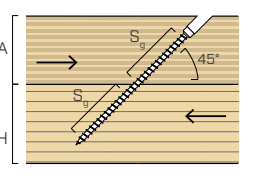
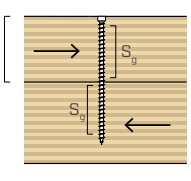
- The characteristic sliding strengths of the connectors inserted with double inclination (45°-45°) were evaluated considering an  $\varepsilon$  angle of 60° between the grains and the connector; in fact, the geometry of the joint requires that the connectors have to be inserted at an angle of 45° with respect to the face of the CLT panel and at an angle of 45° with respect to the shear plane between the two panels.  
The use of the JIG VGZ 45 template is recommended for professional installation of the connectors in this application.
- Connectors instability must be verified separately.

GENERAL PRINCIPLES on page 143.

| TENSION                                                                           |           |                                                                                   |                          |                                                                                   |                             |                                                                                   |                          |                                                                                    |                             |                                                                                     |
|-----------------------------------------------------------------------------------|-----------|-----------------------------------------------------------------------------------|--------------------------|-----------------------------------------------------------------------------------|-----------------------------|-----------------------------------------------------------------------------------|--------------------------|------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------|
| geometry                                                                          |           | total thread withdrawal                                                           |                          |                                                                                   |                             | partial thread withdrawal                                                         |                          |                                                                                    |                             | steel tension                                                                       |
|                                                                                   |           | wide                                                                              |                          | edge                                                                              |                             | wide                                                                              |                          | edge                                                                               |                             |                                                                                     |
|  |           |  |                          |  |                             |  |                          |  |                             |  |
| d <sub>1</sub><br>[mm]                                                            | L<br>[mm] | S <sub>g,tot</sub><br>[mm]                                                        | A <sub>min</sub><br>[mm] | R <sub>ax,90,k</sub><br>[kN]                                                      | R <sub>ax,0,k</sub><br>[kN] | S <sub>g</sub><br>[mm]                                                            | A <sub>min</sub><br>[mm] | R <sub>ax,90,k</sub><br>[kN]                                                       | R <sub>ax,0,k</sub><br>[kN] | R <sub>tens,k</sub><br>[kN]                                                         |
| 7                                                                                 | 80        | 70                                                                                | 90                       | 7,11                                                                              | 4,74                        | -                                                                                 | -                        | -                                                                                  | -                           | 15,40                                                                               |
|                                                                                   | 100       | 90                                                                                | 110                      | 9,15                                                                              | 5,44                        | 35                                                                                | 55                       | 3,56                                                                               | 2,37                        |                                                                                     |
|                                                                                   | 120       | 110                                                                               | 130                      | 11,18                                                                             | 6,52                        | 45                                                                                | 65                       | 4,57                                                                               | 3,05                        |                                                                                     |
|                                                                                   | 140       | 130                                                                               | 150                      | 13,21                                                                             | 7,58                        | 55                                                                                | 75                       | 5,59                                                                               | 3,73                        |                                                                                     |
|                                                                                   | 160       | 150                                                                               | 170                      | 15,24                                                                             | 8,62                        | 65                                                                                | 85                       | 6,61                                                                               | 4,40                        |                                                                                     |
|                                                                                   | 180       | 170                                                                               | 190                      | 17,28                                                                             | 9,65                        | 75                                                                                | 95                       | 7,62                                                                               | 5,08                        |                                                                                     |
|                                                                                   | 200       | 190                                                                               | 210                      | 19,31                                                                             | 10,67                       | 85                                                                                | 105                      | 8,64                                                                               | 5,76                        |                                                                                     |
|                                                                                   | 220       | 210                                                                               | 230                      | 21,34                                                                             | 11,67                       | 95                                                                                | 115                      | 9,65                                                                               | 6,44                        |                                                                                     |
|                                                                                   | 240       | 230                                                                               | 250                      | 23,37                                                                             | 12,67                       | 105                                                                               | 125                      | 10,67                                                                              | 7,11                        |                                                                                     |
|                                                                                   | 260       | 250                                                                               | 270                      | 25,41                                                                             | 13,65                       | 115                                                                               | 135                      | 11,69                                                                              | 7,79                        |                                                                                     |
|                                                                                   | 280       | 270                                                                               | 290                      | 27,44                                                                             | 14,63                       | 125                                                                               | 145                      | 12,70                                                                              | 8,47                        |                                                                                     |
|                                                                                   | 300       | 290                                                                               | 310                      | 29,47                                                                             | 15,61                       | 135                                                                               | 155                      | 13,72                                                                              | 9,15                        |                                                                                     |
|                                                                                   | 320       | 310                                                                               | 330                      | 31,50                                                                             | 16,57                       | 145                                                                               | 165                      | 14,74                                                                              | 9,82                        |                                                                                     |
|                                                                                   | 340       | 330                                                                               | 350                      | 33,54                                                                             | 17,53                       | 155                                                                               | 175                      | 15,75                                                                              | 10,50                       |                                                                                     |
