

### INTEGRATED WASHER

The flange head serves as a washer and ensures high head strength and pull-through. Ideal in the presence of wind or variations in timber dimensions.

### 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.

### NEW-GENERATION WOODS

Tested and certified for use on a wide variety of engineered timbers such as CLT, GL, LVL, OSB and Beech LVL.

Extremely versatile, the TBS screw guarantees the use of new-generation woods for the creation of increasingly innovative and sustainable structures.

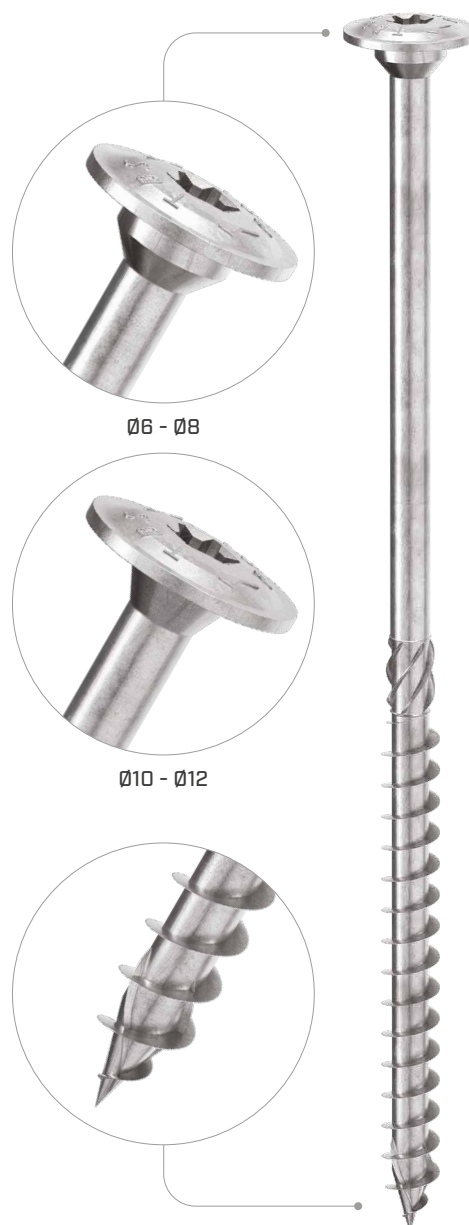
### FAST

With the 3 THORNS tip, screw grip becomes more reliable and faster, while maintaining the usual mechanical performance.

More speed, less effort.

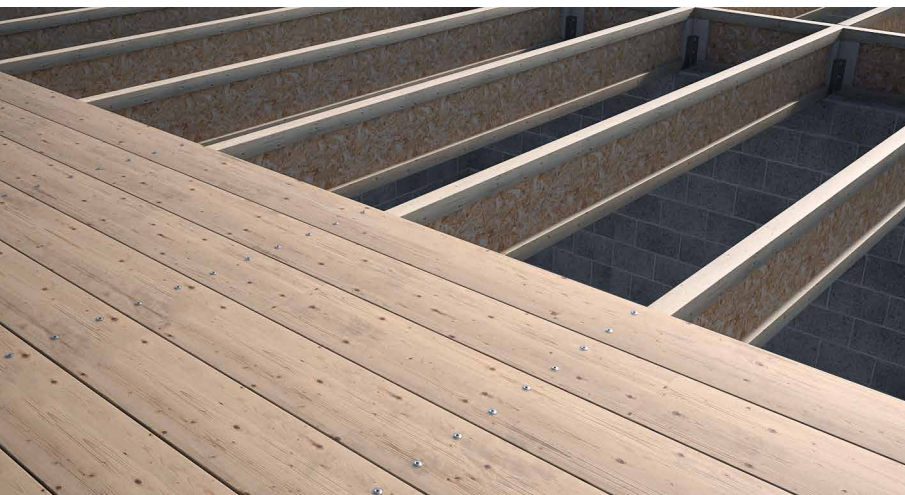
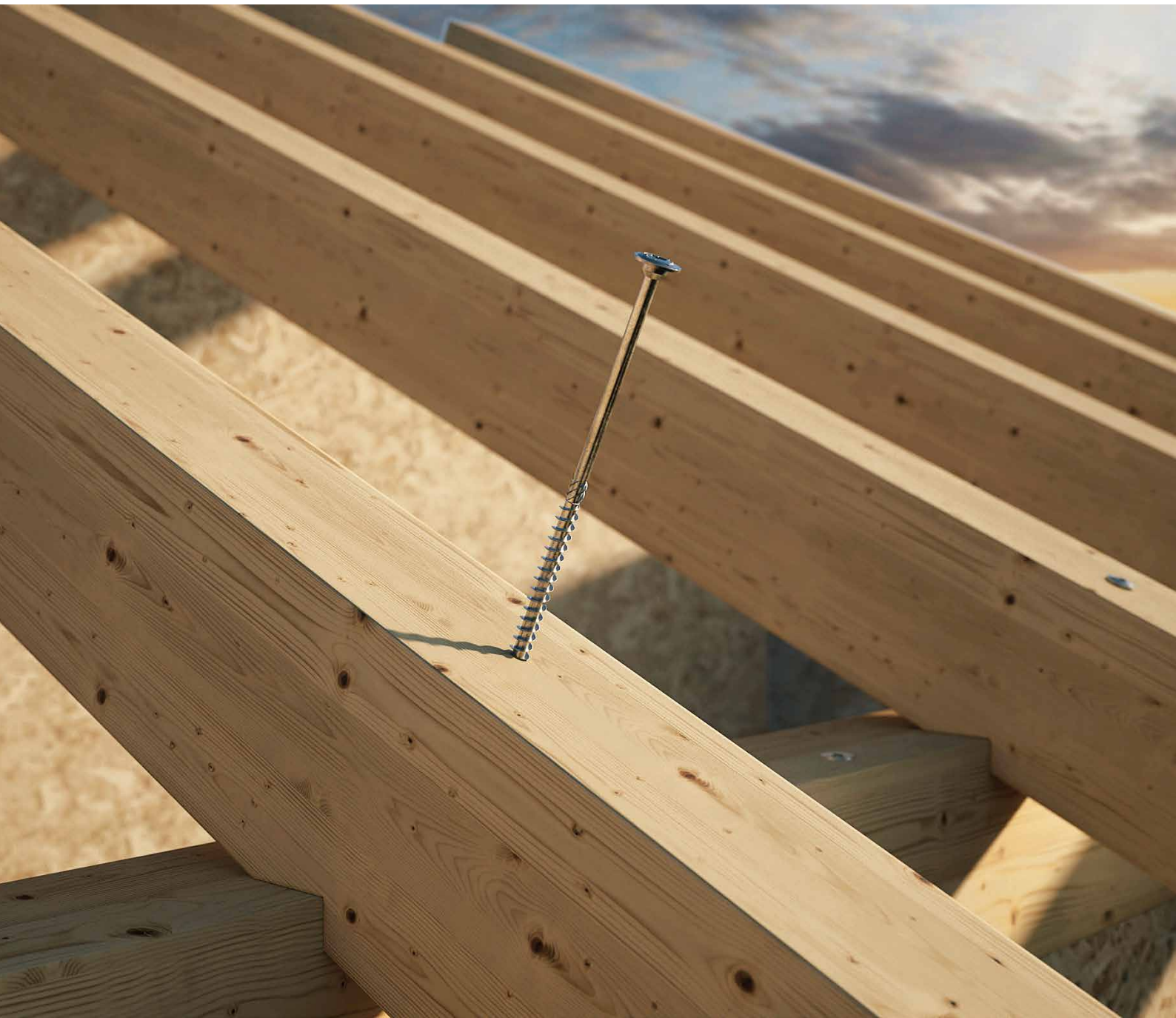


|                         |                                                  |
|-------------------------|--------------------------------------------------|
| DIAMETER [mm]           | 6 6 12 16                                        |
| LENGTH [mm]             | 40 40 1000 1000                                  |
| SERVICE CLASS           | SC1 SC2                                          |
| ATMOSPHERIC CORROSIVITY | C1 C2                                            |
| WOOD CORROSIVITY        | T1 T2                                            |
| MATERIAL                | Zn ELECTRO PLATED electrogalvanized carbon steel |



