

# TBS EVO

## FLANGE HEAD SCREW



### 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.

### INTEGRATED WASHER

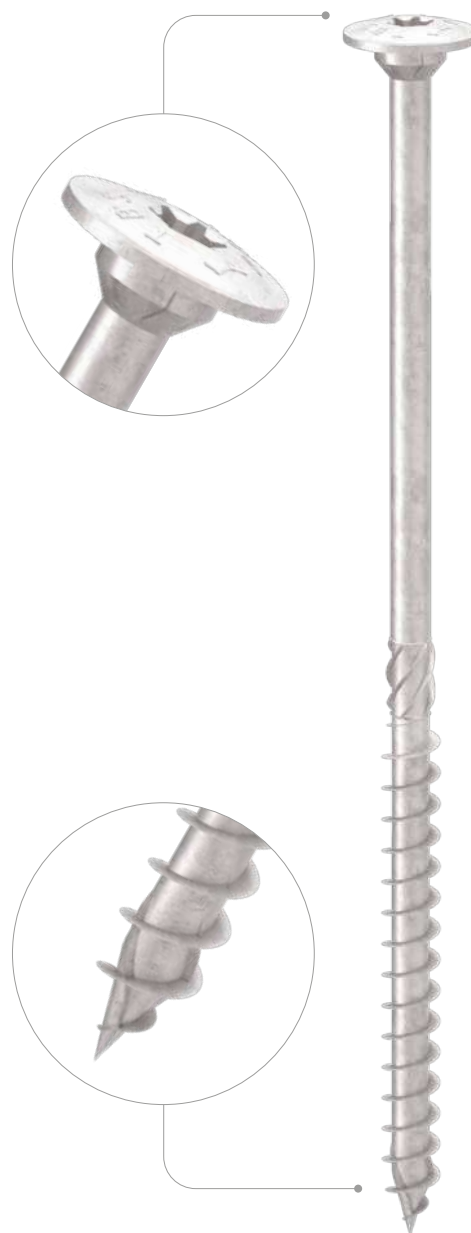
The flange head serves as washer and ensures high head strength and pull-through. Ideal in the presence of wind or variations in timber dimensions.

### PRESSURE TREATED LUMBER

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

### T3 TIMBER CORROSIVITY

Coating suitable for use in applications on wood with an acidity level (pH) greater than 4, such as spruce, larch and pine (see page 354).

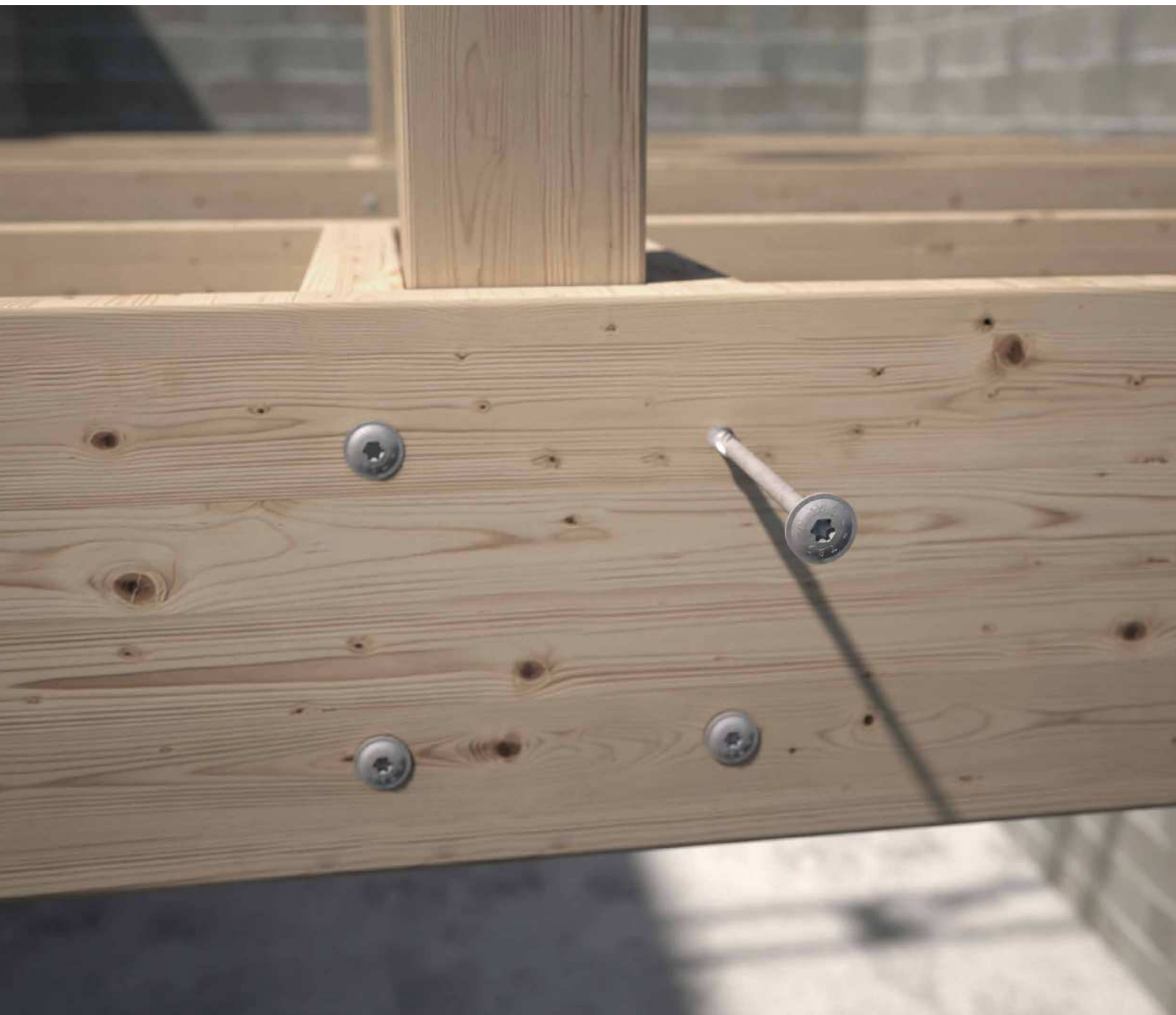


|                         |                                                 |
|-------------------------|-------------------------------------------------|
| DIAMETER [in]           | 0.24 0.24 0.40 0.63                             |
| LENGTH [in]             | 1 9/16 2 3/8 15 3/4 39 3/8                      |
| 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



## OUTDOOR WALKWAYS

Ideal for the construction of outdoor structures such as walkways and arcades. Values also certified for screw insertion parallel to the grain.

## SIP PANELS

Values also tested and certified for CLT and high density woods such as LVL and other laminated veneer products. Suitable for fastening SIP and sandwich panels.

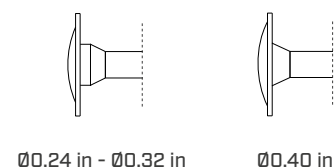
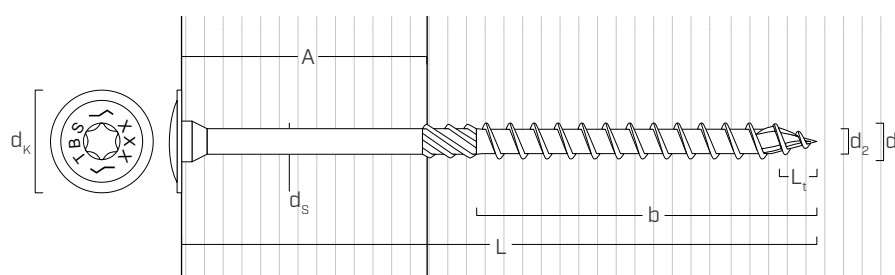


Fastening Wood Trusses outdoors.



Multi-ply beam fastening.

