

## COUNTERSUNK SCREW

### 3 THORNS TIP

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

### FAST

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

### JOINTS WITH SOUNDPROOFING PROFILES

The screw has been tested and characterised in applications with soundproofing layers (XYLOFON) interposed on the shear plane. The impact of acoustic profiles on the mechanical performance of the HBS screw is described on page 88.

### NEW-GENERATION TIMBER PRODUCTS

Tested and certified for use on a wide variety of engineered timbers such as CLT, GL, LVL, OSB and beech LVL. Extremely versatile, the HBS screw guarantees the use of new-generation woods for the creation of increasingly innovative and sustainable structures.

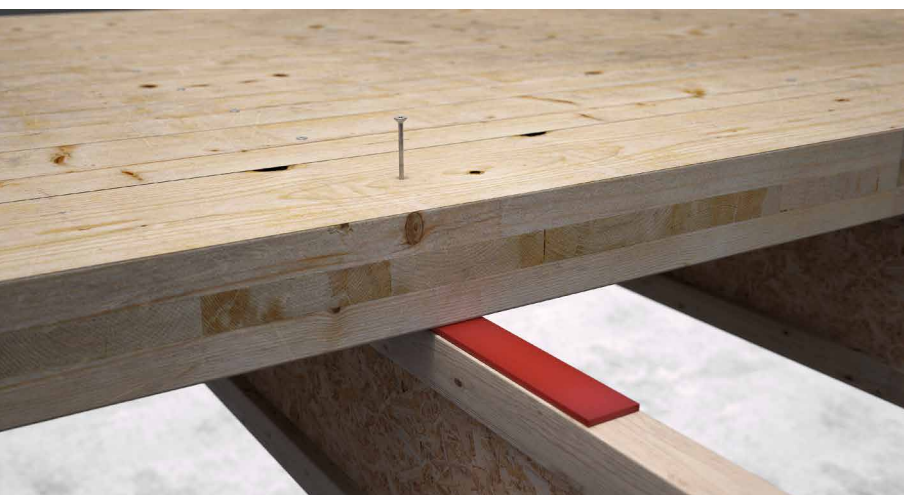


|                         |                                |        |        |        |
|-------------------------|--------------------------------|--------|--------|--------|
| DIAMETER [in]           | 0.12                           | 0.14   | 0.48   | 0.48   |
| LENGTH [in]             | 1/2                            | 1 3/16 | 39 3/8 | 39 3/8 |
| EXPOSURE CONDITION      | EC1                            | DRY    |        |        |
| ATMOSPHERIC CORROSIVITY | C1                             | C2     |        |        |
| WOOD CORROSIVITY        | T1                             | T2     |        |        |
| MATERIAL                | electrogalvanized carbon steel |        |        |        |



### FIELDS OF USE

- timber based panels
- fibreboard, MDF, HDF and LDF
- plated and melamine faced panels
- glulam (Glued Laminated Timber)
- CLT and LVL
- soft woods (e.g. Spruce, Pine, Western red cedar)
- hard woods (e.g. Douglas Fir, Oak)



## CLT, LVL AND HARDWOOD

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

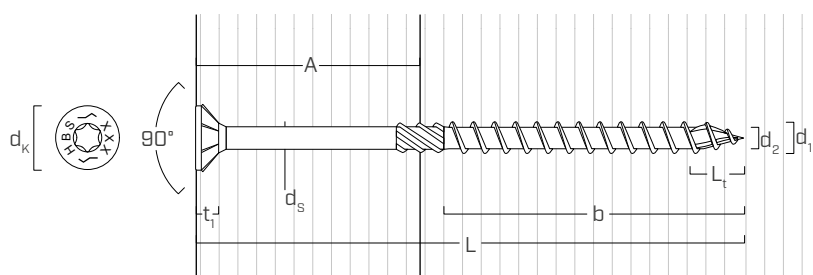


Wall insulation boards fastening with THERMOWASHER and HBS 0.32 inch (8 mm) diameter.



Fastening CLT walls with 0.24 inch (6 mm) diameter HBS screws.

## GEOMETRY AND MECHANICAL CHARACTERISTICS



### GEOMETRY

| Nominal diameter                          | $d_1$               | [in] <sup>(1)</sup> | 0.14  | 0.16  | 0.18  | 0.20  | 0.24  | 0.32  | 0.40  | 0.48  |
|-------------------------------------------|---------------------|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                           |                     | [mm]                | 3,5   | 4     | 4,5   | 5     | 6     | 8     | 10    | 12    |
| Outer thread diameter                     | $d_1$               | [in]                | 0.138 | 0.157 | 0.177 | 0.197 | 0.236 | 0.315 | 0.394 | 0.472 |
| Head diameter                             | $d_K$               | [in]                | 0.276 | 0.315 | 0.354 | 0.394 | 0.472 | 0.571 | 0.719 | 0.817 |
| Root diameter                             | $d_2$               | [in]                | 0.089 | 0.100 | 0.110 | 0.134 | 0.156 | 0.213 | 0.252 | 0.268 |
| Shank diameter                            | $d_S$               | [in]                | 0.096 | 0.108 | 0.124 | 0.144 | 0.169 | 0.228 | 0.276 | 0.315 |
| Head thickness                            | $t_1$               | [in]                | 0.087 | 0.110 | 0.110 | 0.122 | 0.177 | 0.177 | 0.228 | 0.283 |
| Tip Length                                | $L_t$               | [in]                | 0.138 | 0.157 | 0.177 | 0.197 | 0.236 | 0.315 | 0.394 | 0.472 |
| Pre-drilling hole diameter <sup>(2)</sup> | $d_{V,G \leq 0.55}$ | [in]                | -     | -     | -     | 1/8   | 5/32  | 13/64 | 15/64 | 9/32  |
| Pre-drilling hole diameter <sup>(3)</sup> | $d_{V,G > 0.55}$    | [in]                | -     | -     | -     | 9/64  | 5/32  | 15/64 | 9/32  | 5/16  |