### FIELDS OF USE

- timber based panels
- fibreboard and MDF panels
- solid timber and glulam
- CLT and LVL
- high density woods



## SECONDARY BEAMS

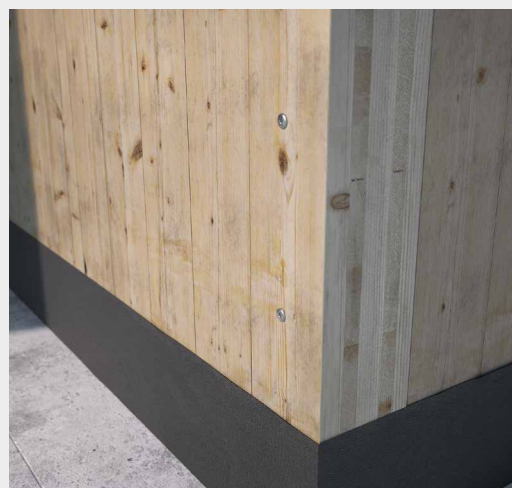
Ideal for fastening joists to sill beams to achieve high wind uplift resistance. The flange head guarantees excellent tensile strength which means the use of additional lateral fastening systems can be avoided.

## I-JOIST

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

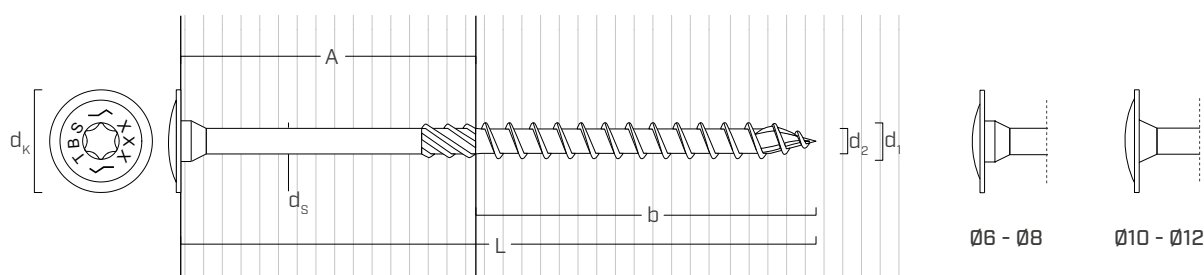


Fastening SIP panels with 8 mm diameter TBS screws.



Fastening CLT walls with TBS screws.

## ■ GEOMETRY AND MECHANICAL CHARACTERISTICS



### GEOMETRY

| Nominal diameter                          | $d_1$     | [mm] | 6     | 8     | 10    | 12    |
|-------------------------------------------|-----------|------|-------|-------|-------|-------|
| Head diameter                             | $d_k$     | [mm] | 15,50 | 19,00 | 25,00 | 29,00 |
| Thread diameter                           | $d_2$     | [mm] | 3,95  | 5,40  | 6,40  | 6,80  |
| Shank diameter                            | $d_s$     | [mm] | 4,30  | 5,80  | 7,00  | 8,00  |
| Pre-drilling hole diameter <sup>(1)</sup> | $d_{V,S}$ | [mm] | 4,0   | 5,0   | 6,0   | 7,0   |
| Pre-drilling hole diameter <sup>(2)</sup> | $d_{V,H}$ | [mm] | 4,0   | 6,0   | 7,0   | 8,0   |

<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] | 6    | 8    | 10   | 12   |
|------------------|--------------|------|------|------|------|------|
| Tensile strength | $f_{tens,k}$ | [kN] | 11,3 | 20,1 | 31,4 | 33,9 |
| Yield moment     | $M_{y,k}$    | [Nm] | 9,5  | 20,1 | 35,8 | 48,0 |

|                                 |              |                      | 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                                            |
| Head-pull-through parameter     | $f_{head,k}$ | [N/mm <sup>2</sup> ] | 10,5                   | 20,0                           | -                                               |
| 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] | d <sub>k</sub><br>[mm] | CODE    | L<br>[mm] | b<br>[mm] | A<br>[mm] | pcs |
|------------------------|------------------------|---------|-----------|-----------|-----------|-----|
| 6<br>TX 30             | 15,5                   | TBS660  | 60        | 40        | 20        | 100 |
|                        |                        | TBS670  | 70        | 40        | 30        | 100 |
|                        |                        | TBS680  | 80        | 50        | 30        | 100 |
|                        |                        | TBS690  | 90        | 50        | 40        | 100 |
|                        |                        | TBS6100 | 100       | 60        | 40        | 100 |
|                        |                        | TBS6120 | 120       | 75        | 45        | 100 |
|                        |                        | TBS6140 | 140       | 75        | 65        | 100 |
|                        |                        | TBS6160 | 160       | 75        | 85        | 100 |
|                        |                        | TBS6180 | 180       | 75        | 105       | 100 |
|                        |                        | TBS6200 | 200       | 75        | 125       | 100 |
|                        |                        | TBS6220 | 220       | 100       | 120       | 100 |
|                        |                        | TBS6240 | 240       | 100       | 140       | 100 |
|                        |                        | TBS6260 | 260       | 100       | 160       | 100 |
|                        |                        | TBS6280 | 280       | 100       | 180       | 100 |
|                        |                        | TBS6300 | 300       | 100       | 200       | 100 |
|                        |                        | TBS6320 | 320       | 100       | 220       | 100 |
|                        |                        | TBS6360 | 360       | 100       | 260       | 100 |
|                        |                        | TBS6400 | 400       | 100       | 300       | 100 |
| 8<br>TX 40             | 19,0                   | TBS840  | 40        | 32        | 8         | 100 |
|                        |                        | TBS860  | 60        | 52        | 8         | 100 |
|                        |                        | TBS880  | 80        | 52        | 28        | 50  |
|                        |                        | TBS8100 | 100       | 52        | 48        | 50  |
|                        |                        | TBS8120 | 120       | 80        | 40        | 50  |
|                        |                        | TBS8140 | 140       | 80        | 60        | 50  |
|                        |                        | TBS8160 | 160       | 100       | 60        | 50  |
|                        |                        | TBS8180 | 180       | 100       | 80        | 50  |
|                        |                        | TBS8200 | 200       | 100       | 100       | 50  |
|                        |                        | TBS8220 | 220       | 100       | 120       | 50  |
|                        |                        | TBS8240 | 240       | 100       | 140       | 50  |
|                        |                        | TBS8260 | 260       | 100       | 160       | 50  |
|                        |                        | TBS8280 | 280       | 100       | 180       | 50  |
|                        |                        | TBS8300 | 300       | 100       | 200       | 50  |
|                        |                        | TBS8320 | 320       | 100       | 220       | 50  |
|                        |                        | TBS8340 | 340       | 100       | 240       | 50  |
|                        |                        | TBS8360 | 360       | 100       | 260       | 50  |
|                        |                        | TBS8380 | 380       | 100       | 280       | 50  |
|                        |                        | TBS8400 | 400       | 100       | 300       | 50  |
|                        |                        | TBS8440 | 440       | 100       | 340       | 50  |
|                        |                        | TBS8480 | 480       | 100       | 380       | 50  |
|                        |                        | TBS8520 | 520       | 100       | 420       | 50  |
|                        |                        | TBS8560 | 560       | 100       | 460       | 50  |
|                        |                        | TBS8580 | 580       | 100       | 480       | 50  |
|                        |                        | TBS8600 | 600       | 100       | 500       | 50  |