## GEOMETRY AND MECHANICAL CHARACTERISTICS



### GEOMETRY

| Nominal diameter                          | $d_1$               | [in] <sup>(1)</sup> | 0.24  | 0.32  | 0.40  |
|-------------------------------------------|---------------------|---------------------|-------|-------|-------|
|                                           |                     | [mm]                | 6     | 8     | 10    |
| Outer thread diameter                     | $d_1$               | [in]                | 0.236 | 0.315 | 0.394 |
| Head diameter                             | $d_k$               | [in]                | 0.610 | 0.748 | 0.984 |
| Root diameter                             | $d_2$               | [in]                | 0.156 | 0.213 | 0.252 |
| Shank diameter                            | $d_s$               | [in]                | 0.169 | 0.228 | 0.276 |
| Tip Length                                | $L_t$               | [in]                | 0.236 | 0.315 | 0.394 |
| Pre-drilling hole diameter <sup>(2)</sup> | $d_{V,G \leq 0.55}$ | [in]                | 5/32  | 13/64 | 15/64 |
| Pre-drilling hole diameter <sup>(3)</sup> | $d_{V,G > 0.55}$    | [in]                | 5/32  | 15/64 | 9/32  |

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

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

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

### MECHANICAL PARAMETERS

| Nominal diameter                   | $d_1$      | [in]  | 0.24   | 0.32   | 0.40   |
|------------------------------------|------------|-------|--------|--------|--------|
| Tensile strength (allowable)       | $f_{tens}$ | [lbf] | 1180   | 2040   | 2700   |
| Bending yield strength (specified) | $F_{y,b}$  | [psi] | 200000 | 180000 | 185000 |

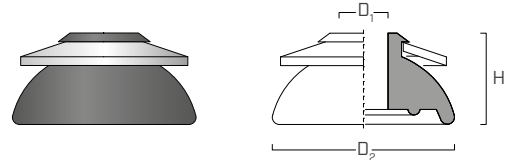
| Nominal diameter                    | $d_1$    | [in]     | 0.24     | 0.32  | 0.40  |
|-------------------------------------|----------|----------|----------|-------|-------|
| Withdrawal<br>(design value)        | $W_{90}$ | [lbf/in] | G = 0.35 | 131   | 172   |
|                                     |          |          | G = 0.42 | 151   | 199   |
|                                     |          |          | G = 0.49 | 171   | 225   |
|                                     |          |          | G = 0.55 | 188   | 247   |
| minimum embedded<br>length          |          | [in]     | 1 7/16   | 1 7/8 | 2 3/8 |
| Head pull-through<br>(design value) | $W_H$    | [lbf]    | G = 0.35 | 182   | 223   |
|                                     |          |          | G = 0.42 | 263   | 322   |
|                                     |          |          | G = 0.49 | 357   | 438   |
|                                     |          |          | G = 0.55 | 450   | 552   |
| minimum side member<br>thickness    |          | [in]     | 1 1/2    | 1 1/2 | 1 1/2 |

## CODES AND DIMENSIONS

| d <sub>1</sub><br>[mm]<br>[in] | CODE       | L    |        | b    |         | A      | pcs |
|--------------------------------|------------|------|--------|------|---------|--------|-----|
|                                |            | [mm] | [in]   | [mm] | [in]    | [in]   |     |
| 6<br>0.24<br>#14<br>TX 30      | TBSEVO660  | 60   | 2 3/8  | 40   | 1 9/16  | 3/4    | 100 |
|                                | TBSEVO680  | 80   | 3 1/8  | 50   | 1 15/16 | 1      | 100 |
|                                | TBSEVO6100 | 100  | 4      | 60   | 2 3/8   | 1 1/2  | 100 |
|                                | TBSEVO6120 | 120  | 4 3/4  | 75   | 2 15/16 | 1 3/4  | 100 |
|                                | TBSEVO6140 | 140  | 5 1/2  | 75   | 2 15/16 | 2 1/2  | 100 |
|                                | TBSEVO6160 | 160  | 6 1/4  | 75   | 2 15/16 | 3 1/4  | 100 |
|                                | TBSEVO6180 | 180  | 7 1/8  | 75   | 2 15/16 | 4      | 100 |
|                                | TBSEVO6200 | 200  | 8      | 75   | 2 15/16 | 4 3/4  | 100 |
| 8<br>0.32<br>TX 40             | TBSEVO8100 | 100  | 4      | 52   | 2 1/16  | 1 3/4  | 50  |
|                                | TBSEVO8120 | 120  | 4 3/4  | 80   | 3 1/8   | 1 1/2  | 50  |
|                                | TBSEVO8140 | 140  | 5 1/2  | 80   | 3 1/8   | 2 1/4  | 50  |
|                                | TBSEVO8160 | 160  | 6 1/4  | 100  | 4       | 2 1/4  | 50  |
|                                | TBSEVO8180 | 180  | 7 1/8  | 100  | 4       | 3      | 50  |
|                                | TBSEVO8200 | 200  | 8      | 100  | 4       | 3 3/4  | 50  |
|                                | TBSEVO8220 | 220  | 8 5/8  | 100  | 4       | 4 1/2  | 50  |
|                                | TBSEVO8240 | 240  | 9 1/2  | 100  | 4       | 5 1/2  | 50  |
|                                | TBSEVO8280 | 280  | 11     | 100  | 4       | 7      | 50  |
|                                | TBSEVO8320 | 320  | 12 5/8 | 100  | 4       | 8 1/2  | 50  |
|                                | TBSEVO8360 | 360  | 14 1/4 | 100  | 4       | 10     | 50  |
|                                | TBSEVO8400 | 400  | 15 3/4 | 100  | 4       | 11 3/4 | 50  |

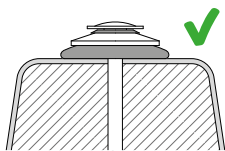
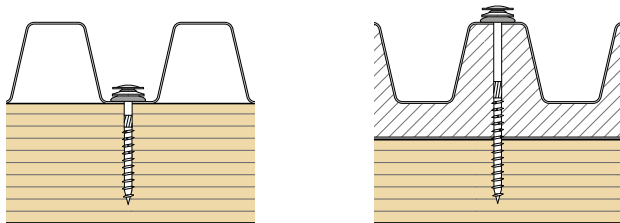
| d <sub>1</sub><br>[mm]<br>[in] | CODE        | L    |       | b    |       | A     | pcs |
|--------------------------------|-------------|------|-------|------|-------|-------|-----|
|                                |             | [mm] | [in]  | [mm] | [in]  | [in]  |     |
| 10<br>0.40<br>TX 50            | TBSEVO10120 | 120  | 4 3/4 | 60   | 2 3/8 | 1/2   | 50  |
|                                | TBSEVO10140 | 140  | 5 1/2 | 60   | 2 3/8 | 1     | 50  |
|                                | TBSEVO10160 | 160  | 6 1/4 | 80   | 3 1/8 | 2 1/8 | 50  |
|                                | TBSEVO10180 | 180  | 7 1/8 | 80   | 3 1/8 | 2 3/4 | 50  |
|                                | TBSEVO10200 | 200  | 8     | 100  | 4     | 3 3/4 | 50  |
|                                | TBSEVO10220 | 220  | 8 5/8 | 100  | 4     | 4 1/2 | 50  |
|                                | TBSEVO10240 | 240  | 9 1/2 | 100  | 4     | 5 1/2 | 50  |
|                                | TBSEVO10280 | 280  | 11    | 100  | 4     | 7     | 50  |

### WBAZ WASHER

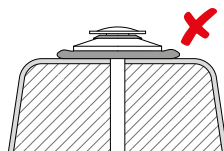


| CODE     | Ø <sub>screw</sub><br>[mm]<br>[in] | D <sub>2</sub><br>[in] | D <sub>1</sub><br>[in] | H<br>[in] | pcs |
|----------|------------------------------------|------------------------|------------------------|-----------|-----|
| WBAZ25A2 | 6 - 6,5<br>0.24 - 0.26             | 0.98                   | 0.26                   | 0.59      | 100 |