|                                                                                   | 360       | 350                                                                               | 370                      | 35,57                                                                             | 18,48                       | 165                                                                               | 185                      | 16,77                                                                              | 11,18                       |                                                                                     |
|                                                                                   | 380       | 370                                                                               | 390                      | 37,60                                                                             | 19,43                       | 175                                                                               | 195                      | 17,78                                                                              | 11,86                       |                                                                                     |
|                                                                                   | 400       | 390                                                                               | 410                      | 39,63                                                                             | 20,37                       | 185                                                                               | 205                      | 18,80                                                                              | 12,53                       |                                                                                     |
| 9                                                                                 | 160       | 150                                                                               | 170                      | 19,60                                                                             | 10,54                       | 65                                                                                | 85                       | 8,49                                                                               | 5,66                        | 25,40                                                                               |
|                                                                                   | 180       | 170                                                                               | 190                      | 22,21                                                                             | 11,80                       | 75                                                                                | 95                       | 9,80                                                                               | 6,53                        |                                                                                     |
|                                                                                   | 200       | 190                                                                               | 210                      | 24,83                                                                             | 13,04                       | 85                                                                                | 105                      | 11,11                                                                              | 7,40                        |                                                                                     |
|                                                                                   | 220       | 210                                                                               | 230                      | 27,44                                                                             | 14,27                       | 95                                                                                | 115                      | 12,41                                                                              | 8,28                        |                                                                                     |
|                                                                                   | 240       | 230                                                                               | 250                      | 30,05                                                                             | 15,49                       | 105                                                                               | 125                      | 13,72                                                                              | 9,15                        |                                                                                     |
|                                                                                   | 260       | 250                                                                               | 270                      | 32,67                                                                             | 16,69                       | 115                                                                               | 135                      | 15,03                                                                              | 10,02                       |                                                                                     |
|                                                                                   | 280       | 270                                                                               | 290                      | 35,28                                                                             | 17,89                       | 125                                                                               | 145                      | 16,33                                                                              | 10,89                       |                                                                                     |
|                                                                                   | 300       | 290                                                                               | 310                      | 37,89                                                                             | 19,08                       | 135                                                                               | 155                      | 17,64                                                                              | 11,76                       |                                                                                     |
|                                                                                   | 320       | 310                                                                               | 330                      | 40,51                                                                             | 20,26                       | 145                                                                               | 165                      | 18,95                                                                              | 12,63                       |                                                                                     |
|                                                                                   | 340       | 330                                                                               | 350                      | 43,12                                                                             | 21,43                       | 155                                                                               | 175                      | 20,25                                                                              | 13,50                       |                                                                                     |
|                                                                                   | 360       | 350                                                                               | 370                      | 45,73                                                                             | 22,60                       | 165                                                                               | 185                      | 21,56                                                                              | 14,37                       |                                                                                     |
|                                                                                   | 380       | 370                                                                               | 390                      | 48,35                                                                             | 23,76                       | 175                                                                               | 195                      | 22,87                                                                              | 15,24                       |                                                                                     |
|                                                                                   | 400       | 390                                                                               | 410                      | 50,96                                                                             | 24,91                       | 185                                                                               | 205                      | 24,17                                                                              | 16,12                       |                                                                                     |
|                                                                                   | 440       | 430                                                                               | 450                      | 56,18                                                                             | 27,20                       | 205                                                                               | 225                      | 26,79                                                                              | 17,86                       |                                                                                     |
|                                                                                   | 480       | 470                                                                               | 490                      | 61,41                                                                             | 29,47                       | 225                                                                               | 245                      | 29,40                                                                              | 19,60                       |                                                                                     |
|                                                                                   | 520       | 510                                                                               | 530                      | 66,64                                                                             | 31,71                       | 245                                                                               | 265                      | 32,01                                                                              | 21,34                       |                                                                                     |
|                                                                                   | 560       | 550                                                                               | 570                      | 71,86                                                                             | 33,94                       | 265                                                                               | 285                      | 34,63                                                                              | 23,08                       |                                                                                     |
|                                                                                   | 600       | 590                                                                               | 610                      | 77,09                                                                             | 36,16                       | 285                                                                               | 305                      | 37,24                                                                              | 24,83                       |                                                                                     |