| d <sub>1</sub><br>[mm] | d <sub>k</sub><br>[mm] | CODE      | L<br>[mm] | b<br>[mm] | A<br>[mm] | pcs |
|------------------------|------------------------|-----------|-----------|-----------|-----------|-----|
| 10<br>TX 50            | 25,0                   | TBS10100  | 100       | 52        | 48        | 50  |
|                        |                        | TBS10120  | 120       | 60        | 60        | 50  |
|                        |                        | TBS10140  | 140       | 60        | 80        | 50  |
|                        |                        | TBS10160  | 160       | 80        | 80        | 50  |
|                        |                        | TBS10180  | 180       | 80        | 100       | 50  |
|                        |                        | TBS10200  | 200       | 100       | 100       | 50  |
|                        |                        | TBS10220  | 220       | 100       | 120       | 50  |
|                        |                        | TBS10240  | 240       | 100       | 140       | 50  |
|                        |                        | TBS10260  | 260       | 100       | 160       | 50  |
|                        |                        | TBS10280  | 280       | 100       | 180       | 50  |
|                        |                        | TBS10300  | 300       | 100       | 200       | 50  |
|                        |                        | TBS10320  | 320       | 120       | 200       | 50  |
|                        |                        | TBS10340  | 340       | 120       | 220       | 50  |
|                        |                        | TBS10360  | 360       | 120       | 240       | 50  |
|                        |                        | TBS10380  | 380       | 120       | 260       | 50  |
|                        |                        | TBS10400  | 400       | 120       | 280       | 50  |
|                        |                        | TBS10440  | 440       | 120       | 320       | 50  |
|                        |                        | TBS10480  | 480       | 120       | 360       | 50  |
|                        |                        | TBS10520  | 520       | 120       | 400       | 50  |
|                        |                        | TBS10560  | 560       | 120       | 440       | 50  |
|                        |                        | TBS10600  | 600       | 120       | 480       | 50  |
| 12<br>TX 50            | 29,0                   | TBS12200  | 200       | 120       | 80        | 25  |
|                        |                        | TBS12240  | 240       | 120       | 120       | 25  |
|                        |                        | TBS12280  | 280       | 120       | 160       | 25  |
|                        |                        | TBS12320  | 320       | 120       | 200       | 25  |
|                        |                        | TBS12360  | 360       | 120       | 240       | 25  |
|                        |                        | TBS12400  | 400       | 140       | 260       | 25  |
|                        |                        | TBS12440  | 440       | 140       | 300       | 25  |
|                        |                        | TBS12480  | 480       | 140       | 340       | 25  |
|                        |                        | TBS12520  | 520       | 140       | 380       | 25  |
|                        |                        | TBS12560  | 560       | 140       | 420       | 25  |
|                        |                        | TBS12600  | 600       | 140       | 460       | 25  |
|                        |                        | TBS12800  | 800       | 160       | 640       | 25  |
|                        |                        | TBS121000 | 1000      | 160       | 840       | 25  |

## RELATED PRODUCTS



TBS MAX  
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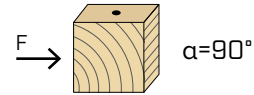
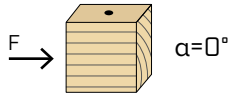
XYLOFON WASHER  
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TORQUE LIMITER  
page 408

## MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

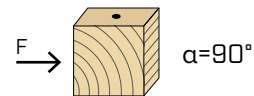
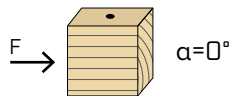
 screws inserted **WITHOUT** pre-drilled hole  $\rho_k \leq 420 \text{ kg/m}^3$



| $d_1$ [mm]     |             | 6  | 8   | 10  | 12  |
|----------------|-------------|----|-----|-----|-----|
| $a_1$ [mm]     | <b>10·d</b> | 60 | 80  | 100 | 120 |
| $a_2$ [mm]     | <b>5·d</b>  | 30 | 40  | 50  | 60  |
| $a_{3,t}$ [mm] | <b>15·d</b> | 90 | 120 | 150 | 180 |
| $a_{3,c}$ [mm] | <b>10·d</b> | 60 | 80  | 100 | 120 |
| $a_{4,t}$ [mm] | <b>5·d</b>  | 30 | 40  | 50  | 60  |
| $a_{4,c}$ [mm] | <b>5·d</b>  | 30 | 40  | 50  | 60  |

| $d_1$ [mm]     |             | 6  | 8  | 10  | 12  |
|----------------|-------------|----|----|-----|-----|
| $a_1$ [mm]     | <b>5·d</b>  | 30 | 40 | 50  | 60  |
| $a_2$ [mm]     | <b>5·d</b>  | 30 | 40 | 50  | 60  |
| $a_{3,t}$ [mm] | <b>10·d</b> | 60 | 80 | 100 | 120 |
| $a_{3,c}$ [mm] | <b>10·d</b> | 60 | 80 | 100 | 120 |
| $a_{4,t}$ [mm] | <b>10·d</b> | 60 | 80 | 100 | 120 |
| $a_{4,c}$ [mm] | <b>5·d</b>  | 30 | 40 | 50  | 60  |

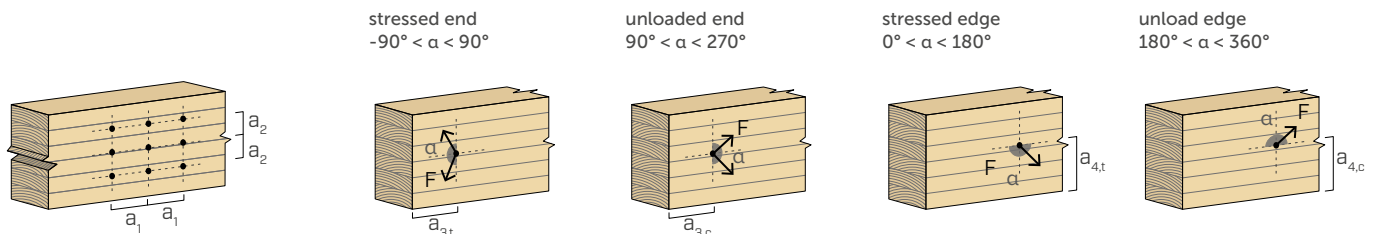
 screws inserted **WITH** pre-drilled hole



| $d_1$ [mm]     |             | 6  | 8  | 10  | 12  |
|----------------|-------------|----|----|-----|-----|
| $a_1$ [mm]     | <b>5·d</b>  | 30 | 40 | 50  | 60  |
| $a_2$ [mm]     | <b>3·d</b>  | 18 | 24 | 30  | 36  |
| $a_{3,t}$ [mm] | <b>12·d</b> | 72 | 96 | 120 | 144 |
| $a_{3,c}$ [mm] | <b>7·d</b>  | 42 | 56 | 70  | 84  |
| $a_{4,t}$ [mm] | <b>3·d</b>  | 18 | 24 | 30  | 36  |
| $a_{4,c}$ [mm] | <b>3·d</b>  | 18 | 24 | 30  | 36  |

| $d_1$ [mm]     |            | 6  | 8  | 10 | 12 |
|----------------|------------|----|----|----|----|
| $a_1$ [mm]     | <b>4·d</b> | 24 | 32 | 40 | 48 |
| $a_2$ [mm]     | <b>4·d</b> | 24 | 32 | 40 | 48 |
| $a_{3,t}$ [mm] | <b>7·d</b> | 42 | 56 | 70 | 84 |
| $a_{3,c}$ [mm] | <b>7·d</b> | 42 | 56 | 70 | 84 |
| $a_{4,t}$ [mm] | <b>7·d</b> | 42 | 56 | 70 | 84 |
| $a_{4,c}$ [mm] | <b>3·d</b> | 18 | 24 | 30 | 36 |

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

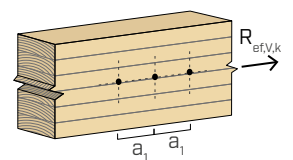


NOTE on page 87.