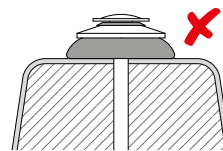
## INSTALLATION



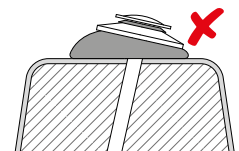
Correct tightening



Excessive tightening



Insufficient tightening

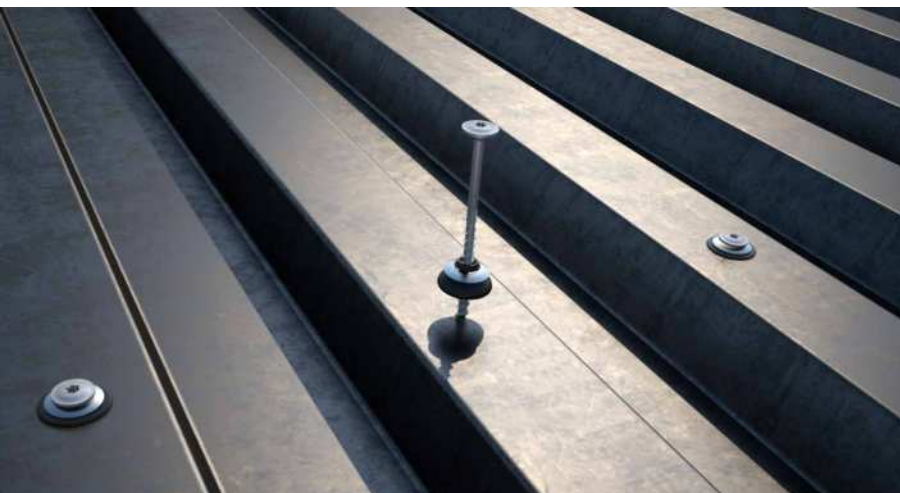


Tightening off axis

**NOTE:** The thickness of the washer after installation is approximately 0.31-0.35 inch.

The maximum thickness of the fastening package was calculated by ensuring a minimum penetration length into the wood of 4-d.

| TBS EVO + WBAZ |              | fastening thickness |             |
|----------------|--------------|---------------------|-------------|
| Ø x L          |              | [min to max]        |             |
| [mm] x [mm]    | [in] x [in]  | [mm]                | [in]        |
| 6 x 60         | 0.24 x 2 3/8 | 0 - 30              | 0 - 1.18    |
| 6 x 80         | 0.24 x 3 1/8 | 10 - 50             | 0.39 - 1.97 |
| 6 x 100        | 0.24 x 4     | 30 - 70             | 1.18 - 2.76 |
| 6 x 120        | 0.24 x 4 3/4 | 50 - 90             | 1.97 - 3.54 |
| 6 x 140        | 0.24 x 5 1/2 | 70 - 110            | 2.76 - 4.33 |
| 6 x 160        | 0.24 x 6 1/4 | 90 - 130            | 3.54 - 5.12 |
| 6 x 180        | 0.24 x 7 1/8 | 110 - 150           | 4.33 - 5.91 |
| 6 x 200        | 0.24 x 8     | 130 - 170           | 5.12 - 6.69 |



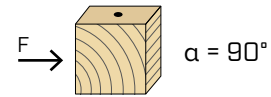
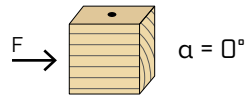
### FASTENING METAL SHEET

Can be installed on sheets up to 0.027 inch (0,7 mm) thick without pre-drilling. TBS EVO Ø0.24 inch (6 mm) is ideal when used in combination with washer WBAZ.

For outdoor use in exposure conditions 1 and 3 according to AC257 and wet use according to NDS.

## MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

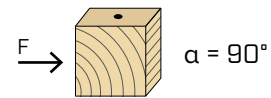
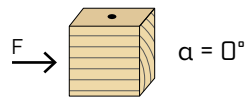
screws inserted **WITHOUT** pre-drilled hole  $G \leq 0.48$



| $d_1$     | [in] |             | 0.24   | 0.32         | 0.40     |
|-----------|------|-------------|--------|--------------|----------|
|           | [mm] |             | 6      | 8            | 10       |
| $a_1$     | [in] | <b>15-d</b> | 3 1/2  | <b>3 1/8</b> | <b>4</b> |
| $a_2$     | [in] | <b>5-d</b>  | 1 3/16 | 1 9/16       | 1 15/16  |
| $a_{3,t}$ | [in] | <b>15-d</b> | 3 1/2  | 4 3/4        | 6        |
| $a_{3,c}$ | [in] | <b>10-d</b> | 2 3/8  | 3 1/8        | 4        |
| $a_{4,t}$ | [in] | <b>10-d</b> | 2 3/8  | 3 1/8        | 4        |
| $a_{4,c}$ | [in] | <b>5-d</b>  | 1 3/16 | 1 9/16       | 1 15/16  |

|             |        | 0.24          | 0.32           | 0.40 |
|-------------|--------|---------------|----------------|------|
|             |        | 6             | 8              | 10   |
| <b>10-d</b> | 2 3/8  | <b>1 9/16</b> | <b>1 15/16</b> |      |
| <b>5-d</b>  | 1 3/16 | 1 9/16        | 1 15/16        |      |
| <b>15-d</b> | 3 1/2  | 4 3/4         | 6              |      |
| <b>10-d</b> | 2 3/8  | 3 1/8         | 4              |      |
| <b>10-d</b> | 2 3/8  | 3 1/8         | 4              |      |
| <b>5-d</b>  | 1 3/16 | 1 9/16        | 1 15/16        |      |

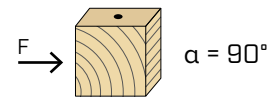
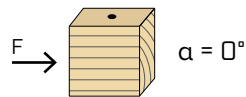
screws inserted **WITHOUT** pre-drilled hole  $0.48 < G \leq 0.50$



| $d_1$     | [in] |             | 0.24   | 0.32   | 0.40    |
|-----------|------|-------------|--------|--------|---------|
|           | [mm] |             | 6      | 8      | 10      |
| $a_1$     | [in] | <b>15-d</b> | 3 1/2  | 4 3/4  | 6       |
| $a_2$     | [in] | <b>5-d</b>  | 1 3/16 | 1 9/16 | 1 15/16 |
| $a_{3,t}$ | [in] | <b>15-d</b> | 3 1/2  | 4 3/4  | 6       |
| $a_{3,c}$ | [in] | <b>10-d</b> | 2 3/8  | 3 1/8  | 4       |
| $a_{4,t}$ | [in] | <b>10-d</b> | 2 3/8  | 3 1/8  | 4       |
| $a_{4,c}$ | [in] | <b>5-d</b>  | 1 3/16 | 1 9/16 | 1 15/16 |

|             |        | 0.24          | 0.32         | 0.40 |
|-------------|--------|---------------|--------------|------|
|             |        | 6             | 8            | 10   |
| <b>10-d</b> | 2 3/8  | <b>2 3/16</b> | <b>2 3/4</b> |      |
| <b>5-d</b>  | 1 3/16 | 1 9/16        | 1 15/16      |      |
| <b>15-d</b> | 3 1/2  | 4 3/4         | 6            |      |
| <b>10-d</b> | 2 3/8  | 3 1/8         | 4            |      |
| <b>10-d</b> | 2 3/8  | 3 1/8         | 4            |      |
| <b>5-d</b>  | 1 3/16 | 1 9/16        | 1 15/16      |      |