(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]  | 0.14   | 0.16   | 0.18   | 0.20   | 0.24   | 0.32   | 0.40   | 0.48   |
|------------------------------------|------------|-------|--------|--------|--------|--------|--------|--------|--------|--------|
| Tensile strength (allowable)       | $f_{tens}$ | [lbf] | 320    | 430    | 540    | 680    | 1180   | 2040   | 2700   | 3060   |
| Bending yield strength (specified) | $F_{y,b}$  | [psi] | 257000 | 248000 | 253500 | 220000 | 200000 | 180000 | 185000 | 190000 |

| Nominal diameter                 | $d_1$    | [in]       | 0.14  | 0.16  | 0.18   | 0.20   | 0.24   | 0.32  | 0.40  | 0.48    |
|----------------------------------|----------|------------|-------|-------|--------|--------|--------|-------|-------|---------|
| Withdrawal (design value)        | $W_{90}$ | [lbf/in]   |       |       |        |        |        |       |       |         |
|                                  |          | $G = 0.35$ | 86    | 86    | 86     | 103    | 131    | 172   | 206   | 220     |
|                                  |          | $G = 0.42$ | 99    | 99    | 99     | 119    | 151    | 199   | 239   | 255     |
|                                  |          | $G = 0.49$ | 111   | 111   | 111    | 133    | 171    | 225   | 270   | 288     |
|                                  |          | $G = 0.55$ | 121   | 121   | 121    | 146    | 188    | 247   | 296   | 316     |
| minimum embedded length          |          | [in]       | 13/16 | 15/16 | 1 1/16 | 1 3/16 | 1 7/16 | 1 7/8 | 2 3/8 | 2 13/16 |
| Head pull-through (design value) | $W_H$    | [lbf]      |       |       |        |        |        |       |       |         |
|                                  |          | $G = 0.35$ | 51    | 75    | 95     | 117    | 142    | 220   | 273   | 392     |
|                                  |          | $G = 0.42$ | 59    | 87    | 110    | 136    | 165    | 264   | 316   | 453     |
|                                  |          | $G = 0.49$ | 67    | 98    | 124    | 153    | 186    | 298   | 357   | 513     |
|                                  |          | $G = 0.55$ | 73    | 108   | 136    | 168    | 204    | 327   | 392   | 562     |
| minimum side member thickness    |          | [in]       | 1     | 1 1/2 | 1 1/2  | 1 1/2  | 1 1/2  | 1 1/2 | 1 1/2 | 1 1/2   |

## CODES AND DIMENSIONS

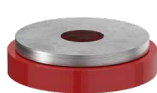
| d <sub>1</sub><br>[mm]<br>[in]    | CODE    | L   |         | b  |         | A      | pcs |
|-----------------------------------|---------|-----|---------|----|---------|--------|-----|
| 3,5<br><b>0.14</b><br>#6<br>TX 15 | HBS3540 | 40  | 1 9/16  | 18 | 11/16   | 3/4    | 500 |
|                                   | HBS3545 | 45  | 1 3/4   | 24 | 15/16   | 3/4    | 400 |
|                                   | HBS3550 | 50  | 1 15/16 | 24 | 15/16   | 1      | 400 |
| 4<br><b>0.16</b><br>#7<br>TX 20   | HBS430  | 30  | 1 3/16  | 18 | 11/16   | 1/4    | 500 |
|                                   | HBS435  | 35  | 1 3/8   | 18 | 11/16   | 1/4    | 500 |
|                                   | HBS440  | 40  | 1 9/16  | 24 | 15/16   | 1/4    | 500 |
|                                   | HBS445  | 45  | 1 3/4   | 30 | 1 3/16  | 1/2    | 400 |
|                                   | HBS450  | 50  | 1 15/16 | 30 | 1 3/16  | 3/4    | 400 |
|                                   | HBS460  | 60  | 2 3/8   | 35 | 1 3/8   | 3/4    | 200 |
|                                   | HBS470  | 70  | 2 3/4   | 40 | 1 9/16  | 1      | 200 |
| 4,5<br><b>0.18</b><br>#9<br>TX 20 | HBS480  | 80  | 3 1/8   | 40 | 1 9/16  | 1 1/2  | 200 |
|                                   | HBS4540 | 40  | 1 9/16  | 24 | 15/16   | 1/2    | 400 |
|                                   | HBS4545 | 45  | 1 3/4   | 30 | 1 3/16  | 1/2    | 400 |
|                                   | HBS4550 | 50  | 1 15/16 | 30 | 1 3/16  | 3/4    | 200 |
|                                   | HBS4560 | 60  | 2 3/8   | 35 | 1 3/8   | 3/4    | 200 |
|                                   | HBS4570 | 70  | 2 3/4   | 40 | 1 9/16  | 1      | 200 |
|                                   | HBS4580 | 80  | 3 1/8   | 40 | 1 9/16  | 1 1/2  | 200 |
| 5<br><b>0.20</b><br>#11<br>TX 25  | HBS540  | 40  | 1 9/16  | 24 | 15/16   | 1/2    | 200 |
|                                   | HBS545  | 45  | 1 3/4   | 24 | 15/16   | 3/4    | 200 |
|                                   | HBS550  | 50  | 1 15/16 | 24 | 15/16   | 1      | 200 |
|                                   | HBS560  | 60  | 2 3/8   | 30 | 1 3/16  | 1      | 200 |
|                                   | HBS570  | 70  | 2 3/4   | 35 | 1 3/8   | 1 1/4  | 100 |
|                                   | HBS580  | 80  | 3 1/8   | 40 | 1 9/16  | 1 1/2  | 100 |
|                                   | HBS590  | 90  | 3 1/2   | 45 | 1 3/4   | 1 3/4  | 100 |
| 6<br><b>0.24</b><br>#14<br>TX 30  | HBS5100 | 100 | 4       | 50 | 1 15/16 | 1 3/4  | 100 |
|                                   | HBS5120 | 120 | 4 3/4   | 60 | 2 3/8   | 2 1/4  | 100 |
|                                   | HBS640  | 40  | 1 9/16  | 35 | 1 3/8   | 1 1/16 | 100 |
|                                   | HBS650  | 50  | 1 15/16 | 35 | 1 3/8   | 3/8    | 100 |
|                                   | HBS660  | 60  | 2 3/8   | 30 | 1 3/16  | 3/4    | 100 |
|                                   | HBS670  | 70  | 2 3/4   | 40 | 1 9/16  | 1      | 100 |
|                                   | HBS680  | 80  | 3 1/8   | 40 | 1 9/16  | 1 1/2  | 100 |
| 7<br><b>0.28</b><br>#18<br>TX 35  | HBS690  | 90  | 3 1/2   | 50 | 1 15/16 | 1 1/2  | 100 |
|                                   | HBS6100 | 100 | 4       | 50 | 1 15/16 | 1 3/4  | 100 |
|                                   | HBS6110 | 110 | 4 3/8   | 60 | 2 3/8   | 1 3/4  | 100 |
|                                   | HBS6120 | 120 | 4 3/4   | 60 | 2 3/8   | 2      | 100 |
|                                   | HBS6130 | 130 | 5 1/8   | 60 | 2 3/8   | 2 1/2  | 100 |
|                                   | HBS6140 | 140 | 5 1/2   | 75 | 2 15/16 | 2 1/2  | 100 |
|                                   | HBS6150 | 150 | 6       | 75 | 2 15/16 | 2 3/4  | 100 |
| 8<br><b>0.32</b><br>#20<br>TX 40  | HBS6160 | 160 | 6 1/4   | 75 | 2 15/16 | 3 1/4  | 100 |
|                                   | HBS6180 | 180 | 7 1/8   | 75 | 2 15/16 | 4      | 100 |
|                                   | HBS6200 | 200 | 8       | 75 | 2 15/16 | 4 3/4  | 100 |
|                                   | HBS6220 | 220 | 8 5/8   | 75 | 2 15/16 | 5 1/2  | 100 |
|                                   | HBS6240 | 240 | 9 1/2   | 75 | 2 15/16 | 6 1/4  | 100 |
|                                   | HBS6260 | 260 | 10 1/4  | 75 | 2 15/16 | 7      | 100 |
|                                   | HBS6280 | 280 | 11      | 75 | 2 15/16 | 8      | 100 |
| 9<br><b>0.36</b><br>#22<br>TX 45  | HBS6300 | 300 | 11 3/4  | 75 | 2 15/16 | 8 3/4  | 100 |
|                                   | HBS6320 | 320 | 12 5/8  | 75 | 2 15/16 | 9 1/2  | 100 |
|                                   | HBS6340 | 340 | 13 3/8  | 75 | 2 15/16 | 10 1/4 | 100 |
|                                   | HBS6360 | 360 | 14 1/4  | 75 | 2 15/16 | 11     | 100 |
|                                   | HBS6380 | 380 | 15      | 75 | 2 15/16 | 12     | 100 |
|                                   | HBS6400 | 400 | 15 3/4  | 75 | 2 15/16 | 12 3/4 | 100 |