## 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 load-bearing capacity is equal to:

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



The  $n_{ef}$  value is given in the table below as a function of  $n$  and  $a_1$ .

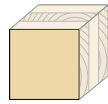
| $n$ |   | $a_1^{(*)}$ |      |      |      |      |      |      |      |      |        |
|-----|---|-------------|------|------|------|------|------|------|------|------|--------|
|     |   | 4·d         | 5·d  | 6·d  | 7·d  | 8·d  | 9·d  | 10·d | 11·d | 12·d | ≥ 14·d |
| $n$ | 2 | 1,41        | 1,48 | 1,55 | 1,62 | 1,68 | 1,74 | 1,80 | 1,85 | 1,90 | 2,00   |
|     | 3 | 1,73        | 1,86 | 2,01 | 2,16 | 2,28 | 2,41 | 2,54 | 2,65 | 2,76 | 3,00   |
|     | 4 | 2,00        | 2,19 | 2,41 | 2,64 | 2,83 | 3,03 | 3,25 | 3,42 | 3,61 | 4,00   |
|     | 5 | 2,24        | 2,49 | 2,77 | 3,09 | 3,34 | 3,62 | 3,93 | 4,17 | 4,43 | 5,00   |

(\*)For intermediate  $a_1$  values a linear interpolation is possible.

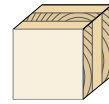
## MINIMUM DISTANCES FOR SHEAR AND AXIAL LOADS | CLT



screws inserted **WITHOUT** pre-drilled hole



lateral face

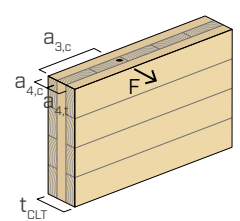
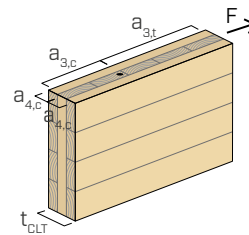
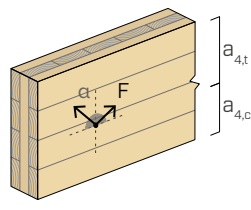
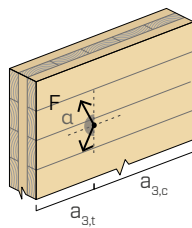
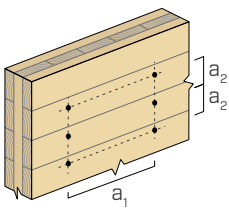


narrow face

| $d_1$ [mm]     |              | 6  | 8  | 10 | 12 |
|----------------|--------------|----|----|----|----|
| $a_1$ [mm]     | <b>4·d</b>   | 24 | 32 | 40 | 48 |
| $a_2$ [mm]     | <b>2,5·d</b> | 15 | 20 | 25 | 30 |
| $a_{3,t}$ [mm] | <b>6·d</b>   | 36 | 48 | 60 | 72 |
| $a_{3,c}$ [mm] | <b>6·d</b>   | 36 | 48 | 60 | 72 |
| $a_{4,t}$ [mm] | <b>6·d</b>   | 36 | 48 | 60 | 72 |
| $a_{4,c}$ [mm] | <b>2,5·d</b> | 15 | 20 | 25 | 30 |

| $d_1$ [mm]     |             | 6  | 8  | 10  | 12  |
|----------------|-------------|----|----|-----|-----|
| $a_1$ [mm]     | <b>10·d</b> | 60 | 80 | 100 | 120 |
| $a_2$ [mm]     | <b>4·d</b>  | 24 | 32 | 40  | 48  |
| $a_{3,t}$ [mm] | <b>12·d</b> | 72 | 96 | 120 | 144 |
| $a_{3,c}$ [mm] | <b>7·d</b>  | 42 | 56 | 70  | 84  |
| $a_{4,t}$ [mm] | <b>6·d</b>  | 36 | 48 | 60  | 72  |
| $a_{4,c}$ [mm] | <b>3·d</b>  | 18 | 24 | 30  | 36  |

$d = d_1$  = nominal screw diameter

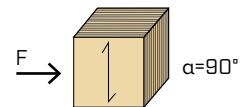
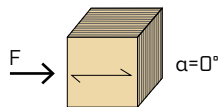


NOTE on page 87.

## MINIMUM DISTANCES FOR SHEAR LOADS | LVL



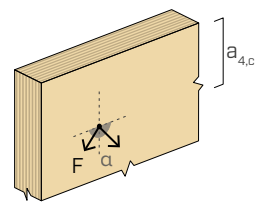
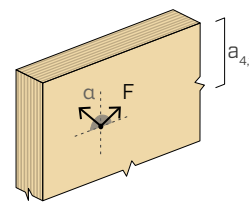
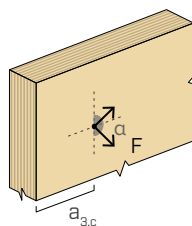
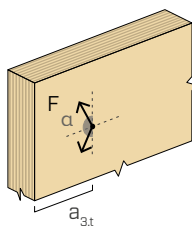
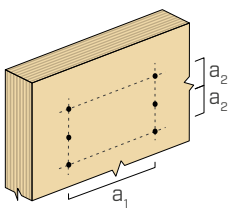
screws inserted **WITHOUT** pre-drilled hole



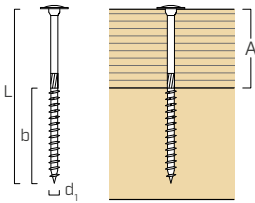
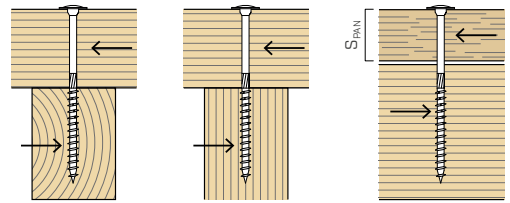
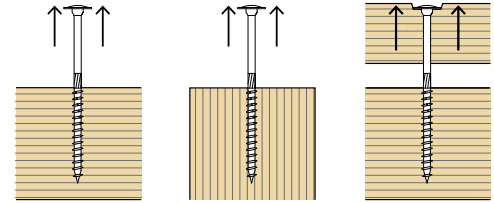
| $d_1$ [mm]     |             | 6  | 8   | 10  |
|----------------|-------------|----|-----|-----|
| $a_1$ [mm]     | <b>12·d</b> | 72 | 96  | 120 |
| $a_2$ [mm]     | <b>5·d</b>  | 30 | 40  | 50  |
| $a_{3,t}$ [mm] | <b>15·d</b> | 90 | 120 | 150 |
| $a_{3,c}$ [mm] | <b>10·d</b> | 60 | 80  | 100 |
| $a_{4,t}$ [mm] | <b>5·d</b>  | 30 | 40  | 50  |
| $a_{4,c}$ [mm] | <b>5·d</b>  | 30 | 40  | 50  |

| $d_1$ [mm]     |            | 6  | 8  | 10  |
|----------------|------------|----|----|-----|
| $a_1$ [mm]     | <b>5d</b>  | 30 | 40 | 50  |
| $a_2$ [mm]     | <b>5d</b>  | 30 | 40 | 50  |
| $a_{3,t}$ [mm] | <b>10d</b> | 60 | 80 | 100 |
| $a_{3,c}$ [mm] | <b>10d</b> | 60 | 80 | 100 |
| $a_{4,t}$ [mm] | <b>10d</b> | 60 | 80 | 100 |
| $a_{4,c}$ [mm] | <b>5d</b>  | 30 | 40 | 50  |