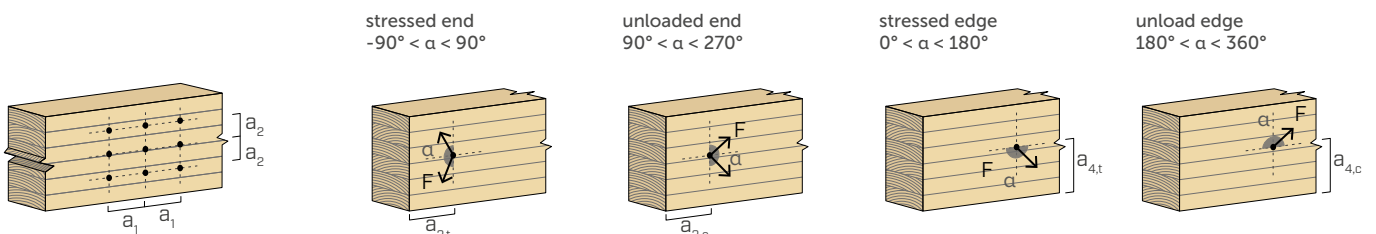
screws inserted **WITHOUT** pre-drilled hole  $G > 0.50$



| $d_1$     | [in] |             | 0.24    | 0.32   | 0.40  |
|-----------|------|-------------|---------|--------|-------|
|           | [mm] |             | 6       | 8      | 10    |
| $a_1$     | [in] | <b>15-d</b> | 3 1/2   | 4 3/4  | 6     |
| $a_2$     | [in] | <b>7-d</b>  | 1 5/8   | 2 3/16 | 2 3/4 |
| $a_{3,t}$ | [in] | <b>20-d</b> | 4 3/4   | 6 1/4  | 8     |
| $a_{3,c}$ | [in] | <b>15-d</b> | 3 1/2   | 4 3/4  | 6     |
| $a_{4,t}$ | [in] | <b>12-d</b> | 2 13/16 | 3 3/4  | 4 3/4 |
| $a_{4,c}$ | [in] | <b>7-d</b>  | 1 5/8   | 2 3/16 | 2 3/4 |

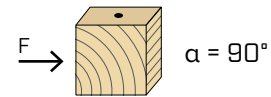
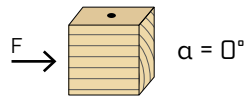
|             |         | 0.24   | 0.32  | 0.40 |
|-------------|---------|--------|-------|------|
|             |         | 6      | 8     | 10   |
| <b>10-d</b> | 2 3/8   | 3 1/8  | 4     |      |
| <b>7-d</b>  | 1 5/8   | 2 3/16 | 2 3/4 |      |
| <b>20-d</b> | 4 3/4   | 6 1/4  | 8     |      |
| <b>15-d</b> | 3 1/2   | 4 3/4  | 6     |      |
| <b>12-d</b> | 2 13/16 | 3 3/4  | 4 3/4 |      |
| <b>7-d</b>  | 1 5/8   | 2 3/16 | 2 3/4 |      |

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





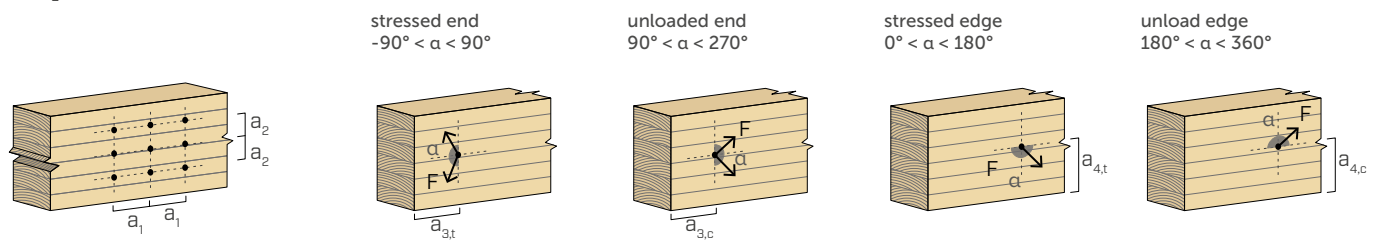
screws inserted **WITH pre-drilled hole**



| $d_1$     | [in]<br>[mm] | 0.24<br>6   | 0.32<br>8 | 0.40<br>10 |
|-----------|--------------|-------------|-----------|------------|
| $a_1$     | [in]         | <b>10·d</b> | 2 3/8     | 3 1/8      |
| $a_2$     | [in]         | <b>4·d</b>  | 15/16     | 1 1/4      |
| $a_{3,t}$ | [in]         | <b>12·d</b> | 2 13/16   | 3 3/4      |
| $a_{3,c}$ | [in]         | <b>7·d</b>  | 1 5/8     | 2 3/16     |
| $a_{4,t}$ | [in]         | <b>7·d</b>  | 1 5/8     | 2 3/16     |
| $a_{4,c}$ | [in]         | <b>3·d</b>  | 11/16     | 15/16      |

|             | 0.24<br>6 | 0.32<br>8 | 0.40<br>10 |
|-------------|-----------|-----------|------------|
| <b>5·d</b>  | 1 3/16    | 1 9/16    | 1 15/16    |
| <b>4·d</b>  | 15/16     | 1 1/4     | 1 15/16    |
| <b>12·d</b> | 2 13/16   | 3 3/4     | 2 3/4      |
| <b>7·d</b>  | 1 5/8     | 2 3/16    | 1 9/16     |
| <b>7·d</b>  | 1 5/8     | 2 3/16    | 1 9/16     |
| <b>3·d</b>  | 11/16     | 15/16     | 1 3/16     |

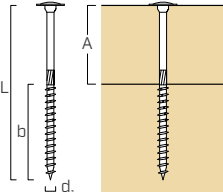
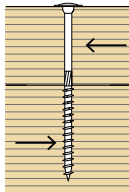
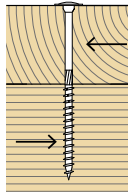
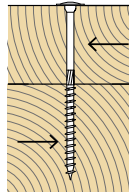
$\alpha$  = load-to-grain angle  
 $d = d_1$  = nominal diameter of the screw



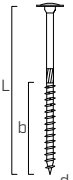
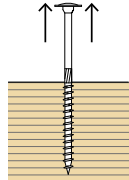
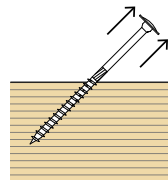
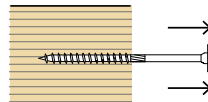
## NOTES