| d <sub>1</sub><br>[mm]<br>[in] | CODE      | L    |          | b   |        | A      | pcs |
|--------------------------------|-----------|------|----------|-----|--------|--------|-----|
| 8<br><b>0.32</b><br>TX 40      | HBS880    | 80   | 3 1/8    | 52  | 2 1/16 | 1      | 100 |
|                                | HBS8100   | 100  | 4        | 52  | 2 1/16 | 1 3/4  | 100 |
|                                | HBS8120   | 120  | 4 3/4    | 60  | 2 3/8  | 2 1/4  | 100 |
|                                | HBS8140   | 140  | 5 1/2    | 60  | 2 3/8  | 3      | 100 |
|                                | HBS8160   | 160  | 6 1/4    | 80  | 3 1/8  | 3      | 100 |
|                                | HBS8180   | 180  | 7 1/8    | 80  | 3 1/8  | 3 3/4  | 100 |
|                                | HBS8200   | 200  | 8        | 80  | 3 1/8  | 4 1/2  | 100 |
| 9<br><b>0.36</b><br>TX 45      | HBS8220   | 220  | 8 5/8    | 80  | 3 1/8  | 5 1/2  | 100 |
|                                | HBS8240   | 240  | 9 1/2    | 80  | 3 1/8  | 6 1/4  | 100 |
|                                | HBS8260   | 260  | 10 1/4   | 80  | 3 1/8  | 7      | 100 |
|                                | HBS8280   | 280  | 11       | 80  | 3 1/8  | 7 3/4  | 100 |
|                                | HBS8300   | 300  | 11 3/4   | 100 | 4      | 7 3/4  | 100 |
|                                | HBS8320   | 320  | 12 5/8   | 100 | 4      | 8 1/2  | 100 |
|                                | HBS8340   | 340  | 13 3/8   | 100 | 4      | 9 1/4  | 100 |
| 10<br><b>0.40</b><br>TX 50     | HBS8360   | 360  | 14 1/4   | 100 | 4      | 10     | 100 |
|                                | HBS8380   | 380  | 15       | 100 | 4      | 11     | 100 |
|                                | HBS8400   | 400  | 15 3/4   | 100 | 4      | 11 1/2 | 100 |
|                                | HBS8440   | 440  | 17 1/4   | 100 | 4      | 13 1/4 | 100 |
|                                | HBS8480   | 480  | 19       | 100 | 4      | 14 3/4 | 100 |
|                                | HBS8520   | 520  | 20 1/2   | 100 | 4      | 16 1/2 | 100 |
|                                | HBS8560   | 560  | 22       | 100 | 4      | 18     | 100 |
| 11<br><b>0.44</b><br>TX 55     | HBS8580   | 580  | 22 13/16 | 100 | 4      | 18 3/4 | 100 |
|                                | HBS8600   | 600  | 23 5/8   | 100 | 4      | 19 1/2 | 100 |
|                                | HBS1080   | 80   | 3 1/8    | 52  | 2 1/16 | 1/2    | 50  |
|                                | HBS10100  | 100  | 4        | 52  | 2 1/16 | 1      | 50  |
|                                | HBS10120  | 120  | 4 3/4    | 60  | 2 3/8  | 2 1/8  | 50  |
|                                | HBS10140  | 140  | 5 1/2    | 60  | 2 3/8  | 2 3/4  | 50  |
|                                | HBS10160  | 160  | 6 1/4    | 80  | 3 1/8  | 3      | 50  |
| 12<br><b>0.48</b><br>TX 50     | HBS10180  | 180  | 7 1/8    | 80  | 3 1/8  | 3 3/4  | 50  |
|                                | HBS10200  | 200  | 8        | 80  | 3 1/8  | 4 1/2  | 50  |
|                                | HBS10220  | 220  | 8 5/8    | 80  | 3 1/8  | 5 1/2  | 50  |
|                                | HBS10240  | 240  | 9 1/2    | 80  | 3 1/8  | 6 1/4  | 50  |
|                                | HBS10260  | 260  | 10 1/4   | 80  | 3 1/8  | 7      | 50  |
|                                | HBS10280  | 280  | 11       | 80  | 3 1/8  | 7 3/4  | 50  |
|                                | HBS10300  | 300  | 11 3/4   | 100 | 4      | 7 3/4  | 50  |
| 13<br><b>0.52</b><br>TX 60     | HBS10320  | 320  | 12 5/8   | 100 | 4      | 8 1/2  | 50  |
|                                | HBS10340  | 340  | 13 3/8   | 100 | 4      | 9 1/4  | 50  |
|                                | HBS10360  | 360  | 14 1/4   | 100 | 4      | 10     | 50  |
|                                | HBS10380  | 380  | 15       | 100 | 4      | 11     | 50  |
|                                | HBS10400  | 400  | 15 3/4   | 100 | 4      | 11 1/2 | 50  |
|                                | HBS10440  | 440  | 17 1/4   | 100 | 4      | 13 1/4 | 50  |
|                                | HBS10480  | 480  | 19       | 100 | 4      | 14 3/4 | 50  |
| 14<br><b>0.56</b><br>TX 65     | HBS10520  | 520  | 20 1/2   | 100 | 4      | 16 1/2 | 50  |
|                                | HBS10560  | 560  | 22       | 100 | 4      | 18     | 50  |
|                                | HBS10600  | 600  | 23 5/8   | 100 | 4      | 19 1/2 | 50  |
|                                | HBS12120  | 120  | 4 3/4    | 80  | 3 1/8  | 1 1/2  | 25  |
|                                | HBS12160  | 160  | 6 1/4    | 80  | 3 1/8  | 3      | 25  |
|                                | HBS12200  | 200  | 8        | 80  | 3 1/8  | 4 1/2  | 25  |
|                                | HBS12240  | 240  | 9 1/2    | 80  | 3 1/8  | 6 1/4  | 25  |
| 15<br><b>0.60</b><br>TX 70     | HBS12280  | 280  | 11       | 80  | 3 1/8  | 7 3/4  | 25  |
|                                | HBS12320  | 320  | 12 5/8   | 120 | 4 3/4  | 7 3/4  | 25  |
|                                | HBS12360  | 360  | 14 1/4   | 120 | 4 3/4  | 9 1/4  | 25  |
|                                | HBS12400  | 400  | 15 3/4   | 120 | 4 3/4  | 11     | 25  |
|                                | HBS12440  | 440  | 17 1/4   | 120 | 4 3/4  | 12 1/2 | 25  |
|                                | HBS12480  | 480  | 19       | 120 | 4 3/4  | 14     | 25  |
|                                | HBS12520  | 520  | 20 1/2   | 120 | 4 3/4  | 15 1/2 | 25  |
| 16<br><b>0.64</b><br>TX 75     | HBS12560  | 560  | 22       | 120 | 4 3/4  | 17     | 25  |
|                                | HBS12600  | 600  | 23 5/8   | 120 | 4 3/4  | 18 1/2 | 25  |
|                                | HBS12700  | 700  | 27 1/2   | 120 | 4 3/4  | 22 3/4 | 25  |
|                                | HBS12800  | 800  | 31 1/2   | 120 | 4 3/4  | 26 3/4 | 25  |
|                                | HBS12900  | 900  | 35 1/2   | 120 | 4 3/4  | 30 1/2 | 25  |
|                                | HBS121000 | 1000 | 39 3/8   | 120 | 4 3/4  | 34 1/2 | 25  |