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

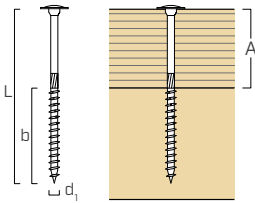
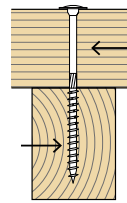
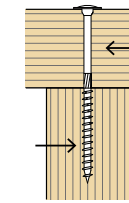
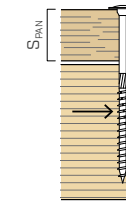
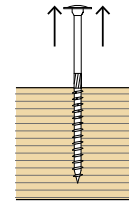
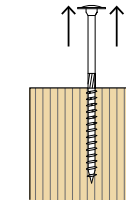
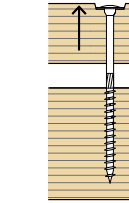


NOTE on page 87.

| geometry                                                                          |      |      |      | SHEAR                                                                             |                                           |                 | TENSION                                                                            |                                               |                      |              |
|-----------------------------------------------------------------------------------|------|------|------|-----------------------------------------------------------------------------------|-------------------------------------------|-----------------|------------------------------------------------------------------------------------|-----------------------------------------------|----------------------|--------------|
|                                                                                   |      |      |      | timber-to-timber<br>$\varepsilon=90^\circ$                                        | timber-to-timber<br>$\varepsilon=0^\circ$ | panel-to-timber | thread<br>withdrawal<br>$\varepsilon=90^\circ$                                     | thread<br>withdrawal<br>$\varepsilon=0^\circ$ | head<br>pull-through |              |
|  |      |      |      |  |                                           |                 |  |                                               |                      |              |
| $d_1$                                                                             | L    | b    | A    | $R_{V,90,k}$                                                                      | $R_{V,0,k}$                               | $S_{PAN}$       | $R_{V,k}$                                                                          | $R_{ax,90,k}$                                 | $R_{ax,0,k}$         | $R_{head,k}$ |
| [mm]                                                                              | [mm] | [mm] | [mm] | [kN]                                                                              | [kN]                                      | [mm]            | [kN]                                                                               | [kN]                                          | [kN]                 | [kN]         |
| 6                                                                                 | 60   | 40   | 20   | 1,89                                                                              | 1,02                                      | 50              | -                                                                                  | 3,03                                          | 0,91                 | 2,72         |
|                                                                                   | 70   | 40   | 30   | 2,15                                                                              | 1,20                                      |                 | -                                                                                  | 3,03                                          | 0,91                 | 2,72         |
|                                                                                   | 80   | 50   | 30   | 2,15                                                                              | 1,37                                      |                 | 2,14                                                                               | 3,79                                          | 1,14                 | 2,72         |
|                                                                                   | 90   | 50   | 40   | 2,35                                                                              | 1,38                                      |                 | 2,50                                                                               | 3,79                                          | 1,14                 | 2,72         |
|                                                                                   | 100  | 60   | 40   | 2,35                                                                              | 1,58                                      |                 | 2,50                                                                               | 4,55                                          | 1,36                 | 2,72         |
|                                                                                   | 120  | 75   | 45   | 2,35                                                                              | 1,69                                      |                 | 2,50                                                                               | 5,68                                          | 1,70                 | 2,72         |
|                                                                                   | 140  | 75   | 65   | 2,35                                                                              | 1,69                                      |                 | 2,50                                                                               | 5,68                                          | 1,70                 | 2,72         |
|                                                                                   | 160  | 75   | 85   | 2,35                                                                              | 1,69                                      |                 | 2,50                                                                               | 5,68                                          | 1,70                 | 2,72         |
|                                                                                   | 180  | 75   | 105  | 2,35                                                                              | 1,69                                      |                 | 2,50                                                                               | 5,68                                          | 1,70                 | 2,72         |
|                                                                                   | 200  | 75   | 125  | 2,35                                                                              | 1,69                                      |                 | 2,50                                                                               | 5,68                                          | 1,70                 | 2,72         |
|                                                                                   | 220  | 100  | 120  | 2,35                                                                              | 1,83                                      |                 | 2,50                                                                               | 7,58                                          | 2,27                 | 2,72         |
|                                                                                   | 240  | 100  | 140  | 2,35                                                                              | 1,83                                      |                 | 2,50                                                                               | 7,58                                          | 2,27                 | 2,72         |
|                                                                                   | 260  | 100  | 160  | 2,35                                                                              | 1,83                                      |                 | 2,50                                                                               | 7,58                                          | 2,27                 | 2,72         |
|                                                                                   | 280  | 100  | 180  | 2,35                                                                              | 1,83                                      |                 | 2,50                                                                               | 7,58                                          | 2,27                 | 2,72         |
|                                                                                   | 300  | 100  | 200  | 2,35                                                                              | 1,83                                      |                 | 2,50                                                                               | 7,58                                          | 2,27                 | 2,72         |
|                                                                                   | 320  | 100  | 220  | 2,35                                                                              | 1,83                                      |                 | 2,50                                                                               | 7,58                                          | 2,27                 | 2,72         |
|                                                                                   | 360  | 100  | 260  | 2,35                                                                              | 1,83                                      |                 | 2,50                                                                               | 7,58                                          | 2,27                 | 2,72         |
|                                                                                   | 400  | 100  | 300  | 2,35                                                                              | 1,83                                      |                 | 2,50                                                                               | 7,58                                          | 2,27                 | 2,72         |
| 8                                                                                 | 40   | 32   | 8    | 1,08                                                                              | 0,90                                      | 65              | -                                                                                  | 3,23                                          | 0,97                 | 4,09         |
|                                                                                   | 60   | 52   | 8    | 1,08                                                                              | 1,08                                      |                 | -                                                                                  | 5,25                                          | 1,58                 | 4,09         |
|                                                                                   | 80   | 52   | 28   | 3,02                                                                              | 1,70                                      |                 | -                                                                                  | 5,25                                          | 1,58                 | 4,09         |
|                                                                                   | 100  | 52   | 48   | 3,71                                                                              | 1,95                                      |                 | 3,22                                                                               | 5,25                                          | 1,58                 | 4,09         |
|                                                                                   | 120  | 80   | 40   | 3,41                                                                              | 2,54                                      |                 | 3,89                                                                               | 8,08                                          | 2,42                 | 4,09         |
|                                                                                   | 140  | 80   | 60   | 3,71                                                                              | 2,61                                      |                 | 3,89                                                                               | 8,08                                          | 2,42                 | 4,09         |
|                                                                                   | 160  | 100  | 60   | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 180  | 100  | 80   | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 200  | 100  | 100  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 220  | 100  | 120  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 240  | 100  | 140  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 260  | 100  | 160  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 280  | 100  | 180  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 300  | 100  | 200  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 320  | 100  | 220  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 340  | 100  | 240  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 360  | 100  | 260  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 380  | 100  | 280  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 400  | 100  | 300  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 440  | 100  | 340  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 480  | 100  | 380  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 520  | 100  | 420  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 560  | 100  | 460  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 580  | 100  | 480  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |
|                                                                                   | 600  | 100  | 500  | 3,71                                                                              | 2,79                                      |                 | 3,89                                                                               | 10,10                                         | 3,03                 | 4,09         |

$\varepsilon$  = screw-to-grain angle

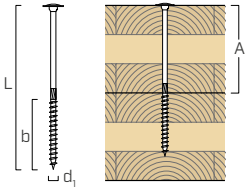
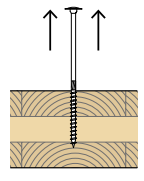
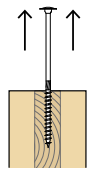
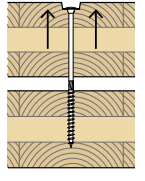
NOTES and GENERAL PRINCIPLES on page 87.