- Values in blue are from Table 10 of ESR-4645 (REDUCED CONNECTION GEOMETRY REQUIREMENTS BASED ON TESTING);
- 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]<br>[in] | [in]         | [in]    | [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] |
| 6<br>0.24                                                                         | 60           | 2 3/8        | 1 9/16  | 3/4          | 87                                                                                | 120           | 142           | 163           | 87                                                                                 | 120           | 142           | 163           | 87                                                                                  | 120           | 142           | 163           |
|                                                                                   | 80           | 3 1/8        | 1 15/16 | 1            | 104                                                                               | 129           | 156           | 182           | 104                                                                                | 129           | 156           | 182           | 104                                                                                 | 129           | 156           | 182           |
|                                                                                   | 100          | 4            | 2 3/8   | 1 1/2        | 120                                                                               | 154           | 190           | 211           | 120                                                                                | 154           | 190           | 211           | 120                                                                                 | 154           | 190           | 211           |
|                                                                                   | 120          | 4 3/4        | 2 15/16 | 1 3/4        | 129                                                                               | 165           | 190           | 211           | 129                                                                                | 165           | 190           | 211           | 129                                                                                 | 165           | 190           | 211           |
|                                                                                   | 140-200      | 5 1/2-8      | 2 15/16 | $\geq 2 1/2$ | 139                                                                               | 165           | 190           | 211           | 139                                                                                | 165           | 190           | 211           | 139                                                                                 | 165           | 190           | 211           |
| 8<br>0.32                                                                         | 100          | 4            | 2 1/16  | 1 3/4        | 156                                                                               | 216           | 270           | 313           | 125                                                                                | 173           | 216           | 251           | 125                                                                                 | 173           | 216           | 251           |
|                                                                                   | 120          | 4 3/4        | 3 1/8   | 1 1/2        | 160                                                                               | 202           | 248           | 292           | 128                                                                                | 161           | 198           | 233           | 128                                                                                 | 161           | 198           | 233           |
|                                                                                   | 140          | 5 1/2        | 3 1/8   | 2 1/4        | 191                                                                               | 245           | 282           | 313           | 153                                                                                | 196           | 225           | 251           | 153                                                                                 | 196           | 225           | 251           |
|                                                                                   | 160          | 6 1/4        | 4       | 2 1/4        | 191                                                                               | 245           | 282           | 313           | 153                                                                                | 196           | 225           | 251           | 153                                                                                 | 196           | 225           | 251           |
|                                                                                   | 180-400      | 7 1/8-15 3/4 | 4       | $\geq 3$     | 207                                                                               | 245           | 282           | 313           | 165                                                                                | 196           | 225           | 251           | 165                                                                                 | 196           | 225           | 251           |
| 10<br>0.40                                                                        | 120          | 4 3/4        | 2 3/8   | 1/2          | 259                                                                               | 311           | 362           | 387           | 173                                                                                | 215           | 259           | 295           | 140                                                                                 | 182           | 228           | 270           |
|                                                                                   | 140          | 5 1/2        | 2 3/8   | 1            | 300                                                                               | 338           | 365           | 387           | 195                                                                                | 245           | 274           | 295           | 165                                                                                 | 216           | 259           | 282           |
|                                                                                   | 160          | 6 1/4        | 3 1/8   | 2 1/8        | 308                                                                               | 338           | 365           | 387           | 220                                                                                | 249           | 274           | 295           | 186                                                                                 | 232           | 259           | 282           |
|                                                                                   | 180          | 7 1/8        | 3 1/8   | 2 3/4        | 308                                                                               | 338           | 365           | 387           | 222                                                                                | 249           | 274           | 295           | 203                                                                                 | 232           | 259           | 282           |
|                                                                                   | 200-280      | 8-11         | 4       | $\geq 3 3/4$ | 308                                                                               | 338           | 365           | 387           | 222                                                                                | 249           | 274           | 295           | 203                                                                                 | 232           | 259           | 282           |

## THREAD WITHDRAWAL (W) | WOOD

| geometry                                                                            |              |                            |         |  | thread withdrawal $\alpha = 90^\circ$                                               |               |               |               | thread withdrawal $\alpha = 45^\circ$                                                |               |               |               | thread withdrawal $\alpha = 0^\circ$                                                  |               |               |               |
|-------------------------------------------------------------------------------------|--------------|----------------------------|---------|--|-------------------------------------------------------------------------------------|---------------|---------------|---------------|--------------------------------------------------------------------------------------|---------------|---------------|---------------|---------------------------------------------------------------------------------------|---------------|---------------|---------------|
|  |              |                            |         |  |  |               |               |               |  |               |               |               |  |               |               |               |
| $d_1$                                                                               | L            | b                          |         |  | G                                                                                   |               |               |               | G                                                                                    |               |               |               | G                                                                                     |               |               |               |
| [mm]<br>[in]                                                                        | [mm]<br>[in] | [in]                       | [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] |
| 6<br>0.24                                                                           | 60           | 2 3/8 <sup>(1)</sup>       | 1 9/16  |  | 175                                                                                 | 202           | 229           | 252           | 160                                                                                  | 184           | 208           | 229           | 53                                                                                    | 61            | 69            | 75            |
|                                                                                     | 80           | 3 1/8 <sup>(2)</sup>       | 1 15/16 |  | 227                                                                                 | 262           | 296           | 326           | 207                                                                                  | 238           | 270           | 296           | 68                                                                                    | 78            | 89            | 98            |
|                                                                                     | 100          | 4                          | 2 3/8   |  | 279                                                                                 | 321           | 364           | 400           | 253                                                                                  | 292           | 331           | 364           | 84                                                                                    | 96            | 109           | 120           |
|                                                                                     | 120-200      | 4 3/4-8                    | 2 15/16 |  | 356                                                                                 | 410           | 465           | 511           | 324                                                                                  | 373           | 423           | 465           | 107                                                                                   | 123           | 139           | 153           |
|                                                                                     | 100          | 4 <sup>(1)</sup>           | 2 1/16  |  | 298                                                                                 | 345           | 390           | 428           | 271                                                                                  | 314           | 355           | 389           | 89                                                                                    | 103           | 117           | 128           |
| 8<br>0.32                                                                           | 120-140      | 4 3/4-5 1/2                | 3 1/8   |  | 488                                                                                 | 564           | 638           | 700           | 444                                                                                  | 513           | 580           | 637           | 146                                                                                   | 169           | 191           | 210           |
|                                                                                     | 160-400      | 6 1/4-15 3/4               | 4       |  | 623                                                                                 | 721           | 815           | 895           | 567                                                                                  | 656           | 742           | 814           | 187                                                                                   | 216           | 244           | 268           |
|                                                                                     | 120-140      | 4 3/4-5 1/2 <sup>(1)</sup> | 2 3/8   |  | 406                                                                                 | 470           | 531           | 583           | 369                                                                                  | 428           | 484           | 530           | 122                                                                                   | 141           | 159           | 175           |
|                                                                                     | 160-180      | 6 1/4-7 1/8 <sup>(2)</sup> | 3 1/8   |  | 568                                                                                 | 659           | 744           | 816           | 517                                                                                  | 599           | 677           | 742           | 170                                                                                   | 198           | 223           | 245           |
|                                                                                     | 200-280      | 8-11                       | 4       |  | 730                                                                                 | 847           | 957           | 1049          | 664                                                                                  | 771           | 871           | 954           | 219                                                                                   | 254           | 287           | 315           |

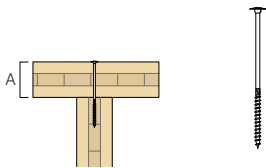
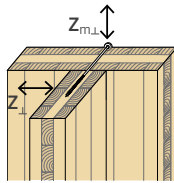
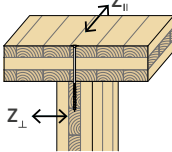
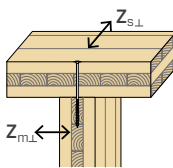
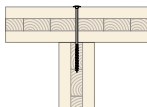
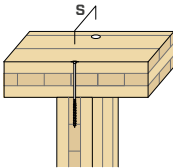
<sup>(1)</sup> The embedded thread length does not comply with the minimum requirement of ESR-4645 (6 times the outer thread diameter for screws installed at  $90^\circ$  to the grain and 8 times the outer thread diameter for screws installed at an angle  $0^\circ \leq \alpha < 90^\circ$  to the grain).

<sup>(2)</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).

