

# VGZ EVO



## FULLY THREADED SCREW WITH CYLINDRICAL HEAD

### C4 EVO COATING

Multilayer coating with a surface treatment of epoxy resin and aluminium flakes. No rust after 1440 hours of salt spray exposure test, as per ISO 9227. Can be used in exposure condition 3 outdoor applications and under class C4 atmospheric corrosion conditions.

### AUTOCLAVE-TREATED TIMBER

The C4 EVO coating has been certified according to US acceptance criteria AC257 for outdoor use with ACQ-treated timber.

### STRUCTURAL APPLICATIONS

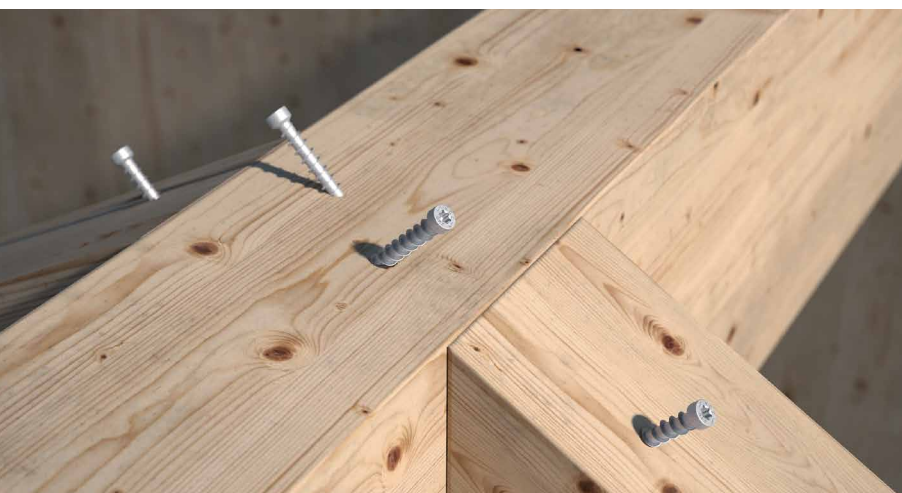
Deep thread and high resistance steel for excellent tensile performance. Approved for structural applications subject to stresses in any direction vs the grain (0° - 90°). Reduced minimum distances.

### CYLINDRICAL HEAD

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



|                         |                                                 |
|-------------------------|-------------------------------------------------|
| DIAMETER [in]           | 0.20 (0.21) 0.44 0.44                           |
| LENGTH [in]             | 3 1/8 (3 1/8) 23 5/8 39 3/8                     |
| EXPOSURE CONDITION      | EC1 EC3                                         |
| ATMOSPHERIC CORROSIVITY | C1 C2 C3 C4                                     |
| WOOD CORROSIVITY        | T1 T2 T3                                        |
| MATERIAL                | C4 EVO COATING carbon steel with C4 EVO coating |



### FIELDS OF USE

- timber based panels
- solid timber and glulam
- CLT and LVL
- high density woods
- ACQ, CCA treated timber



## TRUSS & RAFTER JOINTS

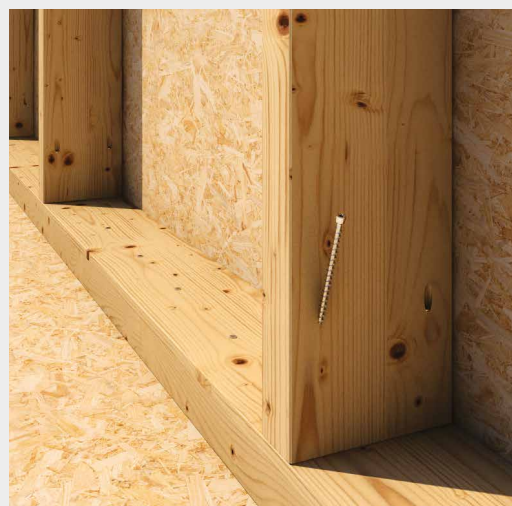
Ideal for joining small timber elements such as the crossbeams and uprights of light frame structures. Certified for application parallel to the grain and with reduced minimum distances.

## TIMBER STUDS

Values also tested, certified and calculated for CLT and high density woods such as LVL, Plywood or other laminated veneer products. Ideal for fastening I-Joist beams.

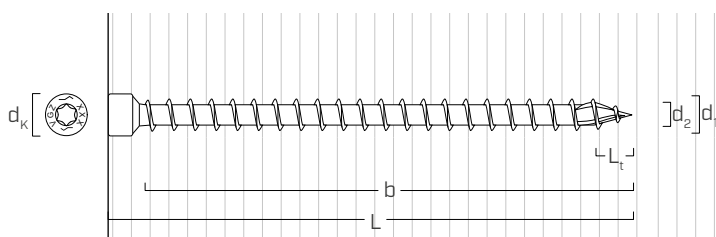


Fastening Wood Trusses outdoors.



Fastening the uprights of light frame structures with VGZ EVO #11 (0.21 inch) and #12 (0.23 inch).

## ■ GEOMETRY AND MECHANICAL CHARACTERISTICS



### GEOMETRY

| Nominal diameter                          | $d_1$               | [in] <sup>(1)</sup> | 0.21  | 0.23  | 0.28  | 0.36  | 0.44  |
|-------------------------------------------|---------------------|---------------------|-------|-------|-------|-------|-------|
|                                           |                     | [mm]                | 5,3   | 5,6   | 7     | 9     | 11    |
| Outer thread diameter                     | $d_1$               | [in]                | 0.209 | 0.220 | 0.276 | 0.354 | 0.433 |
| Head diameter                             | $d_k$               | [in]                | 0.315 | 0.315 | 0.374 | 0.453 | 0.531 |
| Root diameter                             | $d_2$               | [in]                | 0.142 | 0.142 | 0.181 | 0.232 | 0.260 |
| Tip Length                                | $L_t$               | [in]                | 0.209 | 0.220 | 0.276 | 0.354 | 0.433 |
| Pre-drilling hole diameter <sup>(2)</sup> | $d_{V,G \leq 0.55}$ | [in]                | 9/64  | 9/64  | 5/32  | 13/64 | 15/64 |
| Pre-drilling hole diameter <sup>(3)</sup> | $d_{V,G > 0.55}$    | [in]                | 5/32  | 5/32  | 13/64 | 15/64 | 9/32  |

<sup>(1)</sup> The nominal diameter of the screw is converted into imperial units and rounded up to the nearest decimal point.

<sup>(2)</sup>Pre-drilling applies to timber with  $G \leq 0.55$  (optional).

<sup>(3)</sup>Pre-drilling applies to timber with  $G > 0.55$  (required).

### MECHANICAL PARAMETERS

| Nominal diameter                   | $d_1$      | [in]  | 0.21   | 0.23   | 0.28   | 0.36   | 0.44   |
|------------------------------------|------------|-------|--------|--------|--------|--------|--------|
| Tensile strength (allowable)       | $f_{tens}$ | [lbf] | 1000   | 1100   | 1450   | 2450   | 3200   |
| Bending yield strength (specified) | $F_{y,b}$  | [psi] | 168000 | 168000 | 195000 | 180000 | 170000 |

| Nominal diameter             | d <sub>1</sub>  | [in]     | 0.21  | 0.23   | 0.28  | 0.36  | 0.44  |
|------------------------------|-----------------|----------|-------|--------|-------|-------|-------|
| Withdrawal<br>(design value) | W <sub>90</sub> |          |       |        |       |       |       |
|                              |                 | G = 0.35 | 102   | 107    | 141   | 192   | 207   |
|                              |                 | G = 0.42 | 118   | 123    | 164   | 220   | 240   |
|                              |                 | G = 0.49 | 132   | 139    | 185   | 255   | 272   |
|                              |                 | G = 0.55 | 145   | 152    | 203   | 280   | 298   |
| minimum embedded<br>length   |                 | [in]     | 1 1/4 | 1 5/16 | 1 5/8 | 2 1/8 | 2 5/8 |

## CODES AND DIMENSIONS

| d <sub>1</sub><br>[mm]<br>[in] | CODE       | L    |        | b    |          | pcs |
|--------------------------------|------------|------|--------|------|----------|-----|
|                                |            | [mm] | [in]   | [mm] | [in]     |     |
| 5,3<br>0.21<br>#11<br>TX 25    | VGZEVO580  | 80   | 3 1/8  | 70   | 2 3/4    | 50  |
|                                | VGZEVO5100 | 100  | 4      | 90   | 3 1/2    | 50  |
|                                | VGZEVO5120 | 120  | 4 3/4  | 110  | 4 3/8    | 50  |
| 5,6<br>0.23<br>#12<br>TX 25    | VGZEVO5140 | 140  | 5 1/2  | 130  | 5 1/8    | 50  |
|                                | VGZEVO5150 | 150  | 6      | 140  | 5 1/2    | 50  |
|                                | VGZEVO5160 | 160  | 6 1/4  | 150  | 6        | 50  |
| 7<br>0.27<br>#16<br>TX 30      | VGZEVO780  | 80   | 3 1/8  | 70   | 2 3/4    | 50  |
|                                | VGZEVO7100 | 100  | 4      | 90   | 3 1/2    | 50  |
|                                | VGZEVO7120 | 120  | 4 3/4  | 110  | 4 3/8    | 50  |
|                                | VGZEVO7140 | 140  | 5 1/2  | 130  | 5 1/8    | 50  |
|                                | VGZEVO7160 | 160  | 6 1/4  | 150  | 6        | 50  |
|                                | VGZEVO7180 | 180  | 7 1/8  | 170  | 6 3/4    | 50  |
|                                | VGZEVO7200 | 200  | 8      | 190  | 7 1/2    | 50  |
|                                | VGZEVO7220 | 220  | 8 5/8  | 210  | 8 1/4    | 50  |
|                                | VGZEVO7240 | 240  | 9 1/2  | 230  | 9 1/16   | 50  |
|                                | VGZEVO7260 | 260  | 10 1/4 | 250  | 10       | 50  |
|                                | VGZEVO7280 | 280  | 11     | 270  | 10 5/8   | 50  |
|                                | VGZEVO7300 | 300  | 11 3/4 | 290  | 11 7/16  | 50  |
|                                | VGZEVO7340 | 340  | 13 3/8 | 330  | 13       | 50  |
|                                | VGZEVO7380 | 380  | 15     | 370  | 14 9/16  | 50  |
|                                | VGZEVO9160 | 160  | 6 1/4  | 150  | 6        | 50  |
| 9<br>0.36<br>TX 40             | VGZEVO9180 | 180  | 7 1/8  | 170  | 6 3/4    | 50  |
|                                | VGZEVO9200 | 200  | 8      | 190  | 7 1/2    | 50  |
|                                | VGZEVO9220 | 220  | 8 5/8  | 210  | 8 1/4    | 50  |
|                                | VGZEVO9240 | 240  | 9 1/2  | 230  | 9 1/16   | 50  |
|                                | VGZEVO9260 | 260  | 10 1/4 | 250  | 10       | 50  |
|                                | VGZEVO9280 | 280  | 11     | 270  | 10 5/8   | 50  |
|                                | VGZEVO9300 | 300  | 11 3/4 | 290  | 11 7/16  | 50  |
|                                | VGZEVO9320 | 320  | 12 5/8 | 310  | 12 3/16  | 25  |
|                                | VGZEVO9340 | 340  | 13 3/8 | 330  | 13       | 25  |
|                                | VGZEVO9360 | 360  | 14 1/4 | 350  | 13 3/4   | 25  |
|                                | VGZEVO9380 | 380  | 15     | 370  | 14 9/16  | 25  |
|                                | VGZEVO9400 | 400  | 15 3/4 | 390  | 15 3/8   | 25  |
|                                | VGZEVO9440 | 440  | 17 1/4 | 430  | 16 15/16 | 25  |
|                                | VGZEVO9480 | 480  | 19     | 470  | 18 1/2   | 25  |
|                                | VGZEVO9520 | 520  | 20 1/2 | 510  | 20 1/16  | 25  |