|                                                                                   |      |      |      | SHEAR                                                                             |                                                                                   |                                                                                   | TENSION                                                                            |                                                                                     |                                                                                     |              |
|-----------------------------------------------------------------------------------|------|------|------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------|
| geometry                                                                          |      |      |      | timber-to-timber<br>$\varepsilon=90^\circ$                                        | timber-to-timber<br>$\varepsilon=0^\circ$                                         | panel-to-timber                                                                   | thread<br>withdrawal<br>$\varepsilon=90^\circ$                                     | thread<br>withdrawal<br>$\varepsilon=0^\circ$                                       | head<br>pull-through                                                                |              |
|  |      |      |      |  |  |  |  |  |  |              |
| $d_1$                                                                             | L    | b    | A    | $R_{V,90,k}$                                                                      | $R_{V,0,k}$                                                                       | $S_{PAN}$                                                                         | $R_{V,k}$                                                                          | $R_{ax,90,k}$                                                                       | $R_{ax,0,k}$                                                                        | $R_{head,k}$ |
| [mm]                                                                              | [mm] | [mm] | [mm] | [kN]                                                                              | [kN]                                                                              | [mm]                                                                              | [kN]                                                                               | [kN]                                                                                | [kN]                                                                                | [kN]         |
| 10                                                                                | 100  | 52   | 48   | 4,92                                                                              | 2,56                                                                              | 80                                                                                | -                                                                                  | 6,57                                                                                | 1,97                                                                                | 7,08         |
|                                                                                   | 120  | 60   | 60   | 5,64                                                                              | 2,75                                                                              |                                                                                   | -                                                                                  | 7,58                                                                                | 2,27                                                                                | 7,08         |
|                                                                                   | 140  | 60   | 80   | 5,64                                                                              | 2,75                                                                              |                                                                                   | 5,84                                                                               | 7,58                                                                                | 2,27                                                                                | 7,08         |
|                                                                                   | 160  | 80   | 80   | 5,64                                                                              | 3,28                                                                              |                                                                                   | 5,85                                                                               | 10,10                                                                               | 3,03                                                                                | 7,08         |
|                                                                                   | 180  | 80   | 100  | 5,64                                                                              | 3,28                                                                              |                                                                                   | 5,85                                                                               | 10,10                                                                               | 3,03                                                                                | 7,08         |
|                                                                                   | 200  | 100  | 100  | 5,64                                                                              | 3,87                                                                              |                                                                                   | 5,85                                                                               | 12,63                                                                               | 3,79                                                                                | 7,08         |
|                                                                                   | 220  | 100  | 120  | 5,64                                                                              | 3,87                                                                              |                                                                                   | 5,85                                                                               | 12,63                                                                               | 3,79                                                                                | 7,08         |
|                                                                                   | 240  | 100  | 140  | 5,64                                                                              | 3,87                                                                              |                                                                                   | 5,85                                                                               | 12,63                                                                               | 3,79                                                                                | 7,08         |
|                                                                                   | 260  | 100  | 160  | 5,64                                                                              | 3,87                                                                              |                                                                                   | 5,85                                                                               | 12,63                                                                               | 3,79                                                                                | 7,08         |
|                                                                                   | 280  | 100  | 180  | 5,64                                                                              | 3,87                                                                              |                                                                                   | 5,85                                                                               | 12,63                                                                               | 3,79                                                                                | 7,08         |
|                                                                                   | 300  | 100  | 200  | 5,64                                                                              | 3,87                                                                              |                                                                                   | 5,85                                                                               | 12,63                                                                               | 3,79                                                                                | 7,08         |
|                                                                                   | 320  | 120  | 200  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 340  | 120  | 220  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 360  | 120  | 240  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 380  | 120  | 260  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 400  | 120  | 280  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 440  | 120  | 320  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 480  | 120  | 360  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 520  | 120  | 400  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 560  | 120  | 440  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
|                                                                                   | 600  | 120  | 480  | 5,64                                                                              | 4,06                                                                              |                                                                                   | 5,85                                                                               | 15,15                                                                               | 4,55                                                                                | 7,08         |
| 12                                                                                | 200  | 120  | 80   | 7,16                                                                              | 4,98                                                                              | 95                                                                                | 7,35                                                                               | 18,18                                                                               | 5,45                                                                                | 9,53         |
|                                                                                   | 240  | 120  | 120  | 7,16                                                                              | 4,98                                                                              |                                                                                   | 7,35                                                                               | 18,18                                                                               | 5,45                                                                                | 9,53         |
|                                                                                   | 280  | 120  | 160  | 7,16                                                                              | 4,98                                                                              |                                                                                   | 7,35                                                                               | 18,18                                                                               | 5,45                                                                                | 9,53         |
|                                                                                   | 320  | 120  | 200  | 7,16                                                                              | 4,98                                                                              |                                                                                   | 7,35                                                                               | 18,18                                                                               | 5,45                                                                                | 9,53         |
|                                                                                   | 360  | 120  | 240  | 7,16                                                                              | 4,98                                                                              |                                                                                   | 7,35                                                                               | 18,18                                                                               | 5,45                                                                                | 9,53         |
|                                                                                   | 400  | 140  | 260  | 7,16                                                                              | 5,20                                                                              |                                                                                   | 7,35                                                                               | 21,21                                                                               | 6,36                                                                                | 9,53         |
|                                                                                   | 440  | 140  | 300  | 7,16                                                                              | 5,20                                                                              |                                                                                   | 7,35                                                                               | 21,21                                                                               | 6,36                                                                                | 9,53         |
|                                                                                   | 480  | 140  | 340  | 7,16                                                                              | 5,20                                                                              |                                                                                   | 7,35                                                                               | 21,21                                                                               | 6,36                                                                                | 9,53         |
|                                                                                   | 520  | 140  | 380  | 7,16                                                                              | 5,20                                                                              |                                                                                   | 7,35                                                                               | 21,21                                                                               | 6,36                                                                                | 9,53         |
|                                                                                   | 560  | 140  | 420  | 7,16                                                                              | 5,20                                                                              |                                                                                   | 7,35                                                                               | 21,21                                                                               | 6,36                                                                                | 9,53         |
|                                                                                   | 600  | 140  | 460  | 7,16                                                                              | 5,20                                                                              |                                                                                   | 7,35                                                                               | 21,21                                                                               | 6,36                                                                                | 9,53         |
|                                                                                   | 800  | 160  | 640  | 7,16                                                                              | 5,43                                                                              |                                                                                   | 7,35                                                                               | 24,24                                                                               | 7,27                                                                                | 9,53         |
|                                                                                   | 1000 | 160  | 840  | 7,16                                                                              | 5,43                                                                              |                                                                                   | 7,35                                                                               | 24,24                                                                               | 7,27                                                                                | 9,53         |