| TENSION                                                                           |           |                                                                                   |                   |                                                                                   |                      |                                                                                   |                   |                                                                                    |                      |                                                                                     |
|-----------------------------------------------------------------------------------|-----------|-----------------------------------------------------------------------------------|-------------------|-----------------------------------------------------------------------------------|----------------------|-----------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------|----------------------|-------------------------------------------------------------------------------------|
| geometry                                                                          |           | total thread withdrawal                                                           |                   |                                                                                   |                      | partial thread withdrawal                                                         |                   |                                                                                    |                      | steel tension                                                                       |
|                                                                                   |           | wide                                                                              |                   | edge                                                                              |                      | wide                                                                              |                   | edge                                                                               |                      |                                                                                     |
|  |           |  |                   |  |                      |  |                   |  |                      |  |
| $d_1$<br>[mm]                                                                     | L<br>[mm] | $S_{g,tot}$<br>[mm]                                                               | $A_{min}$<br>[mm] | $R_{ax,90,k}$<br>[kN]                                                             | $R_{ax,0,k}$<br>[kN] | $S_g$<br>[mm]                                                                     | $A_{min}$<br>[mm] | $R_{ax,90,k}$<br>[kN]                                                              | $R_{ax,0,k}$<br>[kN] | $R_{tens,k}$<br>[kN]                                                                |
| 11                                                                                | 150       | 140                                                                               | 160               | 22,36                                                                             | 11,63                | 60                                                                                | 80                | 9,58                                                                               | 6,39                 | 38,00                                                                               |
|                                                                                   | 200       | 190                                                                               | 210               | 30,34                                                                             | 15,31                | 85                                                                                | 105               | 13,57                                                                              | 9,05                 |                                                                                     |
|                                                                                   | 250       | 240                                                                               | 260               | 38,33                                                                             | 18,89                | 110                                                                               | 130               | 17,57                                                                              | 11,71                |                                                                                     |
|                                                                                   | 275       | 265                                                                               | 285               | 42,32                                                                             | 20,66                | 123                                                                               | 143               | 19,56                                                                              | 13,04                |                                                                                     |
|                                                                                   | 300       | 290                                                                               | 310               | 46,31                                                                             | 22,40                | 135                                                                               | 155               | 21,56                                                                              | 14,37                |                                                                                     |
|                                                                                   | 325       | 315                                                                               | 335               | 50,31                                                                             | 24,13                | 148                                                                               | 168               | 23,56                                                                              | 15,70                |                                                                                     |
|                                                                                   | 350       | 340                                                                               | 360               | 54,30                                                                             | 25,85                | 160                                                                               | 180               | 25,55                                                                              | 17,03                |                                                                                     |
|                                                                                   | 375       | 365                                                                               | 385               | 58,29                                                                             | 27,56                | 173                                                                               | 193               | 27,55                                                                              | 18,37                |                                                                                     |
|                                                                                   | 400       | 390                                                                               | 410               | 62,28                                                                             | 29,25                | 185                                                                               | 205               | 29,54                                                                              | 19,70                |                                                                                     |
|                                                                                   | 425       | 415                                                                               | 435               | 66,27                                                                             | 30,93                | 198                                                                               | 218               | 31,54                                                                              | 21,03                |                                                                                     |
|                                                                                   | 450       | 440                                                                               | 460               | 70,27                                                                             | 32,60                | 210                                                                               | 230               | 33,54                                                                              | 22,36                |                                                                                     |
|                                                                                   | 475       | 465                                                                               | 485               | 74,26                                                                             | 34,27                | 223                                                                               | 243               | 35,53                                                                              | 23,69                |                                                                                     |
|                                                                                   | 500       | 490                                                                               | 510               | 78,25                                                                             | 35,92                | 235                                                                               | 255               | 37,53                                                                              | 25,02                |                                                                                     |
|                                                                                   | 525       | 515                                                                               | 535               | 82,24                                                                             | 37,56                | 248                                                                               | 268               | 39,53                                                                              | 26,35                |                                                                                     |
|                                                                                   | 550       | 540                                                                               | 560               | 86,24                                                                             | 39,20                | 260                                                                               | 280               | 41,52                                                                              | 27,68                |                                                                                     |
|                                                                                   | 575       | 565                                                                               | 585               | 90,23                                                                             | 40,83                | 273                                                                               | 293               | 43,52                                                                              | 29,01                |                                                                                     |
|                                                                                   | 600       | 590                                                                               | 610               | 94,22                                                                             | 42,45                | 285                                                                               | 305               | 45,51                                                                              | 30,34                |                                                                                     |
|                                                                                   | 650       | 640                                                                               | 660               | 102,21                                                                            | 45,68                | 310                                                                               | 330               | 49,51                                                                              | 33,00                |                                                                                     |
|                                                                                   | 700       | 690                                                                               | 710               | 110,19                                                                            | 48,88                | 335                                                                               | 355               | 53,50                                                                              | 35,67                |                                                                                     |
|                                                                                   | 750       | 740                                                                               | 760               | 118,18                                                                            | 52,05                | 360                                                                               | 380               | 57,49                                                                              | 38,33                |                                                                                     |
|                                                                                   | 800       | 790                                                                               | 810               | 126,16                                                                            | 55,21                | 385                                                                               | 405               | 61,48                                                                              | 40,99                |                                                                                     |
|                                                                                   | 850       | 840                                                                               | 860               | 134,15                                                                            | 58,34                | 410                                                                               | 430               | 65,48                                                                              | 43,65                |                                                                                     |
|                                                                                   | 900       | 890                                                                               | 910               | 142,13                                                                            | 61,46                | 435                                                                               | 455               | 69,47                                                                              | 46,31                |                                                                                     |
|                                                                                   | 950       | 940                                                                               | 960               | 150,12                                                                            | 64,56                | 460                                                                               | 480               | 73,46                                                                              | 48,97                |                                                                                     |
|                                                                                   | 1000      | 990                                                                               | 1010              | 158,10                                                                            | 67,64                | 485                                                                               | 505               | 77,45                                                                              | 51,64                |                                                                                     |