## RELATED PRODUCTS



HUS  
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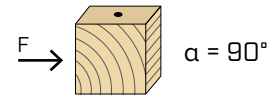
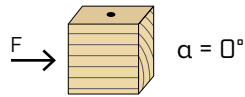
XYLOFON WASHER  
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THERMOWASHER  
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## MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

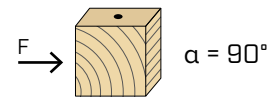
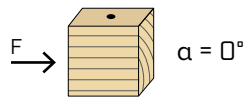
screws inserted **WITHOUT** pre-drilled hole  $G \leq 0.48$



| d <sub>1</sub>   | [in] | 0.14 | 0.16   | 0.18   | 0.20    | 0.24    | 0.32   | 0.40   | 0.48    |       |
|------------------|------|------|--------|--------|---------|---------|--------|--------|---------|-------|
|                  | [mm] | 3,5  | 4      | 4,5    | 5       | 6       | 8      | 10     | 12      |       |
| a <sub>1</sub>   | [in] | 15·d | 2 1/16 | 2 3/8  | 2 11/16 | 2 15/16 | 3 1/2  | 3 1/8  | 4       | 4 3/4 |
| a <sub>2</sub>   | [in] | 5·d  | 11/16  | 13/16  | 7/8     | 1       | 1 3/16 | 1 9/16 | 1 15/16 | 2 3/8 |
| a <sub>3,t</sub> | [in] | 15·d | 2 1/16 | 2 3/8  | 2 11/16 | 2 15/16 | 3 1/2  | 4 3/4  | 6       | 7 1/8 |
| a <sub>3,c</sub> | [in] | 10·d | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | 3 1/8  | 4       | 4 3/4 |
| a <sub>4,t</sub> | [in] | 10·d | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | 3 1/8  | 4       | 4 3/4 |
| a <sub>4,c</sub> | [in] | 5·d  | 11/16  | 13/16  | 7/8     | 1       | 1 3/16 | 1 9/16 | 1 15/16 | 2 3/8 |

|             | 0.14   | 0.16   | 0.18    | 0.20    | 0.24   | 0.32          | 0.40           | 0.48         |
|-------------|--------|--------|---------|---------|--------|---------------|----------------|--------------|
|             | 3,5    | 4      | 4,5     | 5       | 6      | 8             | 10             | 12           |
| <b>10·d</b> | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | <b>1 9/16</b> | <b>1 15/16</b> | <b>2 3/8</b> |
| <b>5·d</b>  | 11/16  | 13/16  | 7/8     | 1       | 1 3/16 | 1 9/16        | 1 15/16        | 2 3/8        |
| <b>15·d</b> | 2 1/16 | 2 3/8  | 2 11/16 | 2 15/16 | 3 1/2  | 4 3/4         | 6              | 7 1/8        |
| <b>10·d</b> | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | 3 1/8         | 4              | 4 3/4        |
| <b>10·d</b> | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | 3 1/8         | 4              | 4 3/4        |
| <b>5·d</b>  | 11/16  | 13/16  | 7/8     | 1       | 1 3/16 | 1 9/16        | 1 15/16        | 2 3/8        |

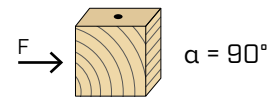
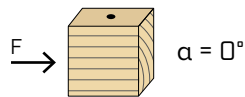
screws inserted **WITHOUT** pre-drilled hole  $0.48 < G \leq 0.50$



| d <sub>1</sub>   | [in] | 0.14 | 0.16   | 0.18   | 0.20    | 0.24    | 0.32   | 0.40   | 0.48    |       |
|------------------|------|------|--------|--------|---------|---------|--------|--------|---------|-------|
|                  | [mm] | 3,5  | 4      | 4,5    | 5       | 6       | 8      | 10     | 12      |       |
| a <sub>1</sub>   | [in] | 15·d | 2 1/16 | 2 3/8  | 2 11/16 | 2 15/16 | 3 1/2  | 4 3/4  | 6       | 7 1/8 |
| a <sub>2</sub>   | [in] | 5·d  | 11/16  | 13/16  | 7/8     | 1       | 1 3/16 | 1 9/16 | 1 15/16 | 2 3/8 |
| a <sub>3,t</sub> | [in] | 15·d | 2 1/16 | 2 3/8  | 2 11/16 | 2 15/16 | 3 1/2  | 4 3/4  | 6       | 7 1/8 |
| a <sub>3,c</sub> | [in] | 10·d | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | 3 1/8  | 4       | 4 3/4 |
| a <sub>4,t</sub> | [in] | 10·d | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | 3 1/8  | 4       | 4 3/4 |
| a <sub>4,c</sub> | [in] | 5·d  | 11/16  | 13/16  | 7/8     | 1       | 1 3/16 | 1 9/16 | 1 15/16 | 2 3/8 |