$\varepsilon$  = screw-to-grain angle

| geometry               |           |           |           | SHEAR                    |                          |                                     |                          |                           |           |                               |  |
|------------------------|-----------|-----------|-----------|--------------------------|--------------------------|-------------------------------------|--------------------------|---------------------------|-----------|-------------------------------|--|
|                        |           |           |           | CLT-CLT<br>lateral face  |                          | CLT-CLT<br>lateral face-narrow face |                          | panel-CLT<br>lateral face |           | CLT-panel-CLT<br>lateral face |  |
|                        |           |           |           |                          |                          |                                     |                          |                           |           |                               |  |
| d <sub>1</sub><br>[mm] | L<br>[mm] | b<br>[mm] | A<br>[mm] | R <sub>V,k</sub><br>[kN] | R <sub>V,k</sub><br>[kN] | S <sub>PAN</sub><br>[mm]            | R <sub>V,k</sub><br>[kN] | S <sub>PAN</sub><br>[mm]  | t<br>[mm] | R <sub>V,k</sub><br>[kN]      |  |
| 6                      | 60÷70     | 40        | ≥ 20      | 1,77                     | -                        | 18                                  | 1,82                     | 18                        | ≥ 20      | 2,67                          |  |
|                        | 80÷90     | 50        | ≥ 30      | 2,00                     | -                        |                                     | 1,82                     |                           | ≥ 30      | 2,67                          |  |
|                        | 100       | 60        | 40        | 2,22                     | -                        |                                     | 1,82                     |                           | ≥ 40      | 2,67                          |  |
|                        | 120÷200   | 75        | ≥ 45      | 2,22                     | -                        |                                     | 1,82                     |                           | ≥ 50      | 2,67                          |  |
|                        | 220÷400   | 100       | ≥ 120     | 2,22                     | -                        |                                     | 1,82                     |                           | ≥ 100     | 2,67                          |  |
| 8                      | 40        | 32        | 8         | 0,98                     | 0,98                     | 22                                  | 1,65                     | 22                        | ≥ 5       | 1,23                          |  |
|                        | 60÷100    | 52        | ≥ 30      | 2,23                     | 1,70                     |                                     | 2,66                     |                           | ≥ 15      | 3,64                          |  |
|                        | 120÷140   | 80        | ≥ 40      | 3,16                     | 2,80                     |                                     | 2,98                     |                           | ≥ 45      | 3,64                          |  |
|                        | 160÷600   | 100       | ≥ 60      | 3,51                     | 2,98                     |                                     | 2,98                     |                           | ≥ 65      | 3,64                          |  |
| 10                     | 100       | 52        | 48        | 4,50                     | 3,14                     | 25                                  | 4,20                     | 25                        | ≥ 35      | 4,47                          |  |
|                        | 120÷140   | 60        | ≥ 60      | 5,22                     | 3,41                     |                                     | 4,44                     |                           | ≥ 45      | 4,47                          |  |
|                        | 160÷180   | 80        | ≥ 80      | 5,33                     | 4,12                     |                                     | 4,44                     |                           | ≥ 65      | 4,47                          |  |
|                        | 200÷300   | 100       | ≥ 100     | 5,33                     | 4,52                     |                                     | 4,44                     |                           | ≥ 85      | 4,47                          |  |
|                        | 320÷600   | 120       | ≥ 200     | 5,33                     | 4,52                     |                                     | 4,44                     |                           | ≥ 145     | 4,47                          |  |
| 12                     | 200÷360   | 120       | ≥ 80      | 6,76                     | 5,72                     | 25                                  | 4,72                     | 25                        | ≥ 85      | 4,72                          |  |
|                        | 400÷600   | 140       | ≥ 260     | 6,76                     | 5,72                     |                                     | 4,72                     |                           | ≥ 185     | 4,72                          |  |
|                        | 800÷1000  | 160       | ≥ 640     | 6,76                     | 5,72                     |                                     | 4,72                     |                           | ≥ 385     | 4,72                          |  |

|                        |           |           |           |                            | SHEAR                     |  |
|------------------------|-----------|-----------|-----------|----------------------------|---------------------------|--|
| geometry               |           |           |           | CLT-timber<br>lateral face | timber-CLT<br>narrow face |  |
|                        |           |           |           |                            |                           |  |
| d <sub>1</sub><br>[mm] | L<br>[mm] | b<br>[mm] | A<br>[mm] | R <sub>V,k</sub><br>[kN]   | R <sub>V,k</sub><br>[kN]  |  |
| 6                      | 60-70     | 40        | ≥ 20      | 1,79                       | -                         |  |
|                        | 80-90     | 50        | ≥ 30      | 2,02                       | -                         |  |
|                        | 100       | 60        | 40        | 2,26                       | -                         |  |
|                        | 120-200   | 75        | ≥ 45      | 2,26                       | -                         |  |
|                        | 220-400   | 100       | ≥ 120     | 2,26                       | -                         |  |
| 8                      | 40        | 32        | 8         | 0,98                       | 1,08                      |  |
|                        | 60-100    | 52        | ≥ 30      | 2,36                       | 1,70                      |  |
|                        | 120-140   | 80        | ≥ 40      | 3,20                       | 2,90                      |  |
|                        | 160-600   | 100       | ≥ 60      | 3,57                       | 3,01                      |  |
| 10                     | 100       | 52        | 48        | 4,78                       | 3,17                      |  |
|                        | 120-140   | 60        | ≥ 60      | 5,32                       | 3,43                      |  |
|                        | 160-180   | 80        | ≥ 80      | 5,42                       | 4,15                      |  |
|                        | 200-300   | 100       | ≥ 100     | 5,42                       | 4,56                      |  |
|                        | 320-600   | 120       | ≥ 200     | 5,42                       | 4,57                      |  |
| 12                     | 200-360   | 120       | ≥ 80      | 6,87                       | 5,77                      |  |
|                        | 400-600   | 140       | ≥ 260     | 6,87                       | 5,77                      |  |
|                        | 800-1000  | 160       | ≥ 640     | 6,87                       | 5,77                      |  |

|                                                                                   |           |           | TENSION                                                                           |                                                                                   |                                                                                     |
|-----------------------------------------------------------------------------------|-----------|-----------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| geometry                                                                          |           |           | thread withdrawal<br>narrow face                                                  | thread withdrawal<br>narrow face                                                  | head<br>pull-through                                                                |
|  |           |           |  |  |  |
| $d_1$<br>[mm]                                                                     | L<br>[mm] | b<br>[mm] | $R_{ax,k}$<br>[kN]                                                                | $R_{ax,k}$<br>[kN]                                                                | $R_{head,k}$<br>[kN]                                                                |
| 6                                                                                 | 60÷70     | 40        | 2,81                                                                              | -                                                                                 | 2,52                                                                                |
|                                                                                   | 80÷90     | 50        | 3,51                                                                              | -                                                                                 | 2,52                                                                                |
|                                                                                   | 100       | 60        | 4,21                                                                              | -                                                                                 | 2,52                                                                                |
|                                                                                   | 120÷200   | 75        | 5,27                                                                              | -                                                                                 | 2,52                                                                                |
|                                                                                   | 220÷400   | 100       | 7,02                                                                              | -                                                                                 | 2,52                                                                                |
| 8                                                                                 | 40        | 32        | 3,00                                                                              | 2,39                                                                              | 3,79                                                                                |
|                                                                                   | 60÷100    | 52        | 4,87                                                                              | 3,70                                                                              | 3,79                                                                                |
|                                                                                   | 120÷140   | 80        | 7,49                                                                              | 5,45                                                                              | 3,79                                                                                |
|                                                                                   | 160÷600   | 100       | 9,36                                                                              | 6,66                                                                              | 3,79                                                                                |
| 10                                                                                | 100       | 52        | 6,08                                                                              | 4,42                                                                              | 6,56                                                                                |
|                                                                                   | 120÷140   | 60        | 7,02                                                                              | 5,03                                                                              | 6,56                                                                                |
|                                                                                   | 160÷180   | 80        | 9,36                                                                              | 6,51                                                                              | 6,56                                                                                |
|                                                                                   | 200÷300   | 100       | 11,70                                                                             | 7,96                                                                              | 6,56                                                                                |
|                                                                                   | 320÷600   | 120       | 14,04                                                                             | 9,38                                                                              | 6,56                                                                                |
| 12                                                                                | 200÷360   | 120       | 16,85                                                                             | 10,86                                                                             | 8,83                                                                                |
|                                                                                   | 400÷600   | 140       | 19,66                                                                             | 12,47                                                                             | 8,83                                                                                |
|                                                                                   | 800÷1000  | 160       | 22,46                                                                             | 14,06                                                                             | 8,83                                                                                |