|                                                                                   |      | SLIDING        |                                                                                   |                  |                  |                        |                                                                                    |                  |                  |                        | SHEAR                                                                               |                     |
|-----------------------------------------------------------------------------------|------|----------------|-----------------------------------------------------------------------------------|------------------|------------------|------------------------|------------------------------------------------------------------------------------|------------------|------------------|------------------------|-------------------------------------------------------------------------------------|---------------------|
| geometry                                                                          |      |                | LVL-LVL                                                                           |                  |                  |                        | LVL-timber                                                                         |                  |                  |                        | LVL-LVL wide                                                                        |                     |
|  |      |                |  |                  |                  |                        |  |                  |                  |                        |  |                     |
| d <sub>1</sub>                                                                    | L    | S <sub>g</sub> | A                                                                                 | B <sub>min</sub> | R <sub>V,k</sub> | R <sub>tens,45,k</sub> | A                                                                                  | H <sub>min</sub> | R <sub>V,k</sub> | R <sub>tens,45,k</sub> | A                                                                                   | R <sub>V,90,k</sub> |
| [mm]                                                                              | [mm] | [mm]           | [mm]                                                                              | [mm]             | [kN]             | [kN]                   | [mm]                                                                               | [mm]             | [kN]             | [kN]                   | [mm]                                                                                | [kN]                |
| 7                                                                                 | 100  | 35             | 40                                                                                | 55               | 2,01             | 10,89                  | 40                                                                                 | 45               | 2,01             | 10,89                  | 50                                                                                  | 3,29                |
|                                                                                   | 120  | 45             | 45                                                                                | 60               | 2,59             |                        | 45                                                                                 | 50               | 2,59             |                        | 60                                                                                  | 3,55                |
|                                                                                   | 140  | 55             | 55                                                                                | 70               | 3,16             |                        | 55                                                                                 | 60               | 3,16             |                        | 70                                                                                  | 3,80                |
|                                                                                   | 160  | 65             | 60                                                                                | 75               | 3,74             |                        | 60                                                                                 | 65               | 3,74             |                        | 80                                                                                  | 4,05                |
|                                                                                   | 180  | 75             | 70                                                                                | 85               | 4,31             |                        | 70                                                                                 | 75               | 4,31             |                        | 90                                                                                  | 4,31                |
|                                                                                   | 200  | 85             | 75                                                                                | 90               | 4,89             |                        | 75                                                                                 | 80               | 4,89             |                        | 100                                                                                 | 4,56                |
|                                                                                   | 220  | 95             | 85                                                                                | 100              | 5,46             |                        | 85                                                                                 | 90               | 5,46             |                        | 110                                                                                 | 4,81                |
|                                                                                   | 240  | 105            | 90                                                                                | 105              | 6,04             |                        | 90                                                                                 | 95               | 6,04             |                        | 120                                                                                 | 4,81                |
|                                                                                   | 260  | 115            | 95                                                                                | 110              | 6,61             |                        | 95                                                                                 | 100              | 6,61             |                        | 130                                                                                 | 4,81                |
|                                                                                   | 280  | 125            | 105                                                                               | 120              | 7,19             |                        | 105                                                                                | 110              | 7,19             |                        | 140                                                                                 | 4,81                |
|                                                                                   | 300  | 135            | 110                                                                               | 125              | 7,76             |                        | 110                                                                                | 115              | 7,76             |                        | 150                                                                                 | 4,81                |
|                                                                                   | 320  | 145            | 120                                                                               | 135              | 8,34             |                        | 120                                                                                | 125              | 8,34             |                        | 160                                                                                 | 4,81                |
|                                                                                   | 340  | 155            | 125                                                                               | 140              | 8,91             |                        | 125                                                                                | 130              | 8,91             |                        | 170                                                                                 | 4,81                |
|                                                                                   | 360  | 165            | 130                                                                               | 145              | 9,49             |                        | 130                                                                                | 135              | 9,49             |                        | 180                                                                                 | 4,81                |
|                                                                                   | 380  | 175            | 140                                                                               | 155              | 10,06            |                        | 140                                                                                | 145              | 10,06            |                        | 190                                                                                 | 4,81                |
|                                                                                   | 400  | 185            | 145                                                                               | 160              | 10,64            |                        | 145                                                                                | 150              | 10,64            |                        | 200                                                                                 | 4,81                |
| 9                                                                                 | 160  | 65             | 60                                                                                | 75               | 4,80             | 17,96                  | 60                                                                                 | 65               | 4,80             | 17,96                  | 80                                                                                  | 5,75                |
|                                                                                   | 180  | 75             | 70                                                                                | 85               | 5,54             |                        | 70                                                                                 | 75               | 5,54             |                        | 90                                                                                  | 6,08                |
|                                                                                   | 200  | 85             | 75                                                                                | 90               | 6,28             |                        | 75                                                                                 | 80               | 6,28             |                        | 100                                                                                 | 6,41                |
|                                                                                   | 220  | 95             | 85                                                                                | 100              | 7,02             |                        | 85                                                                                 | 90               | 7,02             |                        | 110                                                                                 | 6,73                |
|                                                                                   | 240  | 105            | 90                                                                                | 105              | 7,76             |                        | 90                                                                                 | 95               | 7,76             |                        | 120                                                                                 | 7,06                |
|                                                                                   | 260  | 115            | 95                                                                                | 110              | 8,50             |                        | 95                                                                                 | 100              | 8,50             |                        | 130                                                                                 | 7,26                |
|                                                                                   | 280  | 125            | 105                                                                               | 120              | 9,24             |                        | 105                                                                                | 110              | 9,24             |                        | 140                                                                                 | 7,26                |
|                                                                                   | 300  | 135            | 110                                                                               | 125              | 9,98             |                        | 110                                                                                | 115              | 9,98             |                        | 150                                                                                 | 7,26                |
|                                                                                   | 320  | 145            | 120                                                                               | 135              | 10,72            |                        | 120                                                                                | 125              | 10,72            |                        | 160                                                                                 | 7,26                |
|                                                                                   | 340  | 155            | 125                                                                               | 140              | 11,46            |                        | 125                                                                                | 130              | 11,46            |                        | 170                                                                                 | 7,26                |
|                                                                                   | 360  | 165            | 130                                                                               | 145              | 12,20            |                        | 130                                                                                | 135              | 12,20            |                        | 180                                                                                 | 7,26                |
|                                                                                   | 380  | 175            | 140                                                                               | 155              | 12,93            |                        | 140                                                                                | 145              | 12,93            |                        | 190                                                                                 | 7,26                |
|                                                                                   | 400  | 185            | 145                                                                               | 160              | 13,67            |                        | 145                                                                                | 150              | 13,67            |                        | 200                                                                                 | 7,26                |
|                                                                                   | 440  | 205            | 160                                                                               | 175              | 15,15            |                        | 160                                                                                | 165              | 15,15            |                        | 220                                                                                 | 7,26                |
|                                                                                   | 480  | 225            | 175                                                                               | 190              | 16,63            |                        | 175                                                                                | 180              | 16,63            |                        | 240                                                                                 | 7,26                |
|                                                                                   | 520  | 245            | 190                                                                               | 205              | 18,11            |                        | 190                                                                                | 195              | 18,11            |                        | 260                                                                                 | 7,26                |
|                                                                                   | 560  | 265            | 205                                                                               | 220              | 19,59            |                        | 205                                                                                | 210              | 19,59            |                        | 280                                                                                 | 7,26                |
|                                                                                   | 600  | 285            | 215                                                                               | 230              | 21,07            |                        | 215                                                                                | 220              | 21,07            |                        | 300                                                                                 | 7,26                |