|             | 0.14   | 0.16   | 0.18    | 0.20    | 0.24   | 0.32          | 0.40         | 0.48          |
|-------------|--------|--------|---------|---------|--------|---------------|--------------|---------------|
|             | 3,5    | 4      | 4,5     | 5       | 6      | 8             | 10           | 12            |
| <b>10·d</b> | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | <b>2 3/16</b> | <b>2 3/4</b> | <b>3 5/16</b> |
| <b>5·d</b>  | 11/16  | 13/16  | 7/8     | 1       | 1 3/16 | 1 9/16        | 1 15/16      | 2 3/8         |
| <b>15·d</b> | 2 1/16 | 2 3/8  | 2 11/16 | 2 15/16 | 3 1/2  | 4 3/4         | 6            | 7 1/8         |
| <b>10·d</b> | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | 3 1/8         | 4            | 4 3/4         |
| <b>10·d</b> | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8  | 3 1/8         | 4            | 4 3/4         |
| <b>5·d</b>  | 11/16  | 13/16  | 7/8     | 1       | 1 3/16 | 1 9/16        | 1 15/16      | 2 3/8         |

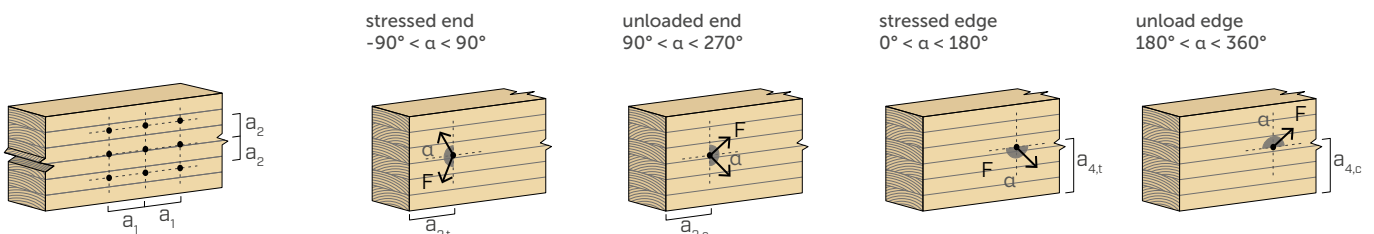
screws inserted **WITHOUT** pre-drilled hole  $G > 0.50$



| d <sub>1</sub>   | [in] | 0.14 | 0.16   | 0.18  | 0.20    | 0.24    | 0.32    | 0.40   | 0.48  |         |
|------------------|------|------|--------|-------|---------|---------|---------|--------|-------|---------|
|                  | [mm] | 3,5  | 4      | 4,5   | 5       | 6       | 8       | 10     | 12    |         |
| a <sub>1</sub>   | [in] | 15·d | 2 1/16 | 2 3/8 | 2 11/16 | 2 15/16 | 3 1/2   | 4 3/4  | 6     | 7 1/8   |
| a <sub>2</sub>   | [in] | 7·d  | 1      | 1 1/8 | 1 1/4   | 1 3/8   | 1 5/8   | 2 3/16 | 2 3/4 | 3 5/16  |
| a <sub>3,t</sub> | [in] | 20·d | 2 3/4  | 3 1/8 | 3 1/2   | 4       | 4 3/4   | 6 1/4  | 8     | 9 1/2   |
| a <sub>3,c</sub> | [in] | 15·d | 2 1/16 | 2 3/8 | 2 11/16 | 2 15/16 | 3 1/2   | 4 3/4  | 6     | 7 1/8   |
| a <sub>4,t</sub> | [in] | 12·d | 1 5/8  | 1 7/8 | 2 1/8   | 2 3/8   | 2 13/16 | 3 3/4  | 4 3/4 | 5 11/16 |
| a <sub>4,c</sub> | [in] | 7·d  | 1      | 1 1/8 | 1 1/4   | 1 3/8   | 1 5/8   | 2 3/16 | 2 3/4 | 3 5/16  |

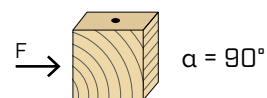
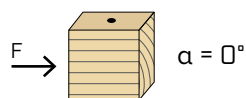
|             | 0.14   | 0.16   | 0.18    | 0.20    | 0.24    | 0.32   | 0.40  | 0.48    |
|-------------|--------|--------|---------|---------|---------|--------|-------|---------|
|             | 3,5    | 4      | 4,5     | 5       | 6       | 8      | 10    | 12      |
| <b>10·d</b> | 1 3/8  | 1 9/16 | 1 3/4   | 1 15/16 | 2 3/8   | 3 1/8  | 4     | 4 3/4   |
| <b>7·d</b>  | 1      | 1 1/8  | 1 1/4   | 1 3/8   | 1 5/8   | 2 3/16 | 2 3/4 | 3 5/16  |
| <b>20·d</b> | 2 3/4  | 3 1/8  | 3 1/2   | 4       | 4 3/4   | 6 1/4  | 8     | 9 1/2   |
| <b>15·d</b> | 2 1/16 | 2 3/8  | 2 11/16 | 2 15/16 | 3 1/2   | 4 3/4  | 6     | 7 1/8   |
| <b>12·d</b> | 1 5/8  | 1 7/8  | 2 1/8   | 2 3/8   | 2 13/16 | 3 3/4  | 4 3/4 | 5 11/16 |
| <b>7·d</b>  | 1      | 1 1/8  | 1 1/4   | 1 3/8   | 1 5/8   | 2 3/16 | 2 3/4 | 3 5/16  |

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





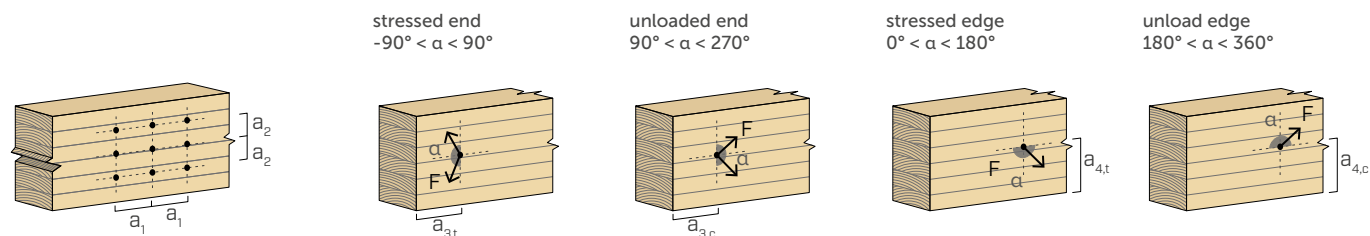
screws inserted **WITH pre-drilled hole**