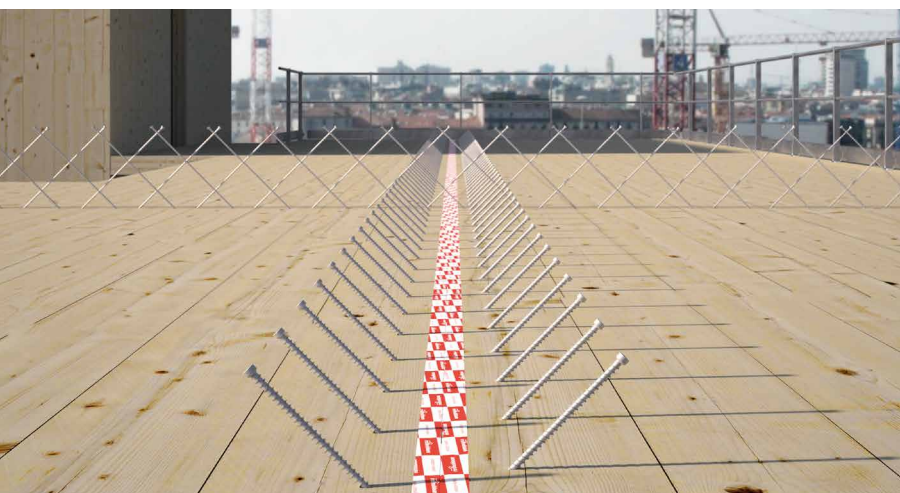
| d <sub>1</sub><br>[mm]<br>[in] | CODE        | L    |        | b    |         | pcs |
|--------------------------------|-------------|------|--------|------|---------|-----|
|                                |             | [mm] | [in]   | [mm] | [in]    |     |
| 11<br>0.44<br>TX 50            | VGZEVO11250 | 250  | 10     | 240  | 9 1/2   | 25  |
|                                | VGZEVO11300 | 300  | 11 3/4 | 290  | 11 7/16 | 25  |
|                                | VGZEVO11350 | 350  | 13 3/4 | 340  | 13 3/8  | 25  |
|                                | VGZEVO11400 | 400  | 15 3/4 | 390  | 15 3/8  | 25  |
|                                | VGZEVO11450 | 450  | 17 3/4 | 440  | 17 1/4  | 25  |
|                                | VGZEVO11500 | 500  | 19 3/4 | 490  | 19 5/16 | 25  |
|                                | VGZEVO11550 | 550  | 21 5/8 | 540  | 21 1/4  | 25  |
|                                | VGZEVO11600 | 600  | 23 5/8 | 590  | 23 1/4  | 25  |

## RELATED PRODUCTS



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

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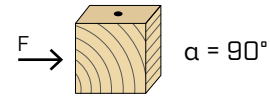
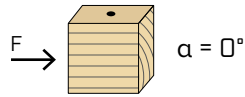


## OUTDOOR STRUCTURAL PERFORMANCE

Values also tested, certified and calculated for CLT and high density woods such as LVL, Plywood or other laminated veneer products. Ideal for fastening timber-framed panels and lattice beams (Rafter, Truss).

## MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

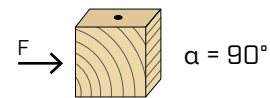
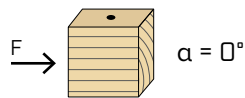
screws inserted **WITHOUT** pre-drilled hole  $G \leq 0.50$



| d <sub>1</sub>   | [in] |      | 0.21   | 0.23   | 0.28  | 0.36   | 0.44   |
|------------------|------|------|--------|--------|-------|--------|--------|
|                  | [mm] |      | 5,3    | 5,6    | 7     | 9      | 11     |
| a <sub>1</sub>   | [in] | 15·d | 3 1/8  | 3 5/16 | 4 1/8 | 5 5/16 | 6 1/2  |
| a <sub>2</sub>   | [in] | 5·d  | 1 1/16 | 1 1/8  | 1 3/8 | 1 3/4  | 2 3/16 |
| a <sub>3,t</sub> | [in] | 15·d | 3 1/8  | 3 5/16 | 4 1/8 | 5 5/16 | 6 1/2  |
| a <sub>3,c</sub> | [in] | 10·d | 2 1/16 | 2 3/16 | 2 3/4 | 3 1/2  | 4 3/8  |
| a <sub>4,t</sub> | [in] | 10·d | 2 1/16 | 2 3/16 | 2 3/4 | 3 1/2  | 4 3/8  |
| a <sub>4,c</sub> | [in] | 5·d  | 1 1/16 | 1 1/8  | 1 3/8 | 1 3/4  | 2 3/16 |

|             | 0.21<br>5,3 | 0.23<br>5,6 | 0.28<br>7 | 0.36<br>9 | 0.44<br>11 |
|-------------|-------------|-------------|-----------|-----------|------------|
| <b>10·d</b> | 2 1/16      | 2 3/16      | 2 3/4     | 3 1/2     | 4 3/8      |
| <b>5·d</b>  | 1 1/16      | 1 1/8       | 1 3/8     | 1 3/4     | 2 3/16     |
| <b>15·d</b> | 3 1/8       | 3 5/16      | 4 1/8     | 5 5/16    | 6 1/2      |
| <b>10·d</b> | 2 1/16      | 2 3/16      | 2 3/4     | 3 1/2     | 4 3/8      |
| <b>10·d</b> | 2 1/16      | 2 3/16      | 2 3/4     | 3 1/2     | 4 3/8      |
| <b>5·d</b>  | 1 1/16      | 1 1/8       | 1 3/8     | 1 3/4     | 2 3/16     |

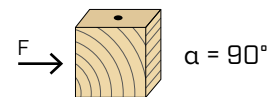
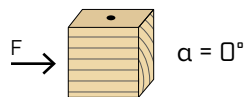
screws inserted **WITHOUT** pre-drilled hole  $G > 0.50$



| $d_1$     | [in] |             | 0.21   | 0.23    | 0.28    | 0.36   | 0.44   |
|-----------|------|-------------|--------|---------|---------|--------|--------|
|           | [mm] |             | 5,3    | 5,6     | 7       | 9      | 11     |
| $a_1$     | [in] | <b>15·d</b> | 3 1/8  | 3 5/16  | 4 1/8   | 5 5/16 | 6 1/2  |
| $a_2$     | [in] | <b>7·d</b>  | 1 1/2  | 1 9/16  | 1 15/16 | 2 1/2  | 3 1/16 |
| $a_{3,t}$ | [in] | <b>20·d</b> | 4 3/16 | 4 7/16  | 5 1/2   | 7 1/8  | 8 5/8  |
| $a_{3,c}$ | [in] | <b>15·d</b> | 3 1/8  | 3 5/16  | 4 1/8   | 5 5/16 | 6 1/2  |
| $a_{4,t}$ | [in] | <b>12·d</b> | 2 1/2  | 2 11/16 | 3 5/16  | 4 1/4  | 5 3/16 |
| $a_{4,c}$ | [in] | <b>7·d</b>  | 1 1/2  | 1 9/16  | 1 15/16 | 2 1/2  | 3 1/16 |

|             | 0.21<br>5,3 | 0.23<br>5,6 | 0.28<br>7 | 0.36<br>9 | 0.44<br>11 |
|-------------|-------------|-------------|-----------|-----------|------------|
| <b>10·d</b> | 2 1/16      | 2 3/16      | 2 3/4     | 3 1/2     | 4 3/8      |
| <b>7·d</b>  | 1 1/2       | 1 9/16      | 1 15/16   | 2 1/2     | 3 1/16     |
| <b>20·d</b> | 4 3/16      | 4 7/16      | 5 1/2     | 7 1/8     | 8 5/8      |
| <b>15·d</b> | 3 1/8       | 3 5/16      | 4 1/8     | 5 5/16    | 6 1/2      |
| <b>12·d</b> | 2 1/2       | 2 11/16     | 3 5/16    | 4 1/4     | 5 3/16     |
| <b>7·d</b>  | 1 1/2       | 1 9/16      | 1 15/16   | 2 1/2     | 3 1/16     |

screws inserted **WITH** pre-drilled hole



| $d_1$     | [in] | 0.21        | 0.23   | 0.28    | 0.36    | 0.44   |            |        |
|-----------|------|-------------|--------|---------|---------|--------|------------|--------|
|           | [mm] | 5,3         | 5,6    | 7       | 9       | 11     |            |        |
| $a_1$     | [in] | <b>10·d</b> | 2 1/16 | 2 3/16  | 2 3/4   | 3 1/2  | <b>5·d</b> | 2 3/16 |
| $a_2$     | [in] | <b>4·d</b>  | 7/8    | 7/8     | 1 1/8   | 1 7/16 | <b>5·d</b> | 2 3/16 |
| $a_{3,t}$ | [in] | <b>12·d</b> | 2 1/2  | 2 11/16 | 3 5/16  | 4 1/4  | <b>7·d</b> | 3 1/16 |
| $a_{3,c}$ | [in] | <b>7·d</b>  | 1 1/2  | 1 9/16  | 1 15/16 | 2 1/2  | <b>4·d</b> | 1 3/4  |
| $a_{4,t}$ | [in] | <b>7·d</b>  | 1 1/2  | 1 9/16  | 1 15/16 | 2 1/2  | <b>4·d</b> | 1 3/4  |
| $a_{4,c}$ | [in] | <b>3·d</b>  | 5/8    | 11/16   | 13/16   | 1 1/16 | <b>3·d</b> | 1 5/16 |

|      | 0.21   | 0.23    | 0.28    | 0.36   |     | 0.44   |
|------|--------|---------|---------|--------|-----|--------|
|      | 5,3    | 5,6     | 7       | 9      |     | 11     |
| 5-d  | 1 1/16 | 1 1/8   | 1 3/8   | 1 3/4  | 5-d | 2 3/16 |
| 4-d  | 7/8    | 7/8     | 1 1/8   | 1 7/16 | 5-d | 2 3/16 |
| 12-d | 2 1/2  | 2 11/16 | 3 5/16  | 4 1/4  | 7-d | 3 1/16 |
| 7-d  | 1 1/2  | 1 9/16  | 1 15/16 | 2 1/2  | 4-d | 1 3/4  |
| 7-d  | 1 1/2  | 1 9/16  | 1 15/16 | 2 1/2  | 4-d | 1 3/4  |
| 3-d  | 5/8    | 11/16   | 13/16   | 1 1/16 | 3-d | 1 5/16 |

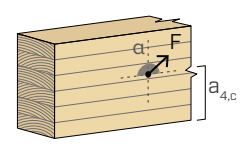
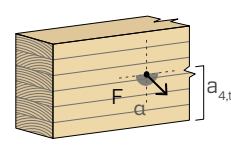
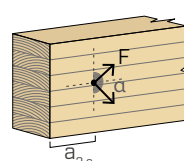
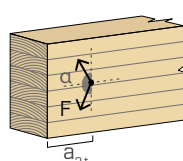
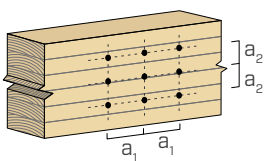
$\alpha$  = load-to-grain angle  
 $d$  =  $d_1$  = nominal diameter of the screw

stressed end  
 $-90^\circ < \alpha < 90^\circ$

unloaded end  
 $90^\circ < \alpha < 270^\circ$

stressed edge  
 $0^\circ < \alpha < 180^\circ$

unload edge  
 $180^\circ < \alpha < 360^\circ$



### NOTES

- The minimum spacing and distances comply with Table 8 of ESR-4645, where  $d$  refers to the nominal diameter of the screw;
- Wood member stresses must be checked in accordance with the corresponding Sections of the NDS; end distances, edge distances and fastener spacing may need to be increased accordingly.