|                                                                                   |      | SLIDING        |                                                                                   |                  |                  |                        |                                                                                    |                  |                  | SHEAR                  |                                                                                     |                     |
|-----------------------------------------------------------------------------------|------|----------------|-----------------------------------------------------------------------------------|------------------|------------------|------------------------|------------------------------------------------------------------------------------|------------------|------------------|------------------------|-------------------------------------------------------------------------------------|---------------------|
| geometry                                                                          |      |                | LVL-LVL                                                                           |                  |                  |                        | LVL-timber                                                                         |                  |                  |                        | LVL-LVL wide                                                                        |                     |
|  |      |                |  |                  |                  |                        |  |                  |                  |                        |  |                     |
| d <sub>1</sub>                                                                    | L    | S <sub>g</sub> | A                                                                                 | B <sub>min</sub> | R <sub>V,k</sub> | R <sub>tens,45,k</sub> | A                                                                                  | H <sub>min</sub> | R <sub>V,k</sub> | R <sub>tens,45,k</sub> | A                                                                                   | R <sub>V,90,k</sub> |
| [mm]                                                                              | [mm] | [mm]           | [mm]                                                                              | [mm]             | [kN]             | [kN]                   | [mm]                                                                               | [mm]             | [kN]             | [kN]                   | [mm]                                                                                | [kN]                |
| 11                                                                                | 150  | 60             | 60                                                                                | 75               | 5,42             | 26,87                  | 60                                                                                 | 65               | 5,42             | 26,87                  | 75                                                                                  | 7,46                |
|                                                                                   | 200  | 85             | 75                                                                                | 90               | 7,68             |                        | 75                                                                                 | 80               | 7,68             |                        | 100                                                                                 | 8,45                |
|                                                                                   | 250  | 110            | 95                                                                                | 110              | 9,94             |                        | 95                                                                                 | 100              | 9,94             |                        | 125                                                                                 | 9,45                |
|                                                                                   | 275  | 123            | 100                                                                               | 115              | 11,07            |                        | 100                                                                                | 105              | 11,07            |                        | 138                                                                                 | 9,95                |
|                                                                                   | 300  | 135            | 110                                                                               | 125              | 12,20            |                        | 110                                                                                | 115              | 12,20            |                        | 150                                                                                 | 10,12               |
|                                                                                   | 325  | 148            | 120                                                                               | 135              | 13,33            |                        | 120                                                                                | 125              | 13,33            |                        | 163                                                                                 | 10,12               |
|                                                                                   | 350  | 160            | 130                                                                               | 145              | 14,45            |                        | 130                                                                                | 135              | 14,45            |                        | 175                                                                                 | 10,12               |
|                                                                                   | 375  | 173            | 140                                                                               | 155              | 15,58            |                        | 140                                                                                | 145              | 15,58            |                        | 188                                                                                 | 10,12               |
|                                                                                   | 400  | 185            | 145                                                                               | 160              | 16,71            |                        | 145                                                                                | 150              | 16,71            |                        | 200                                                                                 | 10,12               |
|                                                                                   | 425  | 198            | 155                                                                               | 170              | 17,84            |                        | 155                                                                                | 160              | 17,84            |                        | 213                                                                                 | 10,12               |
|                                                                                   | 450  | 210            | 165                                                                               | 180              | 18,97            |                        | 165                                                                                | 170              | 18,97            |                        | 225                                                                                 | 10,12               |
|                                                                                   | 475  | 223            | 175                                                                               | 190              | 20,10            |                        | 175                                                                                | 180              | 20,10            |                        | 238                                                                                 | 10,12               |
|                                                                                   | 500  | 235            | 180                                                                               | 195              | 21,23            |                        | 180                                                                                | 185              | 21,23            |                        | 250                                                                                 | 10,12               |
|                                                                                   | 525  | 248            | 190                                                                               | 205              | 22,36            |                        | 190                                                                                | 195              | 22,36            |                        | 263                                                                                 | 10,12               |
|                                                                                   | 550  | 260            | 200                                                                               | 215              | 23,49            |                        | 200                                                                                | 205              | 23,49            |                        | 275                                                                                 | 10,12               |
|                                                                                   | 575  | 273            | 210                                                                               | 225              | 24,62            |                        | 210                                                                                | 215              | 24,62            |                        | 288                                                                                 | 10,12               |
|                                                                                   | 600  | 285            | 215                                                                               | 230              | 25,75            |                        | 215                                                                                | 220              | 25,75            |                        | 300                                                                                 | 10,12               |
|                                                                                   | 650  | 310            | 235                                                                               | 250              | 28,01            |                        | 235                                                                                | 240              | 28,01            |                        | 325                                                                                 | 10,12               |
|                                                                                   | 700  | 335            | 250                                                                               | 265              | 30,26            |                        | 250                                                                                | 255              | 30,26            |                        | 350                                                                                 | 10,12               |
|                                                                                   | 750  | 360            | 270                                                                               | 285              | 32,52            |                        | 270                                                                                | 275              | 32,52            |                        | 375                                                                                 | 10,12               |
|                                                                                   | 800  | 385            | 290                                                                               | 305              | 34,78            |                        | 290                                                                                | 295              | 34,78            |                        | 400                                                                                 | 10,12               |
|                                                                                   | 850  | 410            | 305                                                                               | 320              | 37,04            |                        | 305                                                                                | 310              | 37,04            |                        | 425                                                                                 | 10,12               |
|                                                                                   | 900  | 435            | 325                                                                               | 340              | 39,30            |                        | 325                                                                                | 330              | 39,30            |                        | 450                                                                                 | 10,12               |
|                                                                                   | 950  | 460            | 340                                                                               | 355              | 41,56            |                        | 340                                                                                | 345              | 41,56            |                        | 475                                                                                 | 10,12               |
|                                                                                   | 1000 | 485            | 360                                                                               | 375              | 43,81            |                        | 360                                                                                | 365              | 43,81            |                        | 500                                                                                 | 10,12               |