| d <sub>1</sub>   | [in] | 0.14 | 0.16  | 0.18   | 0.20  | 0.24    | 0.32    |        |     |         | 0.40   | 0.48 |  |  |  |  |  |  |  |  |  |      | 0.14  | 0.16  | 0.18  | 0.20  | 0.24    | 0.32   |     |         |        | 0.40 | 0.48 |  |
|------------------|------|------|-------|--------|-------|---------|---------|--------|-----|---------|--------|------|--|--|--|--|--|--|--|--|--|------|-------|-------|-------|-------|---------|--------|-----|---------|--------|------|------|--|
|                  | [mm] | 3,5  | 4     | 4,5    | 5     | 6       | 8       |        |     |         | 10     | 12   |  |  |  |  |  |  |  |  |  |      | 3,5   | 4     | 4,5   | 5     | 6       | 8      |     |         |        | 10   | 12   |  |
| a <sub>1</sub>   | [in] | 10·d | 1 3/8 | 1 9/16 | 1 3/4 | 1 15/16 | 2 3/8   | 3 1/8  | 5·d | 1 15/16 | 2 3/8  |      |  |  |  |  |  |  |  |  |  | 5·d  | 11/16 | 13/16 | 7/8   | 1     | 1 3/13  | 1 9/16 | 5·d | 1 15/16 | 2 3/8  |      |      |  |
| a <sub>2</sub>   | [in] | 4·d  | 9/16  | 5/8    | 11/16 | 13/16   | 15/16   | 1 1/4  | 5·d | 1 15/16 | 2 3/8  |      |  |  |  |  |  |  |  |  |  | 4·d  | 9/16  | 5/8   | 11/16 | 13/16 | 15/16   | 1 1/4  | 5·d | 1 15/16 | 2 3/8  |      |      |  |
| a <sub>3,t</sub> | [in] | 12·d | 1 5/8 | 1 7/8  | 2 1/8 | 2 3/8   | 2 13/16 | 3 3/4  | 7·d | 2 3/4   | 3 5/16 |      |  |  |  |  |  |  |  |  |  | 12·d | 1 5/8 | 1 7/8 | 2 1/8 | 2 3/8 | 2 13/16 | 3 3/4  | 7·d | 2 3/4   | 3 5/16 |      |      |  |
| a <sub>3,c</sub> | [in] | 7·d  | 1     | 1 1/8  | 1 1/4 | 1 3/8   | 1 5/8   | 2 3/16 | 4·d | 1 9/16  | 1 7/8  |      |  |  |  |  |  |  |  |  |  | 7·d  | 1     | 1 1/8 | 1 1/4 | 1 3/8 | 1 5/8   | 2 3/16 | 4·d | 1 9/16  | 1 7/8  |      |      |  |
| a <sub>4,t</sub> | [in] | 7·d  | 1     | 1 1/8  | 1 1/4 | 1 3/8   | 1 5/8   | 2 3/16 | 4·d | 1 9/16  | 1 7/8  |      |  |  |  |  |  |  |  |  |  | 7·d  | 1     | 1 1/8 | 1 1/4 | 1 3/8 | 1 5/8   | 2 3/16 | 4·d | 1 9/16  | 1 7/8  |      |      |  |
| a <sub>4,c</sub> | [in] | 3·d  | 7/16  | 1/2    | 9/16  | 9/16    | 11/16   | 15/16  | 3·d | 1 3/16  | 1 7/16 |      |  |  |  |  |  |  |  |  |  | 3·d  | 7/16  | 1/2   | 9/16  | 9/16  | 11/16   | 15/16  | 3·d | 1 3/16  | 1 7/16 |      |      |  |