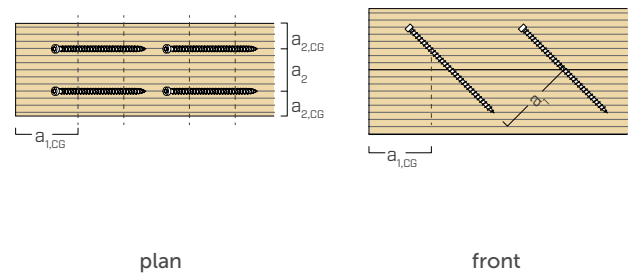
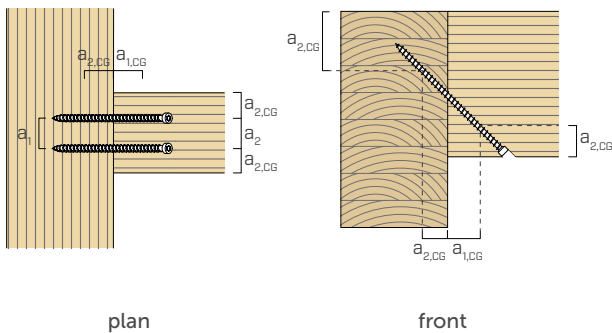
## MINIMUM DISTANCES FOR AXIAL STRESSES | TIMBER

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

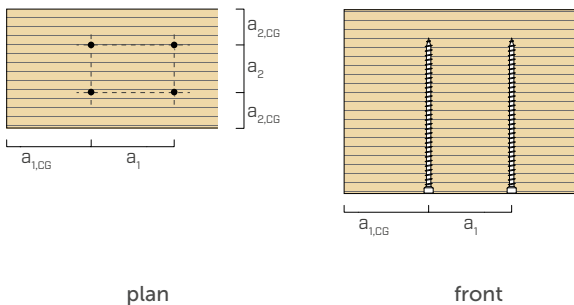
| d <sub>1</sub>     | [in] | 0.21  | 0.23   | 0.28   | 0.36    | 0.44   |       |        |
|--------------------|------|-------|--------|--------|---------|--------|-------|--------|
|                    | [mm] | 5,3   | 5,6    | 7      | 9       | 11     |       |        |
| a <sub>1</sub>     | [in] | 7·d   | 1 1/2  | 1 9/16 | 1 15/16 | 2 1/2  | 7·d   | 3 1/16 |
| a <sub>2</sub>     | [in] | 4·d   | 7/8    | 7/8    | 1 1/8   | 1 7/16 | 5·d   | 2 3/16 |
| a <sub>1,CG</sub>  | [in] | 10·d  | 2 1/16 | 2 3/16 | 2 3/4   | 3 1/2  | 10·d  | 4 3/8  |
| a <sub>2,CG</sub>  | [in] | 4·d   | 7/8    | 7/8    | 1 1/8   | 1 7/16 | 4·d   | 1 3/4  |
| a <sub>CROSS</sub> | [in] | 1,5·d | 5/16   | 3/8    | 7/16    | 9/16   | 1,5·d | 11/16  |

| d <sub>1</sub>     | [in] | 0.21  | 0.23  | 0.28   | 0.36    | 0.44   |       |        |
|--------------------|------|-------|-------|--------|---------|--------|-------|--------|
|                    | [mm] | 5,3   | 5,6   | 7      | 9       | 11     |       |        |
| a <sub>1</sub>     | [in] | 7•d   | 1 1/2 | 1 9/16 | 1 15/16 | 2 1/2  | 5•d   | 2 3/16 |
| a <sub>2</sub>     | [in] | 3•d   | 5/8   | 11/16  | 13/16   | 1 1/16 | 5•d   | 2 3/16 |
| a <sub>1,CG</sub>  | [in] | 7•d   | 1 1/2 | 1 9/16 | 1 15/16 | 2 1/2  | 4•d   | 1 3/4  |
| a <sub>2,CG</sub>  | [in] | 3•d   | 5/8   | 11/16  | 13/16   | 1 1/16 | 3•d   | 1 5/16 |
| a <sub>CROSS</sub> | [in] | 1,5•d | 5/16  | 3/8    | 7/16    | 9/16   | 1,5•d | 11/16  |

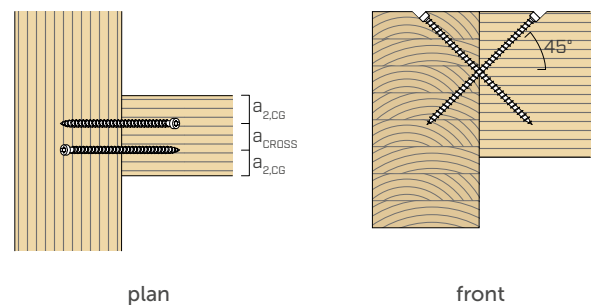
### SCREWS UNDER TENSION INSERTED WITH AN ANGLE $\alpha$ WITH RESPECT TO THE GRAIN



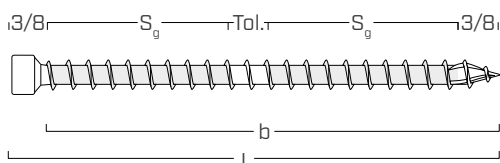
### SCREWS INSERTED WITH $\alpha = 90^\circ$ ANGLE WITH RESPECT TO THE GRAIN



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



## EFFECTIVE THREAD USED IN CALCULATION



$$b = S_{g,tot} = L - 3/8"$$

$$S_g = (L - 3/8" - 3/8" - Tol.) / 2$$

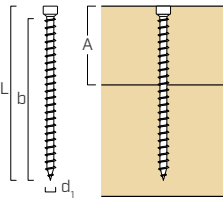
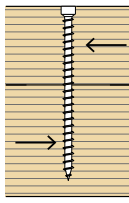
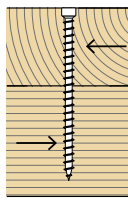
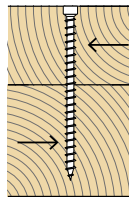
represents the entire length of the threaded part

represents the partial length of the threaded part net of a laying tolerance (Tol.) of 3/8"

### NOTES

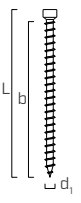
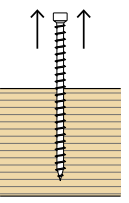
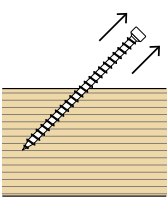
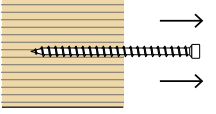
- The minimum spacing and distances comply with Table 8 of ESR-4645, where d refers to the nominal diameter of the screw;
- Wood member stresses must be checked in accordance with the corresponding Sections of the NDS; end distances, edge distances and fastener spacing may need to be increased accordingly.

## REFERENCE LATERAL DESIGN VALUES (Z) | WOOD-TO-WOOD

| geometry                                                                          |      |        |          |         | $Z_{  }$                                                                          |      |      |      | $Z_{\perp/  }$                                                                     |      |      |      | $Z_{\perp}$                                                                         |      |      |      |
|-----------------------------------------------------------------------------------|------|--------|----------|---------|-----------------------------------------------------------------------------------|------|------|------|------------------------------------------------------------------------------------|------|------|------|-------------------------------------------------------------------------------------|------|------|------|
|  |      |        |          |         |  |      |      |      |  |      |      |      |  |      |      |      |
| $d_1$                                                                             | L    | b      | A        |         | G                                                                                 |      |      |      | G                                                                                  |      |      |      | G                                                                                   |      |      |      |
| [mm]<br>[in]                                                                      | [mm] | [in]   | [in]     | [in]    | 0.35                                                                              | 0.42 | 0.49 | 0.55 | 0.35                                                                               | 0.42 | 0.49 | 0.55 | 0.35                                                                                | 0.42 | 0.49 | 0.55 |
| <b>5,3</b><br><b>0.21</b>                                                         | 80   | 3 1/8  | 2 3/4    | 1 9/16  | 98                                                                                | 125  | 144  | 161  | 98                                                                                 | 125  | 144  | 161  | 98                                                                                  | 125  | 144  | 161  |
|                                                                                   | 100  | 4      | 3 1/2    | 1 15/16 | 106                                                                               | 125  | 144  | 161  | 106                                                                                | 125  | 144  | 161  | 106                                                                                 | 125  | 144  | 161  |
|                                                                                   | 120  | 4 3/4  | 4 3/8    | 2 3/8   | 106                                                                               | 125  | 144  | 161  | 106                                                                                | 125  | 144  | 161  | 106                                                                                 | 125  | 144  | 161  |
| <b>5,6</b><br><b>0.23</b>                                                         | 140  | 5 1/2  | 5 1/8    | 2 3/4   | 106                                                                               | 125  | 144  | 161  | 106                                                                                | 125  | 144  | 161  | 106                                                                                 | 125  | 144  | 161  |
|                                                                                   | 150  | 6      | 5 1/2    | 2 15/16 | 106                                                                               | 125  | 144  | 161  | 106                                                                                | 125  | 144  | 161  | 106                                                                                 | 125  | 144  | 161  |
|                                                                                   | 160  | 6 1/4  | 6        | 3 1/8   | 106                                                                               | 125  | 144  | 161  | 106                                                                                | 125  | 144  | 161  | 106                                                                                 | 125  | 144  | 161  |
| <b>7</b><br><b>0.28</b>                                                           | 80   | 3 1/8  | 2 3/4    | 1 9/16  | 118                                                                               | 165  | 219  | 263  | 94                                                                                 | 132  | 175  | 211  | 94                                                                                  | 132  | 175  | 211  |
|                                                                                   | 100  | 4      | 3 1/2    | 1 15/16 | 148                                                                               | 206  | 242  | 269  | 119                                                                                | 165  | 193  | 215  | 119                                                                                 | 165  | 193  | 215  |
|                                                                                   | 120  | 4 3/4  | 4 3/8    | 2 3/8   | 174                                                                               | 210  | 242  | 269  | 140                                                                                | 168  | 193  | 215  | 140                                                                                 | 168  | 193  | 215  |
|                                                                                   | 140  | 5 1/2  | 5 1/8    | 2 3/4   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 160  | 6 1/4  | 6        | 3 1/8   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 180  | 7 1/8  | 6 3/4    | 3 1/2   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 200  | 8      | 7 1/2    | 4       | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 220  | 8 5/8  | 8 1/4    | 4 3/8   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 240  | 9 1/2  | 9 1/16   | 4 3/4   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 260  | 10 1/4 | 10       | 5 1/8   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 280  | 11     | 10 5/8   | 5 1/2   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 300  | 11 3/4 | 11 7/16  | 6       | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
| <b>9</b><br><b>0.36</b>                                                           | 340  | 13 3/8 | 13       | 6 3/4   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 380  | 15     | 14 9/16  | 7 1/2   | 177                                                                               | 210  | 242  | 269  | 142                                                                                | 168  | 193  | 215  | 142                                                                                 | 168  | 193  | 215  |
|                                                                                   | 160  | 6 1/4  | 6        | 3 1/8   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 180  | 7 1/8  | 6 3/4    | 3 1/2   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 200  | 8      | 7 1/2    | 4       | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 220  | 8 5/8  | 8 1/4    | 4 3/8   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 240  | 9 1/2  | 9 1/16   | 4 3/4   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 260  | 10 1/4 | 10       | 5 1/8   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 280  | 11     | 10 5/8   | 5 1/2   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 300  | 11 3/4 | 11 7/16  | 6       | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 320  | 12 5/8 | 12 3/16  | 6 1/4   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 340  | 13 3/8 | 13       | 6 3/4   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
| <b>11</b><br><b>0.44</b>                                                          | 360  | 14 1/4 | 13 3/4   | 7 1/8   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 380  | 15     | 14 9/16  | 7 1/2   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 400  | 15 3/4 | 15 3/8   | 8       | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 440  | 17 1/4 | 16 15/16 | 8 5/8   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 480  | 19     | 18 1/2   | 9 1/2   | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 520  | 20 1/2 | 20 1/16  | 10 1/4  | 230                                                                               | 272  | 313  | 348  | 184                                                                                | 217  | 250  | 278  | 184                                                                                 | 217  | 250  | 278  |
|                                                                                   | 250  | 10     | 9 1/2    | 4 15/16 | 314                                                                               | 344  | 372  | 394  | 225                                                                                | 252  | 278  | 299  | 205                                                                                 | 234  | 262  | 285  |
|                                                                                   | 300  | 11 3/4 | 11 7/16  | 6       | 314                                                                               | 344  | 372  | 394  | 225                                                                                | 252  | 278  | 299  | 205                                                                                 | 234  | 262  | 285  |
|                                                                                   | 350  | 13 3/4 | 13 3/8   | 6 7/8   | 314                                                                               | 344  | 372  | 394  | 225                                                                                | 252  | 278  | 299  | 205                                                                                 | 234  | 262  | 285  |
|                                                                                   | 400  | 15 3/4 | 15 3/8   | 8       | 314                                                                               | 344  | 372  | 394  | 225                                                                                | 252  | 278  | 299  | 205                                                                                 | 234  | 262  | 285  |
|                                                                                   | 450  | 17 3/4 | 17 1/4   | 8 7/8   | 314                                                                               | 344  | 372  | 394  | 225                                                                                | 252  | 278  | 299  | 205                                                                                 | 234  | 262  | 285  |
|                                                                                   | 500  | 19 3/4 | 19 5/16  | 10      | 314                                                                               | 344  | 372  | 394  | 225                                                                                | 252  | 278  | 299  | 205                                                                                 | 234  | 262  | 285  |
|                                                                                   | 550  | 21 5/8 | 21 1/4   | 10 7/8  | 314                                                                               | 344  | 372  | 394  | 225                                                                                | 252  | 278  | 299  | 205                                                                                 | 234  | 262  | 285  |
|                                                                                   | 600  | 23 5/8 | 23 1/4   | 11 3/4  | 314                                                                               | 344  | 372  | 394  | 225                                                                                | 252  | 278  | 299  | 205                                                                                 | 234  | 262  | 285  |

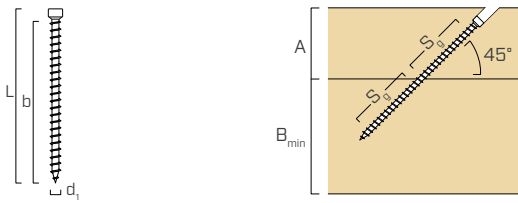
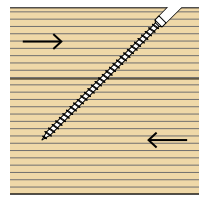
NOTES and GENERAL PRINCIPLES on page 179.