## NOTES

- For the calculation process, a mass density of  $\rho_k = 480 \text{ kg/m}^3$  has been considered for the softwood LVL elements and a mass density of  $\rho_k = 385 \text{ kg/m}^3$  has been considered for timber elements.
- The axial "wide" thread withdrawal resistance was evaluated considering an angle of  $90^\circ$  between the fibers and the connector and is valid in application with LVLs in both parallel and cross grain veneer beams.
- The axial "edge" thread withdrawal resistance was evaluated considering an angle of  $90^\circ$  between the fibers and the connector and is valid in application with parallel veneer LVLs.
- Minimum height LVL  $h_{LVL,min} = 100 \text{ mm}$  for VGZ connectors  $\varnothing 7$  and  $h_{LVL,min} = 120 \text{ mm}$  for VGZ connectors  $\varnothing 9$ .

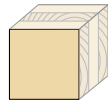
- The characteristic sliding strengths were evaluated by considering, for individual timber elements, a  $45^\circ$  angle between the connector and the grain and a  $45^\circ$  angle between the connector and the side face of the LVL element.
- The characteristic shear strengths were evaluated by considering, for individual timber elements, a  $90^\circ$  angle between the connector and the grain, a  $90^\circ$  angle between the connector and the side face of the LVL element and a  $0^\circ$  angle between the force and the grain.
- Connectors instability must be verified separately.

GENERAL PRINCIPLES on page 143.

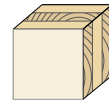


## MINIMUM DISTANCES FOR SHEAR AND AXIAL LOADS | CLT

screws inserted **WITHOUT** pre-drilled hole



lateral face

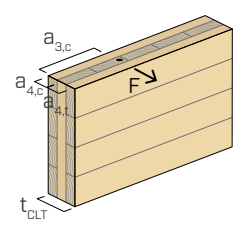
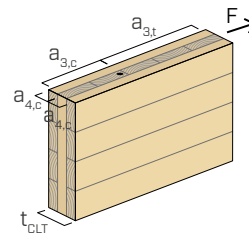
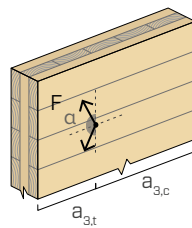
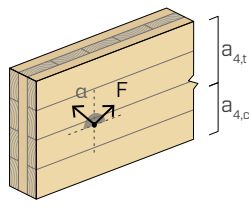
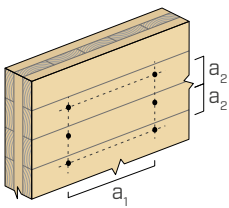