$\alpha$  = 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 ESR-4645, where d refers to the nominal diameter of the screw, and are valid for screw installed into sawn lumber, structural glued laminated timber and cross laminated timber;
- 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]     | [in]            |         |         | 0.35     | 0.42 | 0.49 | 0.55 | 0.35           | 0.42 | 0.49 | 0.55 | 0.35        | 0.42 | 0.49 | 0.55 |
| 3,5<br>0.14 | 40       | 1 9/16          | 11/16   | 3/4     | 30       | 42   | 56   | 69   | 30             | 42   | 56   | 69   | 30          | 42   | 56   | 69   |
|             | 45       | 1 3/4           | 15/16   | 3/4     | 34       | 48   | 61   | 72   | 34             | 48   | 61   | 72   | 34          | 48   | 61   | 72   |
|             | 50       | 1 15/16         | 15/16   | 1       | 38       | 53   | 67   | 78   | 38             | 53   | 67   | 78   | 38          | 53   | 67   | 78   |
| 4<br>0.16   | 30       | 1 3/16          | 11/16   | 1/4     | 27       | 38   | 51   | 63   | 27             | 38   | 51   | 63   | 27          | 38   | 51   | 63   |
|             | 35       | 1 3/8           | 11/16   | 1/4     | 31       | 43   | 57   | 71   | 31             | 43   | 57   | 71   | 31          | 43   | 57   | 71   |
|             | 40       | 1 9/16          | 15/16   | 1/4     | 37       | 51   | 65   | 74   | 37             | 51   | 65   | 74   | 37          | 51   | 65   | 74   |
|             | 45       | 1 3/4           | 1 3/16  | 1/2     | 43       | 55   | 65   | 74   | 43             | 55   | 65   | 74   | 43          | 55   | 65   | 74   |
|             | 50       | 1 15/16         | 1 3/16  | 3/4     | 44       | 61   | 74   | 86   | 44             | 61   | 74   | 86   | 44          | 61   | 74   | 86   |
|             | 60       | 2 3/8           | 1 3/8   | 3/4     | 49       | 61   | 74   | 86   | 49             | 61   | 74   | 86   | 49          | 61   | 74   | 86   |
|             | 70       | 2 3/4           | 1 9/16  | 1       | 54       | 69   | 86   | 98   | 54             | 69   | 86   | 98   | 54          | 69   | 86   | 98   |
| 4,5<br>0.18 | 80       | 3 1/8           | 1 9/16  | 1 1/2   | 65       | 76   | 88   | 98   | 65             | 76   | 88   | 98   | 65          | 76   | 88   | 98   |
|             | 40       | 1 9/16          | 15/16   | 1/2     | 40       | 56   | 74   | 88   | 40             | 56   | 74   | 88   | 40          | 56   | 74   | 88   |
|             | 45       | 1 3/4           | 1 3/16  | 1/2     | 47       | 66   | 78   | 88   | 47             | 66   | 78   | 88   | 47          | 66   | 78   | 88   |
|             | 50       | 1 15/16         | 1 3/16  | 3/4     | 48       | 67   | 86   | 100  | 48             | 67   | 86   | 100  | 48          | 67   | 86   | 100  |
|             | 60       | 2 3/8           | 1 3/8   | 3/4     | 58       | 71   | 86   | 100  | 58             | 71   | 86   | 100  | 58          | 71   | 86   | 100  |
| 5<br>0.20   | 70       | 2 3/4           | 1 9/16  | 1       | 63       | 80   | 98   | 116  | 63             | 80   | 98   | 116  | 63          | 80   | 98   | 116  |
|             | 80       | 3 1/8           | 1 9/16  | 1 1/2   | 76       | 93   | 107  | 119  | 76             | 93   | 107  | 119  | 76          | 93   | 107  | 119  |
|             | 40       | 1 9/16          | 15/16   | 1/2     | 48       | 67   | 89   | 111  | 48             | 67   | 89   | 111  | 48          | 67   | 89   | 111  |
|             | 45       | 1 3/4           | 15/16   | 3/4     | 50       | 71   | 94   | 116  | 50             | 71   | 94   | 116  | 50          | 71   | 94   | 116  |
|             | 50       | 1 15/16         | 15/16   | 1       | 56       | 78   | 104  | 129  | 56             | 78   | 104  | 129  | 56          | 78   | 104  | 129  |
|             | 60       | 2 3/8           | 1 3/16  | 1       | 70       | 98   | 127  | 149  | 70             | 98   | 127  | 149  | 70          | 98   | 127  | 149  |
|             | 70       | 2 3/4           | 1 3/8   | 1 1/4   | 81       | 113  | 143  | 164  | 81             | 113  | 143  | 164  | 81          | 113  | 143  | 164  |
|             | 80       | 3 1/8           | 1 9/16  | 1 1/2   | 92       | 127  | 147  | 164  | 92             | 127  | 147  | 164  | 92          | 127  | 147  | 164  |
| 6<br>0.24   | 90       | 3 1/2           | 1 3/4   | 1 3/4   | 103      | 128  | 147  | 164  | 103            | 128  | 147  | 164  | 103         | 128  | 147  | 164  |
|             | 100      | 4               | 1 15/16 | 1 3/4   | 107      | 128  | 147  | 164  | 107            | 128  | 147  | 164  | 107         | 128  | 147  | 164  |
|             | 120      | 4 3/4           | 2 3/8   | 2 1/4   | 108      | 128  | 147  | 164  | 108            | 128  | 147  | 164  | 108         | 128  | 147  | 164  |
|             | 40       | 1 9/16          | 1 3/8   | 1/16    | 21       | 30   | 39   | 49   | 21             | 30   | 39   | 49   | 21          | 30   | 39   | 49   |
|             | 50       | 1 15/16         | 1 3/8   | 3/8     | 75       | 105  | 135  | 151  | 75             | 105  | 135  | 151  | 75          | 105  | 135  | 151  |
|             | 60       | 2 3/8           | 1 3/16  | 3/4     | 80       | 112  | 149  | 182  | 80             | 112  | 149  | 182  | 80          | 112  | 149  | 182  |
|             | 70       | 2 3/4           | 1 9/16  | 1       | 97       | 129  | 156  | 182  | 97             | 129  | 156  | 182  | 97          | 129  | 156  | 182  |
|             | 80       | 3 1/8           | 1 9/16  | 1 1/2   | 106      | 148  | 190  | 211  | 106            | 148  | 190  | 211  | 106         | 148  | 190  | 211  |
|             | 90       | 3 1/2           | 1 15/16 | 1 1/2   | 120      | 154  | 190  | 211  | 120            | 154  | 190  | 211  | 120         | 154  | 190  | 211  |
|             | 100      | 4               | 1 15/16 | 1 3/4   | 129      | 165  | 190  | 211  | 129            | 165  | 190  | 211  | 129         | 165  | 190  | 211  |
| 8<br>0.32   | 110      | 4 3/8           | 2 3/8   | 1 3/4   | 129      | 165  | 190  | 211  | 129            | 165  | 190  | 211  | 129         | 165  | 190  | 211  |
|             | 120      | 4 3/4           | 2 3/8   | 2       | 139      | 165  | 190  | 211  | 139            | 165  | 190  | 211  | 139         | 165  | 190  | 211  |
|             | 130      | 5 1/8           | 2 3/8   | 2 1/2   | 139      | 165  | 190  | 211  | 139            | 165  | 190  | 211  | 139         | 165  | 190  | 211  |
|             | 140-400  | 5 1/2 - 15 3/4  | 2 15/16 | ≥ 2 1/2 | 139      | 165  | 190  | 211  | 139            | 165  | 190  | 211  | 139         | 165  | 190  | 211  |
|             | 80       | 3 1/8           | 2 1/16  | 1       | 130      | 179  | 213  | 244  | 104            | 143  | 170  | 195  | 104         | 143  | 170  | 195  |
|             | 100      | 4               | 2 1/16  | 1 3/4   | 156      | 216  | 270  | 313  | 125            | 173  | 216  | 251  | 125         | 173  | 216  | 251  |
|             | 120      | 4 3/4           | 2 3/8   | 2 1/4   | 185      | 245  | 282  | 313  | 148            | 196  | 225  | 251  | 148         | 196  | 225  | 251  |
|             | 140      | 5 1/2           | 2 3/8   | 3       | 196      | 245  | 282  | 313  | 157            | 196  | 225  | 251  | 157         | 196  | 225  | 251  |
| 10<br>0.40  | 160-280  | 6 1/4-11        | 3 1/8   | ≥ 3     | 207      | 245  | 282  | 313  | 165            | 196  | 225  | 251  | 165         | 196  | 225  | 251  |
|             | 300-600  | 11 3/4 - 23 5/8 | 4       | ≥ 7 3/4 | 207      | 245  | 282  | 313  | 165            | 196  | 225  | 251  | 165         | 196  | 225  | 251  |
|             | 80       | 3 1/8           | 2 1/16  | 1/2     | 180      | 217  | 253  | 284  | 131            | 161  | 191  | 216  | 98          | 127  | 159  | 188  |
|             | 100      | 4               | 2 1/16  | 1       | 217      | 261  | 304  | 341  | 149            | 184  | 220  | 253  | 118         | 153  | 192  | 226  |
|             | 120      | 4 3/4           | 2 3/8   | 2 1/8   | 259      | 311  | 362  | 387  | 173            | 215  | 259  | 295  | 140         | 182  | 228  | 270  |
|             | 140      | 5 1/2           | 2 3/8   | 2 3/4   | 300      | 338  | 365  | 387  | 195            | 245  | 274  | 295  | 165         | 216  | 259  | 282  |
|             | 160-280  | 6 1/4 - 11      | 3 1/8   | ≥ 2 7/8 | 308      | 338  | 365  | 387  | 220            | 249  | 274  | 295  | 186         | 232  | 259  | 282  |
| 12<br>0.48  | 300-600  | 11 3/4 - 23 5/8 | 4       | ≥ 7 3/4 | 308      | 338  | 365  | 387  | 222            | 249  | 274  | 295  | 203         | 232  | 259  | 282  |
|             | 120      | 4 3/4           | 3 1/8   | 1 1/2   | 273      | 308  | 342  | 372  | 183            | 211  | 240  | 266  | 157         | 197  | 228  | 255  |
|             | 160-280  | 6 1/4-11        | 3 1/8   | ≥ 3     | 353      | 387  | 418  | 442  | 235            | 282  | 311  | 334  | 191         | 248  | 292  | 317  |
|             | 320-1000 | 12 5/8 - 39 3/8 | 4 3/4   | ≥ 7 3/4 | 353      | 387  | 418  | 442  | 251            | 282  | 311  | 334  | 229         | 261  | 292  | 317  |

NOTES and GENERAL PRINCIPLES on page 48.