## ■ THREAD WITHDRAWAL (W) | WOOD

| geometry                                                                          |              |              |          | thread withdrawal $\alpha = 90^\circ$                                             |               |               |               | thread withdrawal $\alpha = 45^\circ$                                              |               |               |               | thread withdrawal $\alpha = 0^\circ$                                                |               |               |               |
|-----------------------------------------------------------------------------------|--------------|--------------|----------|-----------------------------------------------------------------------------------|---------------|---------------|---------------|------------------------------------------------------------------------------------|---------------|---------------|---------------|-------------------------------------------------------------------------------------|---------------|---------------|---------------|
|  |              |              |          |  |               |               |               |  |               |               |               |  |               |               |               |
| d <sub>1</sub>                                                                    | L            |              | b        | G                                                                                 |               |               |               | G                                                                                  |               |               |               | G                                                                                   |               |               |               |
|                                                                                   | [mm]<br>[in] | [mm]<br>[in] |          | 0.35<br>[lbf]                                                                     | 0.42<br>[lbf] | 0.49<br>[lbf] | 0.55<br>[lbf] | 0.35<br>[lbf]                                                                      | 0.42<br>[lbf] | 0.49<br>[lbf] | 0.55<br>[lbf] | 0.35<br>[lbf]                                                                       | 0.42<br>[lbf] | 0.49<br>[lbf] | 0.55<br>[lbf] |
| 5,3<br>0.21                                                                       | 80           | 3 1/8        | 2 3/4    | 260                                                                               | 301           | 336           | 369           | 236                                                                                | 274           | 306           | 336           | 78                                                                                  | 90            | 101           | 111           |
|                                                                                   | 100          | 4            | 3 1/2    | 340                                                                               | 393           | 440           | 484           | 310                                                                                | 358           | 401           | 440           | 102                                                                                 | 118           | 132           | 145           |
|                                                                                   | 120          | 4 3/4        | 4 3/8    | 420                                                                               | 486           | 544           | 598           | 383                                                                                | 443           | 495           | 544           | 126                                                                                 | 146           | 163           | 179           |
| 5,6<br>0.23                                                                       | 140          | 5 1/2        | 5 1/8    | 524                                                                               | 602           | 681           | 744           | 477                                                                                | 548           | 620           | 677           | 157                                                                                 | 181           | 204           | 223           |
|                                                                                   | 150          | 6            | 5 1/2    | 566                                                                               | 651           | 735           | 804           | 515                                                                                | 592           | 669           | 732           | 170                                                                                 | 195           | 221           | 241           |
|                                                                                   | 160          | 6 1/4        | 6        | 608                                                                               | 699           | 790           | 864           | 554                                                                                | 636           | 719           | 786           | 182                                                                                 | 210           | 237           | 259           |
| 7<br>0.28                                                                         | 80           | 3 1/8        | 2 3/4    | 350                                                                               | 407           | 459           | 504           | 318                                                                                | 370           | 418           | 458           | 105                                                                                 | 122           | 138           | 151           |
|                                                                                   | 100          | 4            | 3 1/2    | 461                                                                               | 536           | 605           | 663           | 419                                                                                | 488           | 550           | 604           | 138                                                                                 | 161           | 181           | 199           |
|                                                                                   | 120          | 4 3/4        | 4 3/8    | 572                                                                               | 665           | 750           | 823           | 520                                                                                | 605           | 683           | 749           | 172                                                                                 | 200           | 225           | 247           |
|                                                                                   | 140          | 5 1/2        | 5 1/8    | 683                                                                               | 794           | 896           | 983           | 621                                                                                | 723           | 815           | 895           | 205                                                                                 | 238           | 269           | 295           |
|                                                                                   | 160          | 6 1/4        | 6        | 794                                                                               | 923           | 1042          | 1143          | 722                                                                                | 840           | 948           | 1040          | 238                                                                                 | 277           | 312           | 343           |
|                                                                                   | 180          | 7 1/8        | 6 3/4    | 905                                                                               | 1052          | 1187          | 1303          | 823                                                                                | 958           | 1080          | 1185          | 271                                                                                 | 316           | 356           | 391           |
|                                                                                   | 200          | 8            | 7 1/2    | 1016                                                                              | 1182          | 1333          | 1463          | 924                                                                                | 1075          | 1213          | 1331          | 305                                                                                 | 354           | 400           | 439           |
|                                                                                   | 220          | 8 5/8        | 8 1/4    | 1127                                                                              | 1311          | 1479          | 1622          | 1025                                                                               | 1193          | 1345          | 1476          | 338                                                                                 | 393           | 444           | 487           |
|                                                                                   | 240          | 9 1/2        | 9 1/16   | 1238                                                                              | 1440          | 1624          | 1782          | 1127                                                                               | 1310          | 1478          | 1622          | 371                                                                                 | 432           | 487           | 535           |
|                                                                                   | 260          | 10 1/4       | 10       | 1349                                                                              | 1569          | 1770          | 1942          | 1228                                                                               | 1428          | 1611          | 1767          | 405                                                                                 | 471           | 531           | 583           |
|                                                                                   | 280          | 11           | 10 5/8   | 1460                                                                              | 1698          | 1916          | 2102          | 1329                                                                               | 1545          | 1743          | 1913          | 438                                                                                 | 509           | 575           | 631           |
|                                                                                   | 300          | 11 3/4       | 11 7/16  | 1571                                                                              | 1827          | 2061          | 2262          | 1430                                                                               | 1663          | 1876          | 2058          | 471                                                                                 | 548           | 618           | 679           |
| 9<br>0.36                                                                         | 340          | 13 3/8       | 13       | 1793                                                                              | 2086          | 2353          | 2581          | 1632                                                                               | 1898          | 2141          | 2349          | 538                                                                                 | 626           | 706           | 774           |
|                                                                                   | 380          | 15           | 14 9/16  | 2015                                                                              | 2344          | 2644          | 2901          | 1834                                                                               | 2133          | 2406          | 2640          | 605                                                                                 | 703           | 793           | 870           |
|                                                                                   | 160          | 6 1/4        | 6        | 1066                                                                              | 1221          | 1416          | 1554          | 970                                                                                | 1111          | 1288          | 1414          | 320                                                                                 | 366           | 425           | 466           |
|                                                                                   | 180          | 7 1/8        | 6 3/4    | 1217                                                                              | 1394          | 1616          | 1775          | 1107                                                                               | 1269          | 1471          | 1615          | 365                                                                                 | 418           | 485           | 532           |
|                                                                                   | 200          | 8            | 7 1/2    | 1368                                                                              | 1568          | 1817          | 1995          | 1245                                                                               | 1427          | 1654          | 1816          | 410                                                                                 | 470           | 545           | 599           |
|                                                                                   | 220          | 8 5/8        | 8 1/4    | 1519                                                                              | 1741          | 2018          | 2216          | 1383                                                                               | 1584          | 1836          | 2016          | 456                                                                                 | 522           | 605           | 665           |
|                                                                                   | 240          | 9 1/2        | 9 1/16   | 1671                                                                              | 1914          | 2219          | 2436          | 1520                                                                               | 1742          | 2019          | 2217          | 501                                                                                 | 574           | 666           | 731           |
|                                                                                   | 260          | 10 1/4       | 10       | 1822                                                                              | 2087          | 2419          | 2657          | 1658                                                                               | 1900          | 2202          | 2418          | 547                                                                                 | 626           | 726           | 797           |
|                                                                                   | 280          | 11           | 10 5/8   | 1973                                                                              | 2261          | 2620          | 2877          | 1795                                                                               | 2057          | 2384          | 2618          | 592                                                                                 | 678           | 786           | 863           |
|                                                                                   | 300          | 11 3/4       | 11 7/16  | 2124                                                                              | 2434          | 2821          | 3098          | 1933                                                                               | 2215          | 2567          | 2819          | 637                                                                                 | 730           | 846           | 929           |
|                                                                                   | 320          | 12 5/8       | 12 3/16  | 2275                                                                              | 2607          | 3022          | 3318          | 2071                                                                               | 2372          | 2750          | 3019          | 683                                                                                 | 782           | 907           | 995           |
|                                                                                   | 340          | 13 3/8       | 13       | 2426                                                                              | 2780          | 3223          | 3539          | 2208                                                                               | 2530          | 2933          | 3220          | 728                                                                                 | 834           | 967           | 1062          |
| 11<br>0.44                                                                        | 360          | 14 1/4       | 13 3/4   | 2578                                                                              | 2954          | 3423          | 3759          | 2346                                                                               | 2688          | 3115          | 3421          | 773                                                                                 | 886           | 1027          | 1128          |
|                                                                                   | 380          | 15           | 14 9/16  | 2729                                                                              | 3127          | 3624          | 3980          | 2483                                                                               | 2845          | 3298          | 3621          | 819                                                                                 | 938           | 1087          | 1194          |
|                                                                                   | 400          | 15 3/4       | 15 3/8   | 2880                                                                              | 3300          | 3825          | 4200          | 2621                                                                               | 3003          | 3481          | 3822          | 864                                                                                 | 990           | 1148          | 1260          |
|                                                                                   | 440          | 17 1/4       | 16 15/16 | 3182                                                                              | 3646          | 4227          | 4641          | 2896                                                                               | 3318          | 3846          | 4223          | 955                                                                                 | 1094          | 1268          | 1392          |
|                                                                                   | 480          | 19           | 18 1/2   | 3485                                                                              | 3993          | 4628          | 5082          | 3171                                                                               | 3634          | 4212          | 4625          | 1045                                                                                | 1198          | 1388          | 1525          |
|                                                                                   | 520          | 20 1/2       | 20 1/16  | 3787                                                                              | 4339          | 5030          | 5523          | 3446                                                                               | 3949          | 4577          | 5026          | 1136                                                                                | 1302          | 1509          | 1657          |
|                                                                                   | 250          | 10           | 9 1/2    | 1866                                                                              | 2164          | 2452          | 2687          | 1698                                                                               | 1969          | 2232          | 2445          | 560                                                                                 | 649           | 736           | 806           |
|                                                                                   | 300          | 11 3/4       | 11 7/16  | 2274                                                                              | 2636          | 2988          | 3273          | 2069                                                                               | 2399          | 2719          | 2979          | 682                                                                                 | 791           | 896           | 982           |
|                                                                                   | 350          | 13 3/4       | 13 3/8   | 2681                                                                              | 3109          | 3523          | 3860          | 2440                                                                               | 2829          | 3206          | 3513          | 804                                                                                 | 933           | 1057          | 1158          |
|                                                                                   | 400          | 15 3/4       | 15 3/8   | 3089                                                                              | 3581          | 4059          | 4447          | 2811                                                                               | 3259          | 3693          | 4046          | 927                                                                                 | 1074          | 1218          | 1334          |
|                                                                                   | 450          | 17 3/4       | 17 1/4   | 3496                                                                              | 4054          | 4594          | 5033          | 3182                                                                               | 3689          | 4181          | 4580          | 1049                                                                                | 1216          | 1378          | 1510          |
|                                                                                   | 500          | 19 3/4       | 19 5/16  | 3904                                                                              | 4526          | 5129          | 5620          | 3552                                                                               | 4119          | 4668          | 5114          | 1171                                                                                | 1358          | 1539          | 1686          |
|                                                                                   | 550          | 21 5/8       | 21 1/4   | 4311                                                                              | 4998          | 5665          | 6206          | 3923                                                                               | 4549          | 5155          | 5648          | 1293                                                                                | 1500          | 1699          | 1862          |
|                                                                                   | 600          | 23 5/8       | 23 1/4   | 4719                                                                              | 5471          | 6200          | 6793          | 4294                                                                               | 4978          | 5642          | 6182          | 1416                                                                                | 1641          | 1860          | 2038          |

NOTES and GENERAL PRINCIPLES on page 179.