narrow face

| $d_1$ [mm]     |              | 7  | 9  | 11 |
|----------------|--------------|----|----|----|
| $a_1$ [mm]     | <b>4·d</b>   | 28 | 36 | 44 |
| $a_2$ [mm]     | <b>2,5·d</b> | 18 | 23 | 28 |
| $a_{3,t}$ [mm] | <b>6·d</b>   | 42 | 54 | 66 |
| $a_{3,c}$ [mm] | <b>6·d</b>   | 42 | 54 | 66 |
| $a_{4,t}$ [mm] | <b>6·d</b>   | 42 | 54 | 66 |
| $a_{4,c}$ [mm] | <b>2,5·d</b> | 18 | 23 | 28 |

| $d_1$ [mm]     |             | 7  | 9   | 11  |
|----------------|-------------|----|-----|-----|
| $a_1$ [mm]     | <b>10·d</b> | 70 | 90  | 110 |
| $a_2$ [mm]     | <b>4·d</b>  | 28 | 36  | 44  |
| $a_{3,t}$ [mm] | <b>12·d</b> | 84 | 108 | 132 |
| $a_{3,c}$ [mm] | <b>7·d</b>  | 49 | 63  | 77  |
| $a_{4,t}$ [mm] | <b>6·d</b>  | 42 | 54  | 66  |
| $a_{4,c}$ [mm] | <b>3·d</b>  | 21 | 27  | 33  |

$d = d_1$  = nominal screw diameter

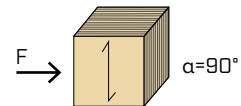
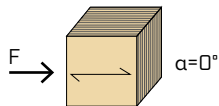


### NOTES

- The minimum distances are compliant with ETA-11/0030 and are to be considered valid unless otherwise specified in the technical documents for the CLT panels.
- Minimum distances are valid for minimum CLT thickness  $t_{CLT,min} = 10 \cdot d_1$ .
- The minimum distances referred to "narrow face" are valid for minimum screw pull-through depth  $t_{pen} = 10 \cdot d_1$ .

## MINIMUM DISTANCES FOR SHEAR LOADS | LVL

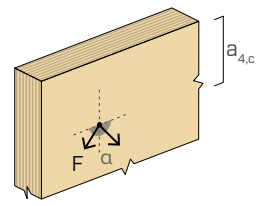
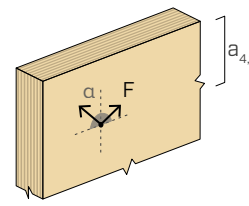
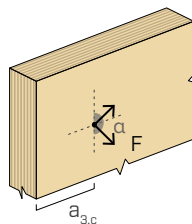
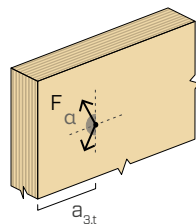
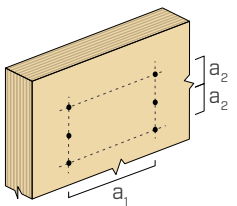
screws inserted **WITHOUT** pre-drilled hole



| $d_1$ [mm]     |             | 7   | 9   | 11  |
|----------------|-------------|-----|-----|-----|
| $a_1$ [mm]     | <b>15·d</b> | 105 | 135 | 165 |
| $a_2$ [mm]     | <b>7·d</b>  | 49  | 63  | 77  |
| $a_{3,t}$ [mm] | <b>20·d</b> | 140 | 180 | 220 |
| $a_{3,c}$ [mm] | <b>15·d</b> | 105 | 135 | 165 |
| $a_{4,t}$ [mm] | <b>7·d</b>  | 49  | 63  | 77  |
| $a_{4,c}$ [mm] | <b>7·d</b>  | 49  | 63  | 77  |

| $d_1$ [mm]     |             | 7   | 9   | 11  |
|----------------|-------------|-----|-----|-----|
| $a_1$ [mm]     | <b>7·d</b>  | 49  | 63  | 77  |
| $a_2$ [mm]     | <b>7·d</b>  | 49  | 63  | 77  |
| $a_{3,t}$ [mm] | <b>15·d</b> | 105 | 135 | 165 |
| $a_{3,c}$ [mm] | <b>15·d</b> | 105 | 135 | 165 |
| $a_{4,t}$ [mm] | <b>12·d</b> | 84  | 108 | 132 |
| $a_{4,c}$ [mm] | <b>7·d</b>  | 49  | 63  | 77  |

$\alpha$  = load-to-grain angle  
 $d = d_1$  = nominal screw diameter



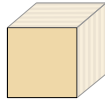
### NOTES

- Minimum distances are obtained from experimental tests carried out at Eurofins Expert Services Oy, Espoo, Finland (Report EUFI29-19000819-T1/T2).