## HEAD PULL-THROUGH ( $W_H$ ) | WOOD

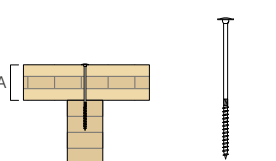
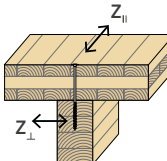
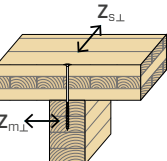
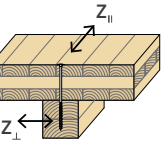
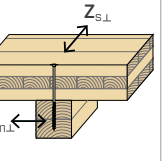
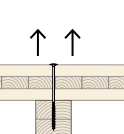
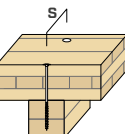
| geometry |       |      | head pull through $90^\circ \leq \alpha \leq 30^\circ$ |               |               |               |
|----------|-------|------|--------------------------------------------------------|---------------|---------------|---------------|
| $d_1$    | $d_k$ |      | G                                                      |               |               |               |
| [mm]     | [in]  | [in] | 0.35<br>[lbf]                                          | 0.42<br>[lbf] | 0.49<br>[lbf] | 0.55<br>[lbf] |
| 6        | 0.24  | 0.61 | 182                                                    | 263           | 357           | 450           |
| 8        | 0.32  | 0.75 | 223                                                    | 322           | 438           | 552           |
| 10       | 0.40  | 0.98 | 314                                                    | 452           | 615           | 774           |

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

| geometry                                                                          |      |                    |             | SHEAR                                                                             |                 |                                                                                   |                 |                                                                                    |                 | TENSION                                                                             | SPACING                                                                             |         |
|-----------------------------------------------------------------------------------|------|--------------------|-------------|-----------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------|-----------------|------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------|
|                                                                                   |      |                    |             | wall-to-wall                                                                      |                 | floor-to-wall<br>orientation 1                                                    |                 | floor-to-wall<br>orientation 2                                                     |                 | withdrawal / head<br>pull-through                                                   | fastener<br>in a row                                                                |         |
|  |      |                    |             |  |                 |  |                 |  |                 |  |  |         |
| side member<br>thickness<br>(wall/floor) = A                                      |      | suggested<br>screw |             | Z <sub>⊥</sub>                                                                    | Z <sub>m⊥</sub> | Z <sub>⊥</sub>                                                                    | Z <sub>  </sub> | Z <sub>m⊥</sub>                                                                    | Z <sub>s⊥</sub> | W(*)                                                                                | minimum                                                                             | typical |
| [mm]                                                                              | [in] | CODE               |             | [lbf]                                                                             | [lbf]           | [lbf]                                                                             | [lbf]           | [lbf]                                                                              | [lbf]           | [lbf]                                                                               | [in]                                                                                | [in]    |
| 3 PLY                                                                             | 60   | 2 3/8              | TBSEVO6140  | 110                                                                               | 110             | 110                                                                               | 110             | 110                                                                                | 110             | 263                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO8140  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO10140 | 144                                                                               | 164             | 144                                                                               | 226             | 164                                                                                | 155             | 452                                                                                 | 4                                                                                   | 8       |
|                                                                                   | 79   | 3 1/8              | TBSEVO6160  | 110                                                                               | 110             | 110                                                                               | 110             | 110                                                                                | 110             | 263                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO8180  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO10180 | 155                                                                               | 167             | 155                                                                               | 226             | 167                                                                                | 167             | 452                                                                                 | 4                                                                                   | 8       |
|                                                                                   | 105  | 4 1/8              | TBSEVO6180  | 110                                                                               | 110             | 110                                                                               | 110             | 110                                                                                | 110             | 263                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO8220  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO10220 | 155                                                                               | 167             | 155                                                                               | 226             | 167                                                                                | 167             | 452                                                                                 | 4                                                                                   | 8       |
|                                                                                   | 120  | 4 3/4              | TBSEVO6200  | 110                                                                               | 110             | 110                                                                               | 110             | 110                                                                                | 110             | 263                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO8220  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO10220 | 155                                                                               | 167             | 155                                                                               | 226             | 167                                                                                | 167             | 452                                                                                 | 4                                                                                   | 8       |
| 5 PLY                                                                             | 100  | 3 15/16            | TBSEVO6180  | 110                                                                               | 110             | 110                                                                               | 110             | 110                                                                                | 110             | 263                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO8200  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO10200 | 155                                                                               | 167             | 155                                                                               | 226             | 167                                                                                | 167             | 452                                                                                 | 4                                                                                   | 8       |
|                                                                                   | 140  | 5 1/2              | TBSEVO8240  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO10240 | 155                                                                               | 167             | 155                                                                               | 226             | 167                                                                                | 167             | 452                                                                                 | 4                                                                                   | 8       |
|                                                                                   | 175  | 6 7/8              | TBSEVO8280  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO10280 | 155                                                                               | 167             | 155                                                                               | 226             | 167                                                                                | 167             | 452                                                                                 | 4                                                                                   | 8       |
|                                                                                   | 200  | 7 7/8              | TBSEVO8320  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
| 7 PLY                                                                             | 140  | 5 1/2              | TBSEVO8240  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | TBSEVO10240 | 155                                                                               | 167             | 155                                                                               | 226             | 167                                                                                | 167             | 452                                                                                 | 4                                                                                   | 8       |
|                                                                                   | 191  | 7 1/2              | TBSEVO8320  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   | 244  | 9 5/8              | TBSEVO8360  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   | 280  | 11                 | TBSEVO8400  | 131                                                                               | 131             | 131                                                                               | 164             | 131                                                                                | 131             | 322                                                                                 | 3 1/8                                                                               | 6       |

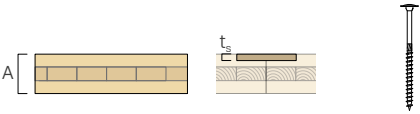
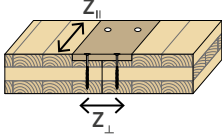
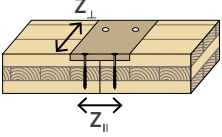
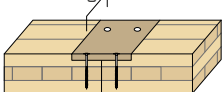
(\*) Minimum between head pull-through and withdrawal resistance

## CLT | FLOOR-TO-BEAM

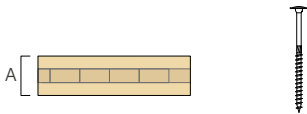
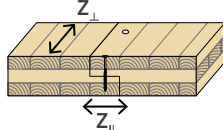
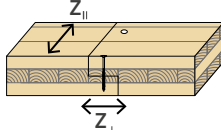
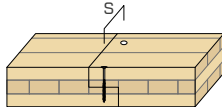
|                                                                                   |      |                    | SHEAR                                                                             |                |                                                                                   |                 |                                                                                   |                |                                                                                     |                 | TENSION                                                                             | SPACING                                                                             |         |   |
|-----------------------------------------------------------------------------------|------|--------------------|-----------------------------------------------------------------------------------|----------------|-----------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------|----------------|-------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------|---|
| geometry                                                                          |      |                    | floor-to-beam<br>orientation 1                                                    |                | floor-to-beam<br>orientation 2                                                    |                 | floor-to-double<br>lumber 2"<br>orientation 1                                     |                | floor-to-double<br>lumber 2"<br>orientation 2                                       |                 | withdrawal / head<br>pull-through                                                   | fastener<br>in a row                                                                |         |   |
|  |      |                    |  |                |  |                 |  |                |  |                 |  |  |         |   |
| side member<br>thickness<br>(wall/floor) = A                                      |      | suggested<br>screw | Z <sub>⊥</sub>                                                                    | Z <sub>∥</sub> | Z <sub>m⊥</sub>                                                                   | Z <sub>s⊥</sub> | Z <sub>⊥</sub>                                                                    | Z <sub>∥</sub> | Z <sub>m⊥</sub>                                                                     | Z <sub>s⊥</sub> | W(*)                                                                                | minimum                                                                             | typical |   |
| [mm]                                                                              | [in] | CODE               | [lbf]                                                                             | [lbf]          | [lbf]                                                                             | [lbf]           | [lbf]                                                                             | [lbf]          | [lbf]                                                                               | [lbf]           | [lbf]                                                                               | [in]                                                                                | [in]    |   |
| 5 PLY                                                                             | 100  | 3 15/16            | TBSEVO6180                                                                        | 165            | 165                                                                               | 110             | 165                                                                               | 165            | 165                                                                                 | 110             | 165                                                                                 | 263                                                                                 | 3 1/2   | 6 |
|                                                                                   |      |                    | TBSEVO8200                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO10180                                                                       | 232            | 338                                                                               | 167             | 249                                                                               | 232            | 338                                                                                 | 167             | 249                                                                                 | 452                                                                                 | 4       | 8 |
|                                                                                   | 140  | 5 1/2              | TBSEVO8240                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO10240                                                                       | 232            | 338                                                                               | 167             | 249                                                                               | 232            | 338                                                                                 | 167             | 249                                                                                 | 452                                                                                 | 4       | 8 |
|                                                                                   | 175  | 6 7/8              | TBSEVO8240                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO8280                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | -              | -                                                                                   | -               | -                                                                                   | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO10240                                                                       | 224            | 338                                                                               | 158             | 249                                                                               | 224            | 338                                                                                 | 158             | 249                                                                                 | 452                                                                                 | 4       | 8 |
|                                                                                   |      |                    | TBSEVO10280                                                                       | 232            | 338                                                                               | 167             | 249                                                                               | -              | -                                                                                   | -               | -                                                                                   | 452                                                                                 | 4       | 8 |
|                                                                                   | 200  | 7 7/8              | TBSEVO8280                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO8320                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | -              | -                                                                                   | -               | -                                                                                   | 322                                                                                 | 3 1/8   | 6 |
| 7 PLY                                                                             | 140  | 5 1/2              | TBSEVO8240                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO10240                                                                       | 232            | 338                                                                               | 167             | 249                                                                               | 232            | 338                                                                                 | 167             | 249                                                                                 | 452                                                                                 | 4       | 8 |
|                                                                                   | 191  | 7 1/2              | TBSEVO8280                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO8320                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | -              | -                                                                                   | -               | -                                                                                   | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   | 244  | 9 5/8              | TBSEVO8320                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO8360                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | -              | -                                                                                   | -               | -                                                                                   | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   | 280  | 11                 | TBSEVO8360                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO8400                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | -              | -                                                                                   | -               | -                                                                                   | 322                                                                                 | 3 1/8   | 6 |
| 9 PLY                                                                             | 180  | 7 1/16             | TBSEVO8280                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO10280                                                                       | 232            | 338                                                                               | 167             | 249                                                                               | 232            | 338                                                                                 | 167             | 249                                                                                 | 452                                                                                 | 4       | 8 |
|                                                                                   | 267  | 10 1/2             | TBSEVO8360                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | 196            | 245                                                                                 | 131             | 196                                                                                 | 322                                                                                 | 3 1/8   | 6 |
|                                                                                   |      |                    | TBSEVO8400                                                                        | 196            | 245                                                                               | 131             | 196                                                                               | -              | -                                                                                   | -               | -                                                                                   | 322                                                                                 | 3 1/8   | 6 |