## SLIDING RESISTANCE ( $R_v$ ) | WOOD

| geometry                                                                          |      |                      |          |         |         |           | $R_v$                                                                               |       |       |       |
|-----------------------------------------------------------------------------------|------|----------------------|----------|---------|---------|-----------|-------------------------------------------------------------------------------------|-------|-------|-------|
|  |      |                      |          |         |         |           |  |       |       |       |
| $d_1$                                                                             | L    |                      | b        | $S_g$   | A       | $B_{min}$ | G                                                                                   |       |       |       |
| [mm]<br>[in]                                                                      | [mm] | [in]                 | [in]     | [in]    | [in]    | [in]      | 0.35                                                                                | 0.42  | 0.49  | 0.55  |
|                                                                                   |      |                      |          |         |         |           | [lbf]                                                                               | [lbf] | [lbf] | [lbf] |
| <b>5,3</b><br><b>0.21</b>                                                         | 80   | 3 1/8 <sup>(1)</sup> | 2 3/4    | 1       | 1 1/4   | 1 7/8     | 66                                                                                  | 76    | 85    | 93    |
|                                                                                   | 100  | 4 <sup>(1)</sup>     | 3 1/2    | 1 3/8   | 1 9/16  | 2 1/8     | 90                                                                                  | 104   | 117   | 128   |
|                                                                                   | 120  | 4 3/4                | 4 3/8    | 1 3/4   | 1 13/16 | 2 3/8     | 115                                                                                 | 133   | 149   | 163   |
| <b>5,6</b><br><b>0.23</b>                                                         | 140  | 5 1/2                | 5 1/8    | 2 3/16  | 2 1/8   | 2 11/16   | 151                                                                                 | 173   | 196   | 214   |
|                                                                                   | 150  | 6                    | 5 1/2    | 2 3/8   | 2 1/4   | 2 13/16   | 164                                                                                 | 188   | 212   | 232   |
|                                                                                   | 160  | 6 1/4                | 6        | 2 9/16  | 2 3/8   | 3         | 176                                                                                 | 203   | 229   | 251   |
| <b>7</b><br><b>0.28</b>                                                           | 80   | 3 1/8 <sup>(1)</sup> | 2 3/4    | 1       | 1 1/4   | 1 7/8     | 91                                                                                  | 106   | 119   | 131   |
|                                                                                   | 100  | 4 <sup>(1)</sup>     | 3 1/2    | 1 3/8   | 1 9/16  | 2 1/8     | 125                                                                                 | 145   | 164   | 180   |
|                                                                                   | 120  | 4 3/4 <sup>(1)</sup> | 4 3/8    | 1 3/4   | 1 13/16 | 2 3/8     | 159                                                                                 | 185   | 208   | 229   |
|                                                                                   | 140  | 5 1/2 <sup>(1)</sup> | 5 1/8    | 2 3/16  | 2 1/8   | 2 11/16   | 198                                                                                 | 231   | 260   | 286   |
|                                                                                   | 160  | 6 1/4                | 6        | 2 9/16  | 2 3/8   | 3         | 232                                                                                 | 270   | 305   | 335   |
|                                                                                   | 180  | 7 1/8                | 6 3/4    | 2 15/16 | 2 11/16 | 3 1/4     | 267                                                                                 | 310   | 350   | 384   |
|                                                                                   | 200  | 8                    | 7 1/2    | 3 3/8   | 2 15/16 | 3 1/2     | 306                                                                                 | 356   | 402   | 441   |
|                                                                                   | 220  | 8 5/8                | 8 1/4    | 3 3/4   | 3 1/4   | 3 13/16   | 340                                                                                 | 396   | 446   | 490   |
|                                                                                   | 240  | 9 1/2                | 9 1/16   | 4 1/8   | 3 1/2   | 4 1/8     | 374                                                                                 | 435   | 491   | 539   |
|                                                                                   | 260  | 10 1/4               | 10       | 4 1/2   | 3 3/4   | 4 3/8     | 408                                                                                 | 475   | 536   | 588   |
|                                                                                   | 280  | 11                   | 10 5/8   | 4 15/16 | 4 1/16  | 4 5/8     | 448                                                                                 | 521   | 588   | 645   |
|                                                                                   | 300  | 11 3/4               | 11 7/16  | 5 5/16  | 4 3/8   | 4 15/16   | 482                                                                                 | 561   | 632   | 694   |
| <b>9</b><br><b>0.36</b>                                                           | 340  | 13 3/8               | 13       | 6 1/8   | 4 7/8   | 5 1/2     | 556                                                                                 | 646   | 729   | 800   |
|                                                                                   | 380  | 15                   | 14 9/16  | 6 7/8   | 5 7/16  | 6         | 624                                                                                 | 726   | 818   | 898   |
|                                                                                   | 160  | 6 1/4 <sup>(1)</sup> | 6        | 2 9/16  | 2 3/8   | 3         | 317                                                                                 | 363   | 420   | 462   |
|                                                                                   | 180  | 7 1/8                | 6 3/4    | 2 15/16 | 2 11/16 | 3 1/4     | 363                                                                                 | 416   | 482   | 529   |
|                                                                                   | 200  | 8                    | 7 1/2    | 3 3/8   | 2 15/16 | 3 1/2     | 417                                                                                 | 478   | 554   | 608   |
|                                                                                   | 220  | 8 5/8                | 8 1/4    | 3 3/4   | 3 1/4   | 3 13/16   | 463                                                                                 | 531   | 615   | 676   |
|                                                                                   | 240  | 9 1/2                | 9 1/16   | 4 1/8   | 3 1/2   | 4 1/8     | 510                                                                                 | 584   | 677   | 743   |
|                                                                                   | 260  | 10 1/4               | 10       | 4 1/2   | 3 3/4   | 4 3/8     | 556                                                                                 | 637   | 738   | 811   |
|                                                                                   | 280  | 11                   | 10 5/8   | 4 15/16 | 4 1/16  | 4 5/8     | 610                                                                                 | 699   | 810   | 890   |
|                                                                                   | 300  | 11 3/4               | 11 7/16  | 5 5/16  | 4 3/8   | 4 15/16   | 656                                                                                 | 752   | 872   | 957   |
|                                                                                   | 320  | 12 5/8               | 12 3/16  | 5 11/16 | 4 5/8   | 5 3/16    | 703                                                                                 | 805   | 933   | 1025  |
|                                                                                   | 340  | 13 3/8               | 13       | 6 1/8   | 4 7/8   | 5 1/2     | 757                                                                                 | 867   | 1005  | 1104  |
| <b>11</b><br><b>0.44</b>                                                          | 360  | 14 1/4               | 13 3/4   | 6 1/2   | 5 3/16  | 5 3/4     | 803                                                                                 | 920   | 1067  | 1171  |
|                                                                                   | 380  | 15                   | 14 9/16  | 6 7/8   | 5 7/16  | 6         | 849                                                                                 | 973   | 1128  | 1239  |
|                                                                                   | 400  | 15 3/4               | 15 3/8   | 7 1/4   | 5 11/16 | 6 1/4     | 896                                                                                 | 1026  | 1190  | 1306  |
|                                                                                   | 440  | 17 1/4               | 16 15/16 | 8 1/16  | 6 1/4   | 6 7/8     | 996                                                                                 | 1141  | 1323  | 1453  |
|                                                                                   | 480  | 19                   | 18 1/2   | 8 7/8   | 6 7/8   | 7 7/16    | 1096                                                                                | 1256  | 1456  | 1599  |
|                                                                                   | 520  | 20 1/2               | 20 1/16  | 9 5/8   | 7 3/8   | 8 1/16    | 1189                                                                                | 1363  | 1579  | 1734  |
|                                                                                   | 250  | 10                   | 9 1/2    | 4 3/8   | 3 5/8   | 4 3/16    | 583                                                                                 | 676   | 766   | 839   |
|                                                                                   | 300  | 11 3/4               | 11 7/16  | 5 5/16  | 4 3/8   | 4 15/16   | 708                                                                                 | 820   | 930   | 1019  |
|                                                                                   | 350  | 13 3/4               | 13 3/8   | 6 1/4   | 5 1/16  | 5 5/8     | 832                                                                                 | 965   | 1094  | 1198  |
|                                                                                   | 400  | 15 3/4               | 15 3/8   | 7 1/4   | 5 11/16 | 6 1/4     | 966                                                                                 | 1120  | 1269  | 1390  |
|                                                                                   | 450  | 17 3/4               | 17 1/4   | 8 1/4   | 6 7/16  | 7         | 1099                                                                                | 1274  | 1444  | 1582  |
|                                                                                   | 500  | 19 3/4               | 19 5/16  | 9 1/4   | 7 1/8   | 7 11/16   | 1232                                                                                | 1428  | 1619  | 1774  |
| <b>11</b><br><b>0.44</b>                                                          | 550  | 21 5/8               | 21 1/4   | 10 1/4  | 7 13/16 | 8 7/16    | 1365                                                                                | 1583  | 1794  | 1965  |
|                                                                                   | 600  | 23 5/8               | 23 1/4   | 11 1/4  | 8 5/8   | 9 1/4     | 1498                                                                                | 1737  | 1969  | 2157  |

<sup>(1)</sup> The embedded thread length does not comply with the minimum requirement of ESR-4645 (8 times the outer thread diameter for screws installed at an angle  $0^\circ \leq \alpha < 90^\circ$  to the grain).

# CLT | FLOOR-TO-BEAM | FLOOR-TO-WALL

|                                        |     |         |                 | SHEAR          |                |                |                 |                |                |                |                 | SPACING              |                   |         |
|----------------------------------------|-----|---------|-----------------|----------------|----------------|----------------|-----------------|----------------|----------------|----------------|-----------------|----------------------|-------------------|---------|
| geometry                               |     |         |                 | CLT-to-wood    |                |                |                 | CLT-to-CLT     |                |                |                 | steel tension        | fastener in a row |         |
|                                        |     |         |                 |                |                |                |                 |                |                |                |                 |                      |                   |         |
| side member thickness (wall/floor) = A |     |         | suggested screw | R <sub>v</sub> | Z <sub>⊥</sub> | R <sub>v</sub> | Z <sub>m⊥</sub> | R <sub>v</sub> | Z <sub>⊥</sub> | R <sub>v</sub> | Z <sub>m⊥</sub> | R <sub>tens,45</sub> | minimum           | typical |
| [mm]                                   |     | [in]    | CODE            | [lbf]          | [lbf]          | [lbf]          | [lbf]           | [lbf]          | [lbf]          | [lbf]          | [lbf]           | [lbf]                | [in]              | [in]    |
| 3 PLY                                  | 60  | 2 3/8   | VGZEVO5160      | 193            | 125            | 193            | 125             | 129            | 84             | 129            | 84              | 778                  | 3 5/16            | 4       |
|                                        |     |         | VGZEVO7160      | 259            | 168            | 259            | 168             | 174            | 112            | 174            | 112             | 1025                 | 4 1/8             | 6       |
|                                        |     |         | VGZEVO9160      | 352            | 217            | 352            | 217             | 236            | 146            | 236            | 146             | 1732                 | 5 5/16            | 7       |
|                                        | 79  | 3 1/8   | VGZEVO7220      | 394            | 168            | 394            | 168             | 264            | 112            | 264            | 112             | 1025                 | 4 1/8             | 6       |
|                                        |     |         | VGZEVO9220      | 526            | 217            | 526            | 217             | 352            | 146            | 352            | 146             | 1732                 | 5 5/16            | 7       |
|                                        |     |         | VGZEVO11250     | 571            | 234            | 571            | 252             | 383            | 157            | 383            | 169             | 2263                 | 6 1/2             | 9       |
|                                        | 105 | 4 1/8   | VGZEVO7300      | 544            | 168            | 544            | 168             | 364            | 112            | 364            | 112             | 1025                 | 4 1/8             | 6       |
|                                        |     |         | VGZEVO9300      | 726            | 217            | 726            | 217             | 486            | 146            | 486            | 146             | 1732                 | 5 5/16            | 7       |
|                                        |     |         | VGZEVO11300     | 790            | 234            | 790            | 252             | 529            | 157            | 529            | 169             | 2263                 | 6 1/2             | 9       |
|                                        | 120 | 4 3/4   | VGZEVO7340      | 633            | 168            | 633            | 168             | 424            | 112            | 424            | 112             | 1025                 | 4 1/8             | 6       |
|                                        |     |         | VGZEVO9340      | 846            | 217            | 846            | 217             | 567            | 146            | 567            | 146             | 1732                 | 5 5/16            | 7       |
|                                        |     |         | VGZEVO11350     | 921            | 234            | 921            | 252             | 617            | 157            | 617            | 169             | 2263                 | 6 1/2             | 9       |
| 5 PLY                                  | 100 | 3 15/16 | VGZEVO7280      | 516            | 168            | 516            | 168             | 346            | 112            | 346            | 112             | 1025                 | 4 1/8             | 6       |
|                                        |     |         | VGZEVO9280      | 688            | 217            | 688            | 217             | 461            | 146            | 461            | 146             | 1732                 | 5 5/16            | 7       |
|                                        |     |         | VGZEVO11300     | 749            | 234            | 749            | 252             | 502            | 157            | 502            | 169             | 2263                 | 6 1/2             | 9       |
|                                        | 140 | 5 1/2   | VGZEVO7380      | 705            | 168            | 705            | 168             | 472            | 112            | 472            | 112             | 1025                 | 4 1/8             | 6       |
|                                        |     |         | VGZEVO9400      | 1001           | 217            | 1001           | 217             | 671            | 146            | 671            | 146             | 1732                 | 5 5/16            | 7       |
|                                        |     |         | VGZEVO11400     | 1090           | 234            | 1090           | 252             | 730            | 157            | 730            | 169             | 2263                 | 6 1/2             | 9       |
|                                        | 175 | 6 7/8   | VGZEVO9480      | 1232           | 217            | 1232           | 217             | 825            | 146            | 825            | 146             | 1732                 | 5 5/16            | 7       |
|                                        |     |         | VGZEVO11500     | 1390           | 234            | 1390           | 252             | 931            | 157            | 931            | 169             | 2263                 | 6 1/2             | 9       |
|                                        |     |         | VGZEVO9520      | 1255           | 217            | 1255           | 217             | 841            | 146            | 841            | 146             | 1732                 | 5 5/16            | 7       |
|                                        | 200 | 7 7/8   | VGZEVO11550     | 1553           | 234            | 1553           | 252             | 1041           | 157            | 1041           | 169             | 2263                 | 6 1/2             | 9       |
|                                        |     |         | VGZEVO7380      | 703            | 168            | 703            | 168             | 471            | 112            | 471            | 112             | 1025                 | 4 1/8             | 6       |
|                                        |     |         | VGZEVO9400      | 1003           | 217            | 1003           | 217             | 672            | 146            | 672            | 146             | 1732                 | 5 5/16            | 7       |
| 7 PLY                                  | 140 | 5 1/2   | VGZEVO11400     | 1093           | 234            | 1093           | 252             | 732            | 157            | 732            | 169             | 2263                 | 6 1/2             | 9       |
|                                        |     |         | VGZEVO9520      | 1329           | 217            | 1329           | 217             | 891            | 146            | 891            | 146             | 1732                 | 5 5/16            | 7       |
|                                        |     |         | VGZEVO11550     | 1527           | 234            | 1527           | 252             | 1023           | 157            | 1023           | 169             | 2263                 | 6 1/2             | 9       |