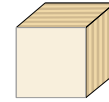
## MINIMUM DISTANCES FOR AXIAL STRESSES | LVL



screws inserted **WITHOUT** pre-drilled hole



wide face



edge face

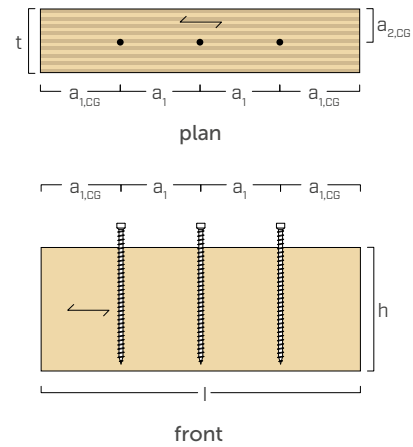
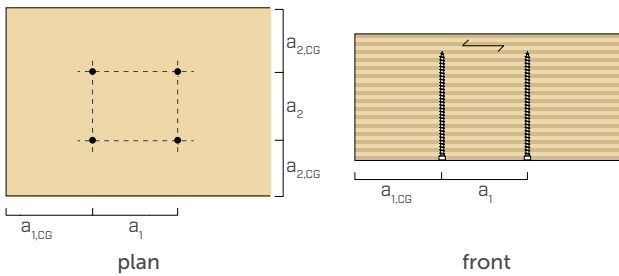
| $d_1$      | [mm] |             | 7  | 9  | 11  |
|------------|------|-------------|----|----|-----|
| $a_1$      | [mm] | <b>5·d</b>  | 35 | 45 | 55  |
| $a_2$      | [mm] | <b>5·d</b>  | 35 | 45 | 55  |
| $a_{1,CG}$ | [mm] | <b>10·d</b> | 70 | 90 | 110 |
| $a_{2,CG}$ | [mm] | <b>4·d</b>  | 28 | 36 | 44  |

$d = d_1 =$  nominal screw diameter

| $d_1$      | [mm] |             | 7  | 9   | 11  |
|------------|------|-------------|----|-----|-----|
| $a_1$      | [mm] | <b>10·d</b> | 70 | 90  | 110 |
| $a_2$      | [mm] | <b>5·d</b>  | 35 | 45  | 55  |
| $a_{1,CG}$ | [mm] | <b>12·d</b> | 84 | 108 | 132 |
| $a_{2,CG}$ | [mm] | <b>3·d</b>  | 21 | 27  | 33  |

SCREWS INSERTED WITH  $\alpha = 90^\circ$  ANGLE WITH RESPECT TO THE GRAIN (wide face)

SCREWS INSERTED WITH  $\alpha = 90^\circ$  ANGLE WITH RESPECT TO THE GRAIN (edge face)



### NOTES

- The minimum distances for Ø7 and Ø9 screws with 3 THORNS bit are compliant with ETA-11/0030 and are to be considered valid unless otherwise specified in the technical documents for the LVL panels. For Ø11 or self-drilling bit screws, the minimum distances are obtained from experimental tests carried out at Eurofins Expert Services Oy, Espoo, Finland (Report EU-FI29-19000819-T1/T2).
- The minimum distances referred to edge face for screws  $d = 7$  mm are valid for minimum thickness LVL  $t_{LVL,min} = 45$  mm and minimum height LVL  $h_{LVL,min} = 100$  mm. The minimum distances referred to edge face for screws  $d = 9$  mm are valid for minimum thickness LVL  $t_{LVL,min} = 57$  mm and minimum height LVL  $h_{LVL,min} = 120$  mm.

## STRUCTURAL VALUES

### GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2014 standard in accordance with ETA-11/0030.
- The tensile design strength of the connector is the lower between the timber-side design strength ( $R_{ax,d}$ ) and the steel-side design strength ( $R_{tens,d}$ ).

$$R_{ax,d} = \min \left\{ \frac{R_{ax,k} \cdot k_{mod}}{\gamma_M}, \frac{R_{tens,k}}{\gamma_{M2}} \right\}$$

- The compression design strength of the connector is the lower between the timber-side design strength ( $R_{ax,d}$ ) and the instability design strength ( $R_{ki,d}$ ).

$$R_{ax,d} = \min \left\{ \frac{R_{ax,k} \cdot k_{mod}}{\gamma_M}, \frac{R_{ki,k}}{\gamma_{M1}} \right\}$$

- The design sliding strength of the joint is either the timber-side design strength ( $R_{V,d}$ ) and the design strength on the steel side projected at  $45^\circ$ . ( $R_{tens,45,d}$ ), whichever is lower:

$$R_{V,d} = \min \left\{ \frac{R_{V,k} \cdot k_{mod}}{\gamma_M}, \frac{R_{tens,45,k}}{\gamma_{M2}} \right\}$$

- The design shear strength of the connector is obtained from the characteristic value as follows:

$$R_{V,d} = \frac{R_{V,k} \cdot k_{mod}}{\gamma_M}$$

- The coefficients  $\gamma_M$  and  $k_{mod}$  should be taken according to the current regulations used for the calculation.
- For the mechanical resistance values and the geometry of the screws, reference was made to ETA-11/0030.
- Dimensioning and verification of the timber elements must be carried out separately.
- The screws must be positioned in accordance with the minimum distances.
- The characteristic thread withdrawal strengths were evaluated considering a penetration length of  $S_{g,tot}$  or  $S_g$ , as shown in the table. For intermediate values of  $S_g$  it is possible to linearly interpolate. A minimum penetration length of  $4 \cdot d_1$  is considered.
- The shear strength and sliding values were evaluated considering the centre of gravity of the connector placed in correspondence with the shear plane.
- The characteristic shear resistances are calculated for screws inserted without pre-drilling hole. In the case of screws inserted with pre-drilling hole, greater resistance values can be obtained.
- For different calculation configurations, the MyProject software is available ([www.rothoblaas.com](http://www.rothoblaas.com)).