(\*) Minimum between head pull-through and withdrawal resistance

# CLT | SPLINE JOINT

|                                                                                   |      |                                      |                    |             | SHEAR                                                                             |                |                                                                                    |                | SPACING                                                                             |         |
|-----------------------------------------------------------------------------------|------|--------------------------------------|--------------------|-------------|-----------------------------------------------------------------------------------|----------------|------------------------------------------------------------------------------------|----------------|-------------------------------------------------------------------------------------|---------|
| geometry                                                                          |      |                                      |                    |             | spline joint orientation 1                                                        |                | spline joint orientation 2                                                         |                | fastener in a row                                                                   |         |
|  |      |                                      |                    |             |  |                |  |                |  |         |
| panel thickness<br>(wall/floor) = A                                               |      | spline<br>thickness = t <sub>s</sub> | suggested<br>screw |             | Z <sub>  </sub>                                                                   | Z <sub>⊥</sub> | Z <sub>  </sub>                                                                    | Z <sub>⊥</sub> | minimum                                                                             | typical |
| [mm]                                                                              | [in] | [in]                                 | CODE               |             | [lbf]                                                                             | [lbf]          | [lbf]                                                                              | [lbf]          | [in]                                                                                | [in]    |
| 3 PLY                                                                             | 79   | 3 1/8                                | 1/2                | TBSEVO660   | 116                                                                               | 116            | 116                                                                                | 116            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      | 3/4                | TBSEVO660   | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO660   | 111                                                                               | 111            | 111                                                                                | 111            | 3 1/2                                                                               | 4       |
|                                                                                   | 86   | 3 3/8                                | 1/2                | TBSEVO660   | 116                                                                               | 116            | 116                                                                                | 116            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      | 3/4                | TBSEVO680   | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO680   | 128                                                                               | 128            | 128                                                                                | 128            | 3 1/2                                                                               | 4       |
|                                                                                   | 105  | 4 1/8                                | 1/2                | TBSEVO680   | 116                                                                               | 116            | 116                                                                                | 116            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 136                                                                               | 108            | 136                                                                                | 108            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      | 3/4                | TBSEVO680   | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 173                                                                               | 139            | 173                                                                                | 139            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO6100  | 128                                                                               | 128            | 128                                                                                | 128            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 179                                                                               | 143            | 179                                                                                | 143            | 3 1/8                                                                               | 4       |
| 5 PLY                                                                             | 130  | 5 1/8                                | 3/4                | TBSEVO660   | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 173                                                                               | 139            | 173                                                                                | 139            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO680   | 128                                                                               | 128            | 128                                                                                | 128            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 179                                                                               | 143            | 179                                                                                | 143            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO10120 | 211                                                                               | 164            | 211                                                                                | 164            | 4                                                                                   | 6       |
|                                                                                   | 140  | 5 1/2                                | 3/4                | TBSEVO680   | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 173                                                                               | 139            | 173                                                                                | 139            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO6100  | 128                                                                               | 128            | 128                                                                                | 128            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 179                                                                               | 143            | 179                                                                                | 143            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO10120 | 211                                                                               | 164            | 211                                                                                | 164            | 4                                                                                   | 6       |
|                                                                                   | 175  | 6 7/8                                | 3/4                | TBSEVO6100  | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 173                                                                               | 139            | 173                                                                                | 139            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO6120  | 128                                                                               | 128            | 128                                                                                | 128            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8120  | 179                                                                               | 143            | 179                                                                                | 143            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO10140 | 211                                                                               | 164            | 211                                                                                | 164            | 4                                                                                   | 6       |
| 7 PLY                                                                             | 191  | 7 1/2                                | 3/4                | TBSEVO680   | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 173                                                                               | 139            | 173                                                                                | 139            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO6100  | 128                                                                               | 128            | 128                                                                                | 128            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 179                                                                               | 143            | 179                                                                                | 143            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO10160 | 211                                                                               | 164            | 211                                                                                | 164            | 4                                                                                   | 6       |
|                                                                                   | 220  | 8 5/8                                | 3/4                | TBSEVO6100  | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8100  | 173                                                                               | 139            | 173                                                                                | 139            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO6120  | 128                                                                               | 128            | 128                                                                                | 128            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8140  | 179                                                                               | 143            | 179                                                                                | 143            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO10160 | 211                                                                               | 164            | 211                                                                                | 164            | 4                                                                                   | 6       |
|                                                                                   | 244  | 9 5/8                                | 3/4                | TBSEVO6120  | 120                                                                               | 120            | 120                                                                                | 120            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8120  | 173                                                                               | 139            | 173                                                                                | 139            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      | 1                  | TBSEVO6140  | 128                                                                               | 128            | 128                                                                                | 128            | 3 1/2                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO8140  | 179                                                                               | 143            | 179                                                                                | 143            | 3 1/8                                                                               | 4       |
|                                                                                   |      |                                      |                    | TBSEVO10160 | 211                                                                               | 164            | 211                                                                                | 164            | 4                                                                                   | 6       |

NOTES and GENERAL PRINCIPLES on page 133.