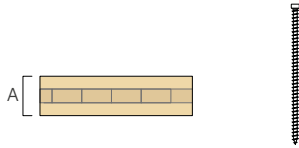
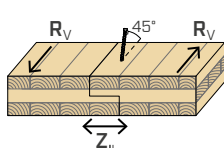
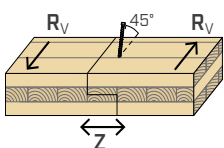
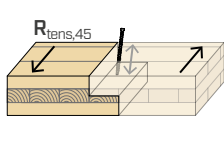
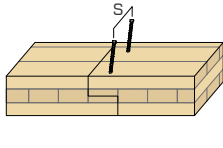
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## CLT | BUTT JOINT (double 45° inclination)

| geometry            |            |         |                 | SHEAR          |                         | SPACING       |         |
|---------------------|------------|---------|-----------------|----------------|-------------------------|---------------|---------|
|                     |            |         |                 | butt joint     |                         | steel tension |         |
|                     |            |         |                 |                |                         |               |         |
| panel thickness = A |            |         | suggested screw | R <sub>v</sub> | R <sub>tens,45+45</sub> | minimum       | typical |
| [mm]                | [in]       | CODE    | [lbf]           |                |                         |               |         |
| 3 PLY               | 60         | 2 3/8   | VGZEVO580       | 37             | 500                     | 3 1/8         | 4       |
|                     |            |         | VGZEVO780       | 51             | 725                     | 4 1/8         | 6       |
|                     | 79         | 3 1/8   | VGZEVO5100      | 52             | 500                     | 3 1/8         | 4       |
|                     |            |         | VGZEVO7100      | 72             | 725                     | 4 1/8         | 6       |
|                     | 105        | 4 1/8   | VGZEVO5120      | 67             | 500                     | 3 1/8         | 4       |
|                     |            |         | VGZEVO7120      | 92             | 725                     | 4 1/8         | 6       |
|                     | 120        | 4 3/4   | VGZEVO5160      | 100            | 550                     | 3 5/16        | 4       |
|                     |            |         | VGZEVO7160      | 134            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9160      | 179            | 1225                    | 5 5/16        | 7       |
|                     | 5 PLY      | 100     | 3 15/16         | VGZEVO5120     | 67                      | 500           | 3 1/8   |
| VGZEVO7120          |            |         |                 | 92             | 725                     | 4 1/8         | 6       |
| 140                 |            | 5 1/2   | VGZEVO7180      | 154            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9180      | 207            | 1225                    | 5 5/16        | 7       |
| 175                 |            | 6 7/8   | VGZEVO7220      | 195            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9220      | 262            | 1225                    | 5 5/16        | 7       |
| 200                 |            | 7 7/8   | VGZEVO7260      | 236            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9260      | 317            | 1225                    | 5 5/16        | 7       |
|                     |            |         | VGZEVO11250     | 331            | 1600                    | 6 1/2         | 9       |
| 7 PLY               |            | 140     | 5 1/2           | VGZEVO7180     | 154                     | 725           | 4 1/8   |
|                     | VGZEVO9180 |         |                 | 207            | 1225                    | 5 5/16        | 7       |
|                     | 191        | 7 1/2   | VGZEVO7240      | 216            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9240      | 289            | 1225                    | 5 5/16        | 7       |
|                     |            |         | VGZEVO11250     | 331            | 1600                    | 6 1/2         | 9       |
|                     | 244        | 9 5/8   | VGZEVO7340      | 319            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9320      | 400            | 1225                    | 5 5/16        | 7       |
|                     |            |         | VGZEVO11300     | 406            | 1600                    | 6 1/2         | 9       |
|                     | 280        | 11      | VGZEVO7380      | 360            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9380      | 482            | 1225                    | 5 5/16        | 7       |
| VGZEVO11350         |            |         | 481             | 1600           | 6 1/2                   | 9             |         |
| 9 PLY               | 180        | 7 1/16  | VGZEVO7220      | 195            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9220      | 262            | 1225                    | 5 5/16        | 7       |
|                     |            |         | VGZEVO11250     | 331            | 1600                    | 6 1/2         | 9       |
|                     | 267        | 10 1/2  | VGZEVO7340      | 319            | 725                     | 4 1/8         | 6       |
|                     |            |         | VGZEVO9360      | 455            | 1225                    | 5 5/16        | 7       |
|                     |            |         | VGZEVO11350     | 481            | 1600                    | 6 1/2         | 9       |
|                     | 314        | 12 3/8  | VGZEVO9400      | 510            | 1225                    | 5 5/16        | 7       |
|                     |            |         | VGZEVO11400     | 556            | 1600                    | 6 1/2         | 9       |
|                     | 360        | 14 3/16 | VGZEVO9480      | 620            | 1225                    | 5 5/16        | 7       |
|                     |            |         | VGZEVO11450     | 631            | 1600                    | 6 1/2         | 9       |

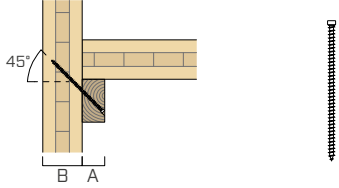
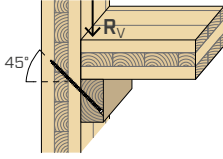
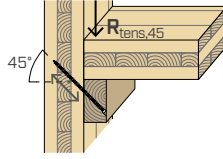
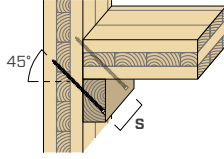
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# CLT | HALF LAP

| geometry                                                                          |      |         | SHEAR                                                                             |                          |                                                                                   |                         |                                                                                     |                 |                                                                                     | SPACING |  |
|-----------------------------------------------------------------------------------|------|---------|-----------------------------------------------------------------------------------|--------------------------|-----------------------------------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|---------|--|
|                                                                                   |      |         | half lap<br>orientation 1                                                         |                          | half lap<br>orientation 2                                                         |                         | steel tension                                                                       |                 | fastener<br>in a row                                                                |         |  |
|  |      |         |  |                          |  |                         |  |                 |  |         |  |
| panel thickness<br>(wall/floor) = A                                               |      |         | suggested<br>screw                                                                |                          |                                                                                   |                         |                                                                                     |                 |                                                                                     |         |  |
| [mm]                                                                              | [in] | CODE    | R <sub>v</sub><br>[lbf]                                                           | Z <sub>II</sub><br>[lbf] | R <sub>v</sub><br>[lbf]                                                           | Z <sub>⊥</sub><br>[lbf] | R <sub>tens,45</sub><br>[lbf]                                                       | minimum<br>[in] | typical<br>[in]                                                                     |         |  |
| 3 PLY                                                                             | 60   | 2 3/8   | VGZEVO580                                                                         | 73                       | 125                                                                               | 73                      | 125                                                                                 | 707             | 3 1/8                                                                               | 4       |  |
|                                                                                   |      |         | VGZEVO780                                                                         | 103                      | 165                                                                               | 103                     | 132                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   | 79   | 3 1/8   | VGZEVO5100                                                                        | 92                       | 125                                                                               | 92                      | 125                                                                                 | 707             | 3 1/8                                                                               | 4       |  |
|                                                                                   |      |         | VGZEVO7100                                                                        | 130                      | 194                                                                               | 130                     | 155                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   | 105  | 4 1/8   | VGZEVO5120                                                                        | 98                       | 125                                                                               | 98                      | 125                                                                                 | 707             | 3 1/8                                                                               | 4       |  |
|                                                                                   |      |         | VGZEVO7120                                                                        | 138                      | 199                                                                               | 138                     | 159                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   | 120  | 4 3/4   | VGZEVO5140                                                                        | 131                      | 125                                                                               | 131                     | 125                                                                                 | 778             | 3 5/16                                                                              | 4       |  |
|                                                                                   |      |         | VGZEVO7140                                                                        | 176                      | 210                                                                               | 176                     | 168                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
| VGZEVO9160                                                                        |      |         | 352                                                                               | 272                      | 352                                                                               | 217                     | 1732                                                                                | 5 5/16          | 7                                                                                   |         |  |
| 5 PLY                                                                             | 100  | 3 15/16 | VGZEVO5120                                                                        | 108                      | 125                                                                               | 108                     | 125                                                                                 | 707             | 3 1/8                                                                               | 4       |  |
|                                                                                   |      |         | VGZEVO7120                                                                        | 152                      | 208                                                                               | 152                     | 166                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   | 140  | 5 1/2   | VGZEVO7180                                                                        | 285                      | 210                                                                               | 285                     | 168                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   |      |         | VGZEVO9180                                                                        | 385                      | 272                                                                               | 385                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   | 175  | 6 7/8   | VGZEVO7220                                                                        | 348                      | 210                                                                               | 348                     | 168                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   |      |         | VGZEVO9220                                                                        | 471                      | 272                                                                               | 471                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   | 200  | 7 7/8   | VGZEVO7260                                                                        | 440                      | 210                                                                               | 440                     | 168                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   |      |         | VGZEVO9260                                                                        | 594                      | 272                                                                               | 594                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
| VGZEVO11250                                                                       |      |         | 589                                                                               | 344                      | 589                                                                               | 234                     | 2263                                                                                | 6 1/2           | 9                                                                                   |         |  |
| 7 PLY                                                                             | 140  | 5 1/2   | VGZEVO7180                                                                        | 284                      | 210                                                                               | 284                     | 168                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   |      |         | VGZEVO9180                                                                        | 384                      | 272                                                                               | 384                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   | 191  | 7 1/2   | VGZEVO7240                                                                        | 385                      | 210                                                                               | 385                     | 168                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   |      |         | VGZEVO9240                                                                        | 520                      | 272                                                                               | 520                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   | 244  | 9 5/8   | VGZEVO11250                                                                       | 630                      | 344                                                                               | 630                     | 234                                                                                 | 2263            | 6 1/2                                                                               | 9       |  |
|                                                                                   |      |         | VGZEVO9320                                                                        | 753                      | 272                                                                               | 753                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   | 280  | 11      | VGZEVO11300                                                                       | 702                      | 344                                                                               | 702                     | 234                                                                                 | 2263            | 6 1/2                                                                               | 9       |  |
|                                                                                   |      |         | VGZEVO7380                                                                        | 703                      | 210                                                                               | 703                     | 168                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
| VGZEVO9380                                                                        |      |         | 947                                                                               | 272                      | 947                                                                               | 217                     | 1732                                                                                | 5 5/16          | 7                                                                                   |         |  |
| 9 PLY                                                                             | 180  | 7 1/16  | VGZEVO11350                                                                       | 853                      | 344                                                                               | 853                     | 234                                                                                 | 2263            | 6 1/2                                                                               | 9       |  |
|                                                                                   |      |         | VGZEVO7220                                                                        | 332                      | 210                                                                               | 332                     | 168                                                                                 | 1025            | 4 1/8                                                                               | 6       |  |
|                                                                                   | 267  | 10 1/2  | VGZEVO9220                                                                        | 450                      | 272                                                                               | 450                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   |      |         | VGZEVO9360                                                                        | 888                      | 272                                                                               | 888                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   | 314  | 12 3/8  | VGZEVO11350                                                                       | 910                      | 344                                                                               | 910                     | 234                                                                                 | 2263            | 6 1/2                                                                               | 9       |  |
|                                                                                   |      |         | VGZEVO9400                                                                        | 923                      | 272                                                                               | 923                     | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   | 360  | 14 3/16 | VGZEVO11400                                                                       | 1010                     | 344                                                                               | 1010                    | 234                                                                                 | 2263            | 6 1/2                                                                               | 9       |  |
|                                                                                   |      |         | VGZEVO9480                                                                        | 1189                     | 272                                                                               | 1189                    | 217                                                                                 | 1732            | 5 5/16                                                                              | 7       |  |
|                                                                                   |      |         | VGZEVO11450                                                                       | 1117                     | 344                                                                               | 1117                    | 234                                                                                 | 2263            | 6 1/2                                                                               | 9       |  |