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| SHEAR                  |           |           |           |                          |              |                        |                          |            |                          |            |                          |
|------------------------|-----------|-----------|-----------|--------------------------|--------------|------------------------|--------------------------|------------|--------------------------|------------|--------------------------|
| geometry               |           |           | LVL-LVL   |                          | LVL-LVL- LVL |                        |                          | LVL-timber |                          | timber-LVL |                          |
|                        |           |           |           |                          |              |                        |                          |            |                          |            |                          |
| d <sub>1</sub><br>[mm] | L<br>[mm] | b<br>[mm] | A<br>[mm] | R <sub>V,k</sub><br>[kN] | A<br>[mm]    | t <sub>2</sub><br>[mm] | R <sub>V,k</sub><br>[kN] | A<br>[mm]  | R <sub>V,k</sub><br>[kN] | A<br>[mm]  | R <sub>V,k</sub><br>[kN] |
| 6                      | 80÷90     | 50        | -         | -                        | -            | -                      | -                        | -          | -                        | ≥ 30       | 2,21                     |
|                        | 100       | 60        | 45        | 3,02                     | -            | -                      | -                        | 45         | 2,80                     | 40         | 2,44                     |
|                        | 120÷200   | 75        | ≥ 45      | 3,02                     | ≥ 45         | ≥ 75                   | 5,47                     | ≥ 45       | 2,92                     | ≥ 45       | 2,44                     |
|                        | 220÷400   | 100       | ≥ 120     | 3,02                     | ≥ 70         | ≥ 85                   | 6,05                     | ≥ 120      | 2,92                     | ≥ 120      | 2,44                     |
| 8                      | 120÷140   | 80        | ≥ 60      | 4,74                     | -            | -                      | -                        | ≥ 60       | 4,34                     | ≥ 40       | 3,51                     |
|                        | 160÷180   | 100       | ≥ 60      | 4,74                     | -            | -                      | -                        | ≥ 60       | 4,57                     | ≥ 60       | 3,85                     |
|                        | 200÷600   | 100       | ≥ 60      | 4,74                     | ≥ 60         | ≥ 75                   | 9,48                     | ≥ 60       | 4,57                     | ≥ 60       | 3,85                     |
| 10                     | 120÷140   | 60        | -         | -                        | -            | -                      | -                        | -          | -                        | ≥ 60       | 5,84                     |
|                        | 160÷180   | 80        | ≥ 75      | 7,23                     | -            | -                      | -                        | ≥ 75       | 6,60                     | ≥ 80       | 5,85                     |
|                        | 200       | 100       | 100       | 7,35                     | -            | -                      | -                        | 100        | 7,10                     | 100        | 5,85                     |
|                        | 220÷300   | 100       | ≥ 120     | 7,35                     | ≥ 75         | ≥ 75                   | 13,73                    | ≥ 100      | 7,10                     | ≥ 100      | 5,85                     |
|                        | 320÷600   | 120       | ≥ 200     | 7,35                     | ≥ 100        | ≥ 125                  | 14,69                    | ≥ 200      | 7,10                     | ≥ 200      | 5,85                     |

| TENSION                |           |           |                           |  |                           |  |                             |  |  |  |  |
|------------------------|-----------|-----------|---------------------------|--|---------------------------|--|-----------------------------|--|--|--|--|
| geometry               |           |           | thread withdrawal<br>flat |  | thread withdrawal<br>edge |  | head pull-through<br>flat   |  |  |  |  |
|                        |           |           |                           |  |                           |  |                             |  |  |  |  |
| d <sub>1</sub><br>[mm] | L<br>[mm] | b<br>[mm] | R <sub>ax,k</sub><br>[kN] |  | R <sub>ax,k</sub><br>[kN] |  | R <sub>head,k</sub><br>[kN] |  |  |  |  |
| 6                      | 60÷70     | 40        | 3,48                      |  | 2,32                      |  | 4,65                        |  |  |  |  |
|                        | 80÷90     | 50        | 4,36                      |  | 2,90                      |  | 4,65                        |  |  |  |  |
|                        | 100       | 60        | 5,23                      |  | 3,48                      |  | 4,65                        |  |  |  |  |
|                        | 120÷200   | 75        | 6,53                      |  | 4,36                      |  | 4,65                        |  |  |  |  |
|                        | 220÷400   | 100       | 8,71                      |  | 5,81                      |  | 4,65                        |  |  |  |  |
| 8                      | 40        | 32        | 3,72                      |  | 2,48                      |  | 6,99                        |  |  |  |  |
|                        | 60÷100    | 52        | 6,04                      |  | 4,03                      |  | 6,99                        |  |  |  |  |
|                        | 120÷140   | 80        | 9,29                      |  | 6,19                      |  | 6,99                        |  |  |  |  |
|                        | 160÷180   | 100       | 11,61                     |  | 7,74                      |  | 6,99                        |  |  |  |  |
|                        | 200÷600   | 100       | 11,61                     |  | 7,74                      |  | 6,99                        |  |  |  |  |
| 10                     | 100       | 52        | 7,55                      |  | 5,03                      |  | 12,10                       |  |  |  |  |
|                        | 120÷140   | 60        | 8,71                      |  | 5,81                      |  | 12,10                       |  |  |  |  |
|                        | 160÷180   | 80        | 11,61                     |  | 7,74                      |  | 12,10                       |  |  |  |  |
|                        | 200÷300   | 100       | 14,52                     |  | 9,68                      |  | 12,10                       |  |  |  |  |
|                        | 320÷600   | 120       | 17,42                     |  | 11,61                     |  | 12,10                       |  |  |  |  |

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## STRUCTURAL VALUES

### GENERAL PRINCIPLES

- Characteristic values consistent with EN 1995:2014 and in accordance with ETA-11/0030.
- Design values can be obtained from characteristic values as follows:

$$R_d = \frac{R_k \cdot k_{mod}}{\gamma_M}$$

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.
- Sizing and verification of the timber elements and panels must be done separately.
- The screws must be positioned in accordance with the minimum distances.
- 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.
- Shear strengths were calculated considering the threaded part fully inserted in the second element.
- The characteristic panel-timber shear strength are calculated considering an OSB panel or particle board with a  $S_{PAN}$  thickness and density  $\rho_k = 500 \text{ kg/m}^3$ .
- The thread withdrawal characteristic strength has been evaluated considering a fixing length equal to  $b$ .
- The head pull-through characteristic strength was calculated using timber elements.
- For different calculation configurations, the MyProject software is available ([www.rothoblaas.com](http://www.rothoblaas.com)).

### NOTES | TIMBER

- The characteristic timber-to-timber shear strengths were evaluated considering both an  $\epsilon$  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.
- The characteristic panel-timber shear strengths were evaluated considering an angle  $\epsilon$  of  $90^\circ$  between the grains of the timber element and the connector.
- The characteristic thread withdrawal resistances were evaluated considering both an  $\epsilon$  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 on the table (timber-to-timber shear and tensile) can be converted by the  $k_{dens}$  coefficient.

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

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

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

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

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

### 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 characteristics shear resistance are calculated considering a minimum fixing length of  $4 d_1$ .
- The characteristic shear strength is independent from the direction of the grain of the CLT panels outer layer.
- 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  $t_{pen} = 10 \cdot d_1$ .

### NOTES | LVL

- 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 characteristic shear strengths are evaluated for connectors inserted on the side face (wide face) 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.
- The axial thread-withdrawal resistance was calculated considering a  $90^\circ$  angle between the grains and the connector.
- Screws shorter than the minimum in the table are not compatible with the calculation assumptions and are therefore not reported.

## MINIMUM DISTANCES

### NOTES | TIMBER

- 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.
- In the case of joints with elements in Douglas fir (*Pseudotsuga menziesii*), the minimum spacing and distances parallel to the grain must be multiplied by a coefficient of 1.5.
- 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  $10 \cdot d$  based on experimental tests; alternatively, adopt  $12 \cdot d$  in accordance with EN 1995:2014.

### NOTES | CLT

- 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  $t_{pen} = 10 \cdot d_1$ .

### NOTES | LVL

- The minimum distances are compliant with ETA-11/0030 and are to be considered valid unless otherwise specified in the technical documents for the LVL panels.
- The minimum distances are applicable when using both parallel and cross grain softwood LVL.
- The minimum distances without pre-drilling hole are valid for minimum thickness of LVL elements  $t_{min}$ :

$$t_1 \geq 8,4 \cdot d - 9$$

$$t_2 \geq \begin{cases} 11,4 \cdot d \\ 75 \end{cases}$$

where:

- $t_1$  is the thickness in mm of the LVL element in a connection with 2 wooden elements. For connections with 3 or more elements,  $t_1$  represents the thickness of the most external LVL;
- $t_2$  is the thickness in mm of the central element in a connection with 3 or more elements.