| geometry                                                                          |     |         |                    | SHEAR                                                                             |                |                                                                                    |                | SPACING                                                                             |         |
|-----------------------------------------------------------------------------------|-----|---------|--------------------|-----------------------------------------------------------------------------------|----------------|------------------------------------------------------------------------------------|----------------|-------------------------------------------------------------------------------------|---------|
|                                                                                   |     |         |                    | half lap<br>orientation 1                                                         |                | half lap<br>orientation 2                                                          |                | fastener<br>in a row                                                                |         |
|  |     |         |                    |  |                |  |                |  |         |
| panel thickness<br>(wall/floor) = A                                               |     |         | suggested<br>screw | Z <sub>⊥</sub>                                                                    | Z <sub>∥</sub> | Z <sub>⊥</sub>                                                                     | Z <sub>∥</sub> | minimum                                                                             | typical |
| [mm]                                                                              |     | [in]    | CODE               | [lbf]                                                                             | [lbf]          | [lbf]                                                                              | [lbf]          | [in]                                                                                | [in]    |
| 3 PLY                                                                             | 79  | 3 1/8   | TBSEVO660          | 119                                                                               | 119            | 119                                                                                | 119            | 3 1/2                                                                               | 6       |
|                                                                                   | 105 | 4 1/8   | TBSEVO6100         | 165                                                                               | 165            | 165                                                                                | 165            | 3 1/2                                                                               | 6       |
|                                                                                   |     |         | TBSEVO8100         | 174                                                                               | 218            | 174                                                                                | 218            | 3 1/8                                                                               | 6       |
|                                                                                   | 120 | 4 3/4   | TBSEVO6100         | 155                                                                               | 155            | 155                                                                                | 155            | 3 1/2                                                                               | 6       |
|                                                                                   |     |         | TBSEVO8100         | 160                                                                               | 200            | 160                                                                                | 200            | 3 1/8                                                                               | 6       |
| 5 PLY                                                                             | 100 | 3 15/16 | TBSEVO680          | 130                                                                               | 130            | 130                                                                                | 130            | 3 1/2                                                                               | 6       |
|                                                                                   | 140 | 5 1/2   | TBSEVO6120         | 165                                                                               | 165            | 165                                                                                | 165            | 3 1/2                                                                               | 6       |
|                                                                                   |     |         | TBSEVO8120         | 178                                                                               | 222            | 178                                                                                | 222            | 3 1/8                                                                               | 6       |
|                                                                                   |     |         | TBSEVO10120        | 189                                                                               | 301            | 189                                                                                | 301            | 4                                                                                   | 8       |
|                                                                                   | 175 | 6 7/8   | TBSEVO6160         | 165                                                                               | 165            | 165                                                                                | 165            | 3 1/2                                                                               | 6       |
|                                                                                   |     |         | TBSEVO8160         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |
|                                                                                   |     |         | TBSEVO10160        | 232                                                                               | 338            | 232                                                                                | 338            | 4                                                                                   | 8       |
|                                                                                   | 200 | 7 7/8   | TBSEVO6180         | 165                                                                               | 165            | 165                                                                                | 165            | 3 1/2                                                                               | 6       |
|                                                                                   |     |         | TBSEVO8180         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |
|                                                                                   |     |         | TBSEVO10180        | 232                                                                               | 338            | 232                                                                                | 338            | 4                                                                                   | 8       |
| 7 PLY                                                                             | 140 | 5 1/2   | TBSEVO6120         | 165                                                                               | 165            | 165                                                                                | 165            | 3 1/2                                                                               | 6       |
|                                                                                   |     |         | TBSEVO8120         | 178                                                                               | 222            | 178                                                                                | 222            | 3 1/8                                                                               | 6       |
|                                                                                   |     |         | TBSEVO10120        | 189                                                                               | 301            | 189                                                                                | 301            | 4                                                                                   | 8       |
|                                                                                   | 191 | 7 1/2   | TBSEVO6180         | 165                                                                               | 165            | 165                                                                                | 165            | 3 1/2                                                                               | 6       |
|                                                                                   |     |         | TBSEVO8180         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |
|                                                                                   |     |         | TBSEVO10180        | 232                                                                               | 338            | 232                                                                                | 338            | 4                                                                                   | 8       |
|                                                                                   | 244 | 9 5/8   | TBSEVO8220         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |
|                                                                                   |     |         | TBSEVO10220        | 232                                                                               | 338            | 232                                                                                | 338            | 4                                                                                   | 8       |
| 9 PLY                                                                             | 280 | 11      | TBSEVO8240         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |
|                                                                                   |     |         | TBSEVO10240        | 232                                                                               | 338            | 232                                                                                | 338            | 4                                                                                   | 8       |
|                                                                                   |     |         | TBSEVO6160         | 165                                                                               | 165            | 165                                                                                | 165            | 3 1/2                                                                               | 6       |
|                                                                                   | 180 | 7 1/16  | TBSEVO8160         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |
|                                                                                   |     |         | TBSEVO10160        | 228                                                                               | 338            | 228                                                                                | 338            | 4                                                                                   | 8       |
|                                                                                   |     |         | TBSEVO8240         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |
|                                                                                   | 267 | 10 1/2  | TBSEVO10240        | 232                                                                               | 338            | 232                                                                                | 338            | 4                                                                                   | 8       |
|                                                                                   |     |         | TBSEVO8280         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |
|                                                                                   | 314 | 12 3/8  | TBSEVO10280        | 232                                                                               | 338            | 232                                                                                | 338            | 4                                                                                   | 8       |
|                                                                                   |     |         | TBSEVO8320         | 196                                                                               | 245            | 196                                                                                | 245            | 3 1/8                                                                               | 6       |

NOTES and GENERAL PRINCIPLES on page 133.

## 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.
- TBS EVO screws must be positioned in accordance with the minimum distances.
- In case of combined axial and shear forces, the designer shall refer to the Hankinson formula, as specified in section 12.4.1 of the NDS, to evaluate the load-bearing capacity.

## REFERENCE LATERAL DESIGN VALUES

- Tabulated values are determined from the yield model equations in the corresponding Section of the NDS.
- Unless otherwise noted, the threaded part of the screw is fully inserted in the main 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  $k_\alpha$ :

$$W_\alpha = W_{ref} \cdot k_\alpha \cdot L_{eff}$$

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;
- $k_\alpha$  factor is calculated as:

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

- $\alpha$  is the angle between the grain direction and screw axis.  
Tabulated values at page 128 are valid for  $L_{eff}$  equal to the screw thread length b minus the tip length  $L_t$  and  $k_\alpha = 1$  for  $\alpha = 90^\circ$ ,  $k_\alpha = 0.91$  for  $\alpha = 45^\circ$ ,  $k_\alpha = 0.3$  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  $\alpha < 15^\circ$ .
- The reference withdrawal design values must be inferior to  $f_{tens}$  of the screw.

## REFERENCE HEAD PULL-THROUGH DESIGN VALUES

While designing a connection the head pull-through values must be compared with the tensile resistance of the screw and, if necessary, thread withdrawal. The lower value is the governing one.

## 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  $G = 0.42$ .
- $Z_{\parallel}$ : 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.
- $Z_{sL}$ : Force-to-grain angle in the shear plane is considered as 90° for side member and as 0° for main member.
- 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°.
- Typical fastener spacings are declared considering a generic load condition; spacings should be verified and defined according to the real load conditions.

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

- The main grain direction of the CLT wall panel is always considered as vertical.
- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the wall plane.
- The threaded part of the screw has been always considered inserted in the central layer of the CLT panel.
- The withdrawal capacity has been considered as the minimum between thread withdrawal, head-pull through and tensile strength of the screw.
- 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.

### CLT | FLOOR-TO-WOOD BEAM

- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the beam's axis.
- The threaded part of the screw has been always considered inserted in the central layer of the CLT panel.
- The withdrawal capacity has been considered as the minimum between thread withdrawal, head-pull through and tensile strength of the screw.
- 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.
- Beam element can be considered both solid wood or glulam.
- Double lumber is considered as two coupled element of 2 inches thick.
- 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. In configurations with no declared value (-) the fastener exceeds the main member depth.

### SPLINE JOINT

- Spline thickness is considered to be thinner than the top CLT layer.
- For Root Diameter  $d_2 > 0.25$  inch, the bearing strength of the spline is conservatively considered as 3350 psi according to NDS.
- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the spline's direction.
- The width of the spline and consequent machining on CLT panel must comply with the minimum distance requirements.

### HALF LAP

- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the machining's direction.
- 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.