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## CLT | LEDGER CONNECTION

|                                                                                   |      |                                    |                   | SHEAR                                                                             |                                                                                    | SPACING                                                                             |         |
|-----------------------------------------------------------------------------------|------|------------------------------------|-------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------|
| geometry                                                                          |      |                                    |                   | CLT-to-ledger                                                                     | steel tension                                                                      | fastener in a row                                                                   |         |
|  |      |                                    |                   |  |  |  |         |
| main member thickness (wall) = B                                                  |      | side member thickness (ledger) = A | suggested screw   | $R_v$                                                                             | $R_{tens,45}$                                                                      | minimum                                                                             | typical |
| [mm]                                                                              | [in] | [in]                               | CODE              | [lbf]                                                                             | [lbf]                                                                              | [in]                                                                                | [in]    |
| 3 PLY                                                                             | 60   | 2 3/8                              | 1 3/4 VGZEVO5120  | 176                                                                               | 707                                                                                | 1 1/16                                                                              | 4       |
|                                                                                   |      |                                    | 1 3/4 VGZEVO7120  | 246                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   | 79   | 3 1/8                              | 1 3/4 VGZEVO5120  | 176                                                                               | 707                                                                                | 1 1/16                                                                              | 4       |
|                                                                                   |      |                                    | 1 3/4 VGZEVO7120  | 246                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   | 105  | 4 1/8                              | 1 3/4 VGZEVO5120  | 176                                                                               | 707                                                                                | 1 1/16                                                                              | 4       |
|                                                                                   |      |                                    | 1 3/4 VGZEVO7120  | 246                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
| 5 PLY                                                                             | 120  | 4 3/4                              | 1 3/4 VGZEVO7160  | 246                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   |      |                                    | 1 3/4 VGZEVO9160  | 340                                                                               | 1732                                                                               | 1 3/4                                                                               | 7       |
|                                                                                   | 100  | 3 15/16                            | 1 3/4 VGZEVO7120  | 246                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   |      |                                    | 3 1/2 VGZEVO7260  | 570                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   |      |                                    | 3 1/2 VGZEVO9260  | 786                                                                               | 1732                                                                               | 1 3/4                                                                               | 7       |
|                                                                                   | 140  | 5 1/2                              | 3 1/2 VGZEVO11250 | 830                                                                               | 2263                                                                               | 2 3/16                                                                              | 9       |
|                                                                                   |      |                                    | 5 1/4 VGZEVO7380  | 874                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   |      |                                    | 5 1/4 VGZEVO9380  | 1172                                                                              | 1732                                                                               | 1 3/4                                                                               | 7       |
|                                                                                   | 175  | 6 7/8                              | 5 1/4 VGZEVO11400 | 1314                                                                              | 2263                                                                               | 2 3/16                                                                              | 9       |
|                                                                                   |      |                                    | 5 1/4 VGZEVO7380  | 874                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   |      |                                    | 5 1/4 VGZEVO9400  | 1232                                                                              | 1732                                                                               | 1 3/4                                                                               | 7       |
|                                                                                   | 200  | 7 7/8                              | 5 1/4 VGZEVO11400 | 1314                                                                              | 2263                                                                               | 2 3/16                                                                              | 9       |
| 7 PLY                                                                             | 140  | 5 1/2                              | 3 1/2 VGZEVO7260  | 570                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   |      |                                    | 3 1/2 VGZEVO9260  | 786                                                                               | 1732                                                                               | 1 3/4                                                                               | 7       |
|                                                                                   |      |                                    | 3 1/2 VGZEVO11250 | 830                                                                               | 2263                                                                               | 2 3/16                                                                              | 9       |
|                                                                                   | 191  | 7 1/2                              | 5 1/4 VGZEVO7380  | 874                                                                               | 1025                                                                               | 1 3/8                                                                               | 6       |
|                                                                                   |      |                                    | 5 1/4 VGZEVO9400  | 1232                                                                              | 1732                                                                               | 1 3/4                                                                               | 7       |
|                                                                                   |      |                                    | 5 1/4 VGZEVO11400 | 1314                                                                              | 2263                                                                               | 2 3/16                                                                              | 9       |
|                                                                                   | 244  | 9 5/8                              | 6 1/2 VGZEVO9480  | 1510                                                                              | 1732                                                                               | 1 3/4                                                                               | 7       |
|                                                                                   |      |                                    | 6 1/2 VGZEVO11500 | 1654                                                                              | 2263                                                                               | 2 3/16                                                                              | 9       |
|                                                                                   | 280  | 11                                 | 6 1/2 VGZEVO9520  | 1551                                                                              | 1732                                                                               | 1 3/4                                                                               | 7       |
|                                                                                   |      |                                    | 6 1/2 VGZEVO11550 | 1654                                                                              | 2263                                                                               | 2 3/16                                                                              | 9       |

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### NOTES

- Ledger Specific Gravity is considered as  $G = 0.49$ .
- The thread axial resistance to withdrawal has been evaluated considering an effective thread length equal to  $S_g$ . The connectors must be inserted at  $45^\circ$  with respect to the shear plane.
- Force-to-fastener angle is considered as  $45^\circ$ .
- The use of the JIG VGZ 45 template is recommended for professional installation of the connectors in this application.

## WOOD | CROSSED SCREW CONNECTION

| geometry                     |              |              |                    | crossed screws |                      |              |                |               |
|------------------------------|--------------|--------------|--------------------|----------------|----------------------|--------------|----------------|---------------|
|                              |              |              |                    |                |                      |              |                |               |
| $H_{HT,min}$<br>$h_{NT,min}$ | $B_{HT,min}$ | $b_{NT,min}$ | suggested<br>screw | m              | number of<br>couples | $R_v$        |                | $R_{tens,45}$ |
| [in]                         | [in]         | [in]         | CODE               | [in]           |                      | SPF<br>[lbf] | D.Fir<br>[lbf] | [lbf]         |
| 6                            | 3 1/8        | 3 1/8        | VGZEVO7200         | 2 15/16        | 1                    | 712          | 804            | 2051          |
|                              |              | 3 1/2        |                    |                | 2                    | 1425         | 1607           | 4101          |
|                              |              | 5 1/8        |                    |                | 3                    | 2137         | 2411           | 6152          |
|                              |              | 3 1/2        | VGZEVO9200         | 2 15/16        | 1                    | 956          | 1108           | 3465          |
|                              |              | 5 1/8        |                    |                | 2                    | 1911         | 2215           | 6930          |
|                              |              | 5 1/2        |                    |                | 3                    | 2867         | 3323           | 10394         |
| 7 1/2                        | 3 1/2        | 3 1/8        | VGZEVO7260         | 3 3/4          | 1                    | 950          | 1071           | 2051          |
|                              |              | 3 1/2        |                    |                | 2                    | 1900         | 2143           | 4101          |
|                              |              | 5 1/8        |                    |                | 3                    | 2849         | 3214           | 6152          |
|                              |              | 3 1/2        | VGZEVO9260         | 3 3/4          | 1                    | 1274         | 1477           | 3465          |
|                              |              | 5 1/8        |                    |                | 2                    | 2548         | 2954           | 6930          |
|                              |              | 5 1/2        |                    |                | 3                    | 3822         | 4430           | 10394         |
|                              |              | 5 1/8        | VGZEVO11250        | 3 9/16         | 1                    | 1351         | 1531           | 4525          |
|                              |              | 5 1/2        |                    |                | 2                    | 2703         | 3063           | 9051          |
|                              |              | 6 3/4        |                    |                | 3                    | 4054         | 4594           | 13576         |
| 9                            | 5 1/8        | 3 1/8        | VGZEVO7300         | 4 5/16         | 1                    | 1121         | 1265           | 2051          |
|                              |              | 3 1/2        |                    |                | 2                    | 2242         | 2530           | 4101          |
|                              |              | 5 1/8        |                    |                | 3                    | 3364         | 3794           | 6152          |
|                              |              | 3 1/2        | VGZEVO9300         | 4 5/16         | 1                    | 1504         | 1743           | 3465          |
|                              |              | 5 1/8        |                    |                | 2                    | 3008         | 3487           | 6930          |
|                              |              | 5 1/2        |                    |                | 3                    | 4512         | 5230           | 10394         |
|                              |              | 5 1/8        | VGZEVO11300        | 4 5/16         | 1                    | 1641         | 1860           | 4525          |
|                              |              | 5 1/2        |                    |                | 2                    | 3282         | 3719           | 9051          |
|                              |              | 6 3/4        |                    |                | 3                    | 4923         | 5579           | 13576         |
| 10 1/2                       | 5 1/2        | 3 1/8        | VGZEVO7340         | 5 1/8          | 1                    | 1293         | 1458           | 2051          |
|                              |              | 3 1/2        |                    |                | 2                    | 2585         | 2917           | 4101          |
|                              |              | 5 1/8        |                    |                | 3                    | 3878         | 4375           | 6152          |
|                              |              | 3 1/2        | VGZEVO9360         | 5 1/8          | 1                    | 1840         | 2133           | 3465          |
|                              |              | 5 1/8        |                    |                | 2                    | 3681         | 4266           | 6930          |
|                              |              | 5 1/2        |                    |                | 3                    | 5521         | 6399           | 10394         |
|                              |              | 5 1/8        | VGZEVO11350        | 5              | 1                    | 1930         | 2188           | 4525          |
|                              |              | 5 1/2        |                    |                | 2                    | 3861         | 4376           | 9051          |
|                              |              | 6 3/4        |                    |                | 3                    | 5791         | 6563           | 13576         |
| 12                           | 6 3/4        | 3 1/8        | VGZEVO7380         | 5 11/16        | 1                    | 1451         | 1637           | 2051          |
|                              |              | 3 1/2        |                    |                | 2                    | 2902         | 3274           | 4101          |
|                              |              | 5 1/8        |                    |                | 3                    | 4353         | 4910           | 6152          |
|                              |              | 3 1/2        | VGZEVO9400         | 5 11/16        | 1                    | 2053         | 2379           | 3465          |
|                              |              | 5 1/8        |                    |                | 2                    | 4105         | 4758           | 6930          |
|                              |              | 5 1/2        |                    |                | 3                    | 6158         | 7138           | 10394         |
|                              |              | 5 1/8        | VGZEVO11400        | 5 11/16        | 1                    | 2239         | 2538           | 4525          |
|                              |              | 5 1/2        |                    |                | 2                    | 4479         | 5076           | 9051          |
|                              |              | 6 3/4        |                    |                | 3                    | 6718         | 7614           | 13576         |
| 13 1/2                       | 6 3/4        | 3 1/2        | VGZEVO9480         | 6 13/16        | 1                    | 2513         | 2912           | 3465          |
|                              |              | 5 1/8        |                    |                | 2                    | 5025         | 5825           | 6930          |
|                              |              | 5 1/2        |                    |                | 3                    | 7538         | 8737           | 10394         |
|                              |              | 5 1/8        | VGZEVO11450        | 6 13/16        | 1                    | 2548         | 2888           | 4525          |
|                              |              | 5 1/2        |                    |                | 2                    | 5096         | 5776           | 9051          |
|                              |              | 6 3/4        |                    |                | 3                    | 7644         | 8664           | 13576         |

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## WOOD | CROSSED SCREW CONNECTION

| geometry                     |              |              |                         | crossed screws |                   |              |       |               |
|------------------------------|--------------|--------------|-------------------------|----------------|-------------------|--------------|-------|---------------|
|                              |              |              |                         |                |                   |              |       |               |
| $h_{HT,min}$<br>$h_{NT,min}$ | $B_{HT,min}$ | $b_{NT,min}$ | suggested screw<br>CODE | m              | number of couples | $R_v$<br>SPF | D.Fir | $R_{tens,45}$ |
| [in]                         | [in]         | [in]         |                         | [in]           |                   | [lbf]        | [lbf] | [lbf]         |
| 15                           | 7 1/2        | 3 1/2        | VGZEVO9520              | 7 3/8          | 1                 | 2725         | 3159  | 3465          |
|                              |              | 5 1/8        |                         |                | 2                 | 5450         | 6317  | 6930          |
|                              |              | 5 1/2        |                         |                | 3                 | 8175         | 9476  | 10394         |
|                              |              | 5 1/8        | VGZEVO11500             | 7 1/2          | 1                 | 2857         | 3238  | 4525          |
|                              |              | 5 1/2        |                         |                | 2                 | 5714         | 6476  | 9051          |
|                              |              | 6 3/4        |                         |                | 3                 | 8571         | 9714  | 13576         |
| 16 1/2                       | 9            | 5 1/8        | VGZEVO11550             | 8 3/16         | 1                 | 3166         | 3588  | 4525          |
|                              |              | 5 1/2        |                         |                | 2                 | 6332         | 7176  | 9051          |
|                              |              | 6 3/4        |                         |                | 3                 | 9498         | 10764 | 13576         |
| 18                           | 9            | 5 1/8        | VGZEVO11600             | 8 7/16         | 1                 | 3475         | 3938  | 4525          |
|                              |              | 5 1/2        |                         |                | 2                 | 6949         | 7876  | 9051          |
|                              |              | 6 3/4        |                         |                | 3                 | 10424        | 11814 | 13576         |

## WOOD | TOE-NAIL CONNECTION

| geometry     |                    |             |       |                         | wooden frame (Northern species) |       |       | wooden frame (SPF) |       |       |
|--------------|--------------------|-------------|-------|-------------------------|---------------------------------|-------|-------|--------------------|-------|-------|
|              |                    |             |       |                         |                                 |       |       |                    |       |       |
| $b_{st,min}$ | $h_{st}=b_{t,min}$ | $h_{t,min}$ | m     | suggested screw<br>CODE | $R_{ax}$                        | $Z_h$ | $Z_p$ | $R_{ax}$           | $Z_h$ | $Z_p$ |
| [in]         | [in]               | [in]        | [in]  |                         | [lbf]                           | [lbf] | [lbf] | [lbf]              | [lbf] | [lbf] |
| 2            | 4                  | 4           | 3     | VGZEVO5120              | 109                             | 100   | 96    | 126                | 125   | 125   |
|              |                    |             | 3     | VGZEVO5140              | 160                             | 106   | 106   | 184                | 125   | 125   |
|              |                    |             | 3     | VGZEVO5150              | 160                             | 106   | 106   | 184                | 125   | 125   |
|              |                    |             | 3     | VGZEVO5160              | 160                             | 106   | 106   | 184                | 125   | 125   |
|              |                    |             | 3     | VGZEVO7160              | 211                             | 142   | 142   | 245                | 168   | 168   |
|              |                    |             | 3     | VGZEVO7180              | 211                             | 142   | 142   | 245                | 168   | 168   |
| 2            | 4                  | 4           | 4     | VGZEVO7200              | 297                             | 142   | 142   | 346                | 168   | 168   |
|              |                    |             | 4 3/4 | VGZEVO7220              | 362                             | 142   | 142   | 421                | 168   | 168   |
|              |                    |             | 5 1/2 | VGZEVO7240              | 424                             | 142   | 142   | 493                | 168   | 168   |
|              |                    |             | 6     | VGZEVO7260              | 458                             | 142   | 142   | 532                | 168   | 168   |

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### CROSSED SCREW CONNECTION

- The thread axial resistance to withdrawal has been evaluated considering an effective thread length equal to  $S_g$ . The connectors must be inserted at 45° with respect to the shear plane.
- The connector compression design strength is the lower between the withdrawal-side design strength and the instability design strength.
- Force-to-fastener angle is considered as 45°.
- The use of the JIG VGZ 45 template is recommended for professional installation of the connectors in this application.

### TOE-NAIL CONNECTION

- The static values were calculated assuming an insertion angle of the screw with respect to the vertical of 20°.
- For uplift loads, the screw is assumed to resist with an axial mechanism. For the other load directions ( $Z_h$  and  $Z_p$ ) the screw is assumed to resist with pure shear.
- The density considered is  $G = 0.35$  for Northern Species,  $G = 0.42$  for SPF.
- For simultaneous loads, in different directions, on a screw, the allowable load must be evaluated using the following equation:  $(\text{Design Uplift} + \text{Allowable Uplift}) + (\text{Design } F_1 + \text{Allowable } F_1) + (\text{Design } F_2 + \text{Allowable } F_2) \leq 1.0$ , where the three terms in the unity equation represent the possible generated force directions. The number of terms that must be considered for simultaneous loading is the sole discretion of the designer and depends on the method of calculating wind forces and the utilization of the screws within the structural system.

## GENERAL PRINCIPLES

- Tabulated values comply with NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION in accordance with ESR-4645.
- To determine allowable loads for use with ASD, design loads for use with LRFD or both, tabulated values must be multiplied by all adjustment factors included in the NDS for dowel-type fasteners.
- As part of the connection design, the structural wood members, the steel plates must be sized and verified in accordance with the corresponding Section of the NDS and must be done separately by the designer.
- Connections with multiple screws must be designed in accordance with the corresponding Sections of the NDS and ESR-4645.
- VGZ screws must be installed and used in dry in-service conditions in accordance with the NDS (wet service factor for connection CM is 1.0).
- VGZ screws must be positioned in accordance with the minimum distances.
- In the case of combined axial and shear forces on a screw, for the determination of the load-bearing capacity refer to the Hankinson formula found in the NDS section 12.4.1.

## REFERENCE LATERAL DESIGN VALUES

- Tabulated values are determined from the yield model equations in the corresponding Section of the NDS.
- Unless otherwise noted, the screw is intended to be inserted half in the main member and half in the side member.
- The screw penetration into the main member is minimum 6 times the outer thread diameter unless otherwise noted.
- The reference lateral design values may be determined for other connection configurations in accordance with the corresponding Section of NDS and ESR-4645.
- The reference lateral design values 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.

### WOOD-TO-WOOD

- The wood main member thickness must be greater than the screw length minus the thickness of the wood side member.
- The tabulated lateral design values are based on both wood members having the same specific gravity G.

## REFERENCE WITHDRAWAL DESIGN VALUES

- The reference withdrawal design values ( $W_{ref}$ ) expressed in pounds-force per inch of thread penetration into the main member for screws installed at an angle of 90° to the grain can be found in the ESR-4645.
- The values for screws installed at an angle  $\alpha$  to the grain are determined by multiplying the reference withdrawal design values with the effective thread penetration  $L_{eff}$  of the screw in the wood member and with the factor  $k_a$ :

$$W_a = W_{ref} \cdot k_a \cdot L_{eff}$$

Where:

- $W_{ref}$  is the reference withdrawal design value for screws installed at an angle of 90° to the grain, as shown in the table on the left;
- $k_a$  factor is calculated as:

$$k_a = \begin{cases} 35^\circ < \alpha \leq 90^\circ & \frac{1}{1.2 \cdot \cos^2(\alpha) + \sin^2(\alpha)} \\ 0^\circ \leq \alpha \leq 35^\circ & 0.3 + 0.7 \cdot \frac{\alpha}{45} \end{cases}$$

- $\alpha$  is the angle between the grain direction and screw axis.

Tabulated values at page 171 are valid for  $L_{eff}$  equal to the screw thread length  $b$  minus the tip length  $L_t$  and  $k_a = 1$  for  $\alpha = 90^\circ$ ,  $k_a = 0.91$  for  $\alpha = 45^\circ$ ,  $k_a = 0.3$  for  $\alpha = 0^\circ$ .

- The minimum embedded thread length is 6 times the outer thread diameter for screws installed at 90° to the grain, unless otherwise noted.
- The minimum embedded thread length for screws installed at an angle  $0^\circ \leq \alpha < 90^\circ$  to the grain is 8 times the outer thread diameter, unless otherwise noted.
- At least four screws must be used in a connection with screws installed in the wood member with an angle between the grain direction and screw axis  $\alpha \leq 15^\circ$ .
- The reference withdrawal design values must be inferior to  $f_{tens}$  of the screw.

## REFERENCE WITHDRAWAL DESIGN VALUES

For fully-threaded screws the head pull-through resistance is not relevant for the connection resistance, thread withdrawal is governing. These values must be compared with the tensile resistance of the screw; the lower value is the governing one.

## SLIDING RESISTANCE

- Unless otherwise noted, the screws are intended to be inserted half in the main member and half in the side member.
- The 45° inclined screw is intended to work in withdrawal and the resulting resistance of the connection is given by the projection of the withdrawal resistance (along screw axis) onto the shear plane.
- The design values must be inferior to  $f_{tens}$  of the screw projected onto the shear plane.

## CONNECTIONS

### GENERAL NOTES

- Designed connections must respect all requirements on general principles and minimum distances.
- Calculations comply with the NDS in accordance with ESR 4645.
- Tabulated values, that are referred to a single fastener, are valid for Allowable Stress Design (ASD) considering a standard loading ( $C_D = 1.0$ ).
- Timber element specific gravity is considered as  $G = 0.42$ , unless otherwise noted.
- $Z_\parallel$ : Force-to-grain angle in the shear plane is considered as 0°.
- $Z_\perp$ : Force-to-grain angle in the shear plane is considered as 90°.
- $Z_{mL}$ : Force-to-grain angle in the shear plane is considered as 0° for side member and as 90° for main member.
- $R_y$ : withdrawal resistance of the screws projected on the shear force axis.
- For the connectors inserted in the panel's face, it has been considered the same grain direction as the layer in the shear plane. For the connectors inserted in the panel's narrow edge, it has been considered the same grain direction as the layer in which the connector is installed.
- For lateral design values the force-to-fastener angle is always considered 90°.

## FLOOR-TO-BEAM | FLOOR-TO-WALL

- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the beam's axis or wall plane.
- The main grain direction of the CLT wall panel is always considered as vertical.
- The threaded part of the screw has been always considered inserted in the central layer of the CLT panel.
- According to NDS, an end grain coefficient  $C_{eg} = 0.67$  is considered for the lateral resistance calculation due to fastener in narrow edge of CLT (FLOOR-TO-WALL).
- Beam element can be considered both solid wood or glulam.
- The width of the beams must comply with the minimum distance requirements.
- The proposed screw's length does not exceed the total thickness of the connection.
- The CLT side  $R_y$  resistance is calculated taking into account a screw-to-grain angle as the lowest between the involved layers. In this case the considered angle is 45°.

## BUTT JOINT

- Force-to-fastener angle is considered to be 60°. The geometry of the joint requires that the connectors be inserted at an angle of 45° with respect to the face of the CLT panel, and at an angle of 45° with respect to the shear plane between the two panels.
- An end grain coefficient  $C_{eg} = 0.67$  is considered for the withdrawal resistance calculation due to fastener in narrow edge of CLT.
- Reported values represent the shear resistance of the connection along the shear plane for a single fastener.
- The proposed screw's length does not exceed the total thickness of the connection.
- The use of the JIG VGZ 45 template is recommended to ensure precise installation of the connectors in this application.

## HALF LAP

- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the machining's direction.
- Force-to-fastener angle is considered as 45°. The screws are considered inserted at an angle of 45° with respect to the face of the CLT panel in the machining's direction. In this direction the screw is intended to work in withdrawal. In the opposite direction the screws are intended to work in shear.
- The width of half-lap machining on CLT panel must comply with the minimum distance requirements.
- The proposed screw's length does not exceed the total thickness of the connection.
- $R_y$  resistance is calculated by taking into account the screw-to-grain angle as the lowest among the involved layers. In this case, the angle considered is 45°.