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

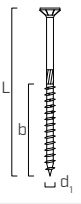
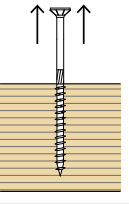
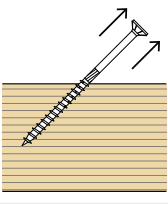
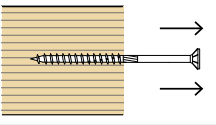
| geometry     |          |                 |         | $Z_{  }^{(1)}$ |               |               |               |               | $Z_{\perp}^{(2)}$ |               |               |               |               |
|--------------|----------|-----------------|---------|----------------|---------------|---------------|---------------|---------------|-------------------|---------------|---------------|---------------|---------------|
|              |          |                 |         |                |               |               |               |               |                   |               |               |               |               |
| $d_1$        | L        |                 | b       | $S_{PLATE}$    | G             |               |               |               | $S_{PLATE}$       | G             |               |               |               |
| [mm]<br>[in] | [mm]     | [in]            | [in]    | [in]           | 0.35<br>[lbf] | 0.42<br>[lbf] | 0.49<br>[lbf] | 0.55<br>[lbf] | [in]              | 0.35<br>[lbf] | 0.42<br>[lbf] | 0.49<br>[lbf] | 0.55<br>[lbf] |
| 3,5<br>0.14  | 40       | 1 9/16          | 11/16   | 1/16           | 54            | 63            | 72            | 79            | 1/16              | 54            | 63            | 72            | 79            |
|              | 45-50    | 1 3/4 - 1 15/16 | 15/16   |                | 54            | 63            | 72            | 79            |                   | 54            | 63            | 72            | 79            |
| 4<br>0.16    | 30       | 1 3/16          | 11/16   | 1/16           | 50            | 68            | 89            | 98            | 1/16              | 50            | 68            | 89            | 98            |
|              | 35       | 1 3/8           | 11/16   |                | 58            | 78            | 89            | 98            |                   | 58            | 78            | 89            | 98            |
|              | 40       | 1 9/16          | 15/16   |                | 66            | 78            | 89            | 98            |                   | 66            | 78            | 89            | 98            |
|              | 45-50    | 1 3/4 - 1 15/16 | 1 3/16  |                | 67            | 78            | 89            | 98            |                   | 67            | 78            | 89            | 98            |
|              | 60       | 2 3/8           | 1 3/8   |                | 67            | 78            | 89            | 98            |                   | 67            | 78            | 89            | 98            |
|              | 70-80    | 2 3/4 - 3 1/8   | 1 9/16  |                | 67            | 78            | 89            | 98            |                   | 67            | 78            | 89            | 98            |
| 4,5<br>0.18  | 40       | 1 9/16          | 15/16   | 1/16           | 72            | 95            | 108           | 119           | 1/16              | 72            | 95            | 108           | 119           |
|              | 45-50    | 1 3/4 - 1 15/16 | 1 3/16  |                | 81            | 95            | 108           | 119           |                   | 81            | 95            | 108           | 119           |
|              | 60       | 2 3/8           | 1 3/8   |                | 81            | 95            | 108           | 119           |                   | 81            | 95            | 108           | 119           |
|              | 70-80    | 2 3/4 - 3 1/8   | 1 9/16  |                | 81            | 95            | 108           | 119           |                   | 81            | 95            | 108           | 119           |
| 5<br>0.20    | 40       | 1 9/16          | 15/16   | 1/16           | 87            | 120           | 147           | 162           | 1/16              | 87            | 120           | 147           | 162           |
|              | 45       | 1 3/4           | 15/16   |                | 98            | 129           | 147           | 162           |                   | 98            | 129           | 147           | 162           |
|              | 50       | 1 15/16         | 15/16   |                | 109           | 129           | 147           | 162           |                   | 109           | 129           | 147           | 162           |
|              | 60       | 2 3/8           | 1 3/16  |                | 110           | 129           | 147           | 162           |                   | 110           | 129           | 147           | 162           |
|              | 70       | 2 3/4           | 1 3/8   |                | 110           | 129           | 147           | 162           |                   | 110           | 129           | 147           | 162           |
|              | 80       | 3 1/8           | 1 9/16  |                | 110           | 129           | 147           | 162           |                   | 110           | 129           | 147           | 162           |
|              | 90       | 3 1/2           | 1 3/4   |                | 110           | 129           | 147           | 162           |                   | 110           | 129           | 147           | 162           |
|              | 100      | 4               | 1 15/16 |                | 110           | 129           | 147           | 162           |                   | 110           | 129           | 147           | 162           |
|              | 120      | 4 3/4           | 2 3/8   |                | 110           | 129           | 147           | 162           |                   | 110           | 129           | 147           | 162           |
| 6<br>0.24    | 40       | 1 9/16          | 1 3/8   | 1/8            | 110           | 145           | 184           | 222           | 1/8               | 110           | 145           | 184           | 222           |
|              | 50       | 1 15/16         | 1 3/8   |                | 132           | 177           | 205           | 225           |                   | 132           | 177           | 205           | 225           |
|              | 60       | 2 3/8           | 1 3/16  |                | 155           | 180           | 205           | 225           |                   | 155           | 180           | 205           | 225           |
|              | 70-80    | 2 3/4 - 3 1/8   | 1 9/16  |                | 155           | 180           | 205           | 225           |                   | 155           | 180           | 205           | 225           |
|              | 90-100   | 3 1/2 - 4       | 1 15/16 |                | 155           | 180           | 205           | 225           |                   | 155           | 180           | 205           | 225           |
|              | 110-130  | 4 3/8 - 5 1/8   | 2 3/8   |                | 155           | 180           | 205           | 225           |                   | 155           | 180           | 205           | 225           |
|              | 140-300  | 5 1/2 - 11 3/4  | 2 15/16 |                | 155           | 180           | 205           | 225           |                   | 155           | 180           | 205           | 225           |
|              | 320-400  | 12 5/8 - 15 3/4 | 2 15/16 |                | 180           | 210           | 238           | 262           |                   | 180           | 210           | 238           | 262           |
| 8<br>0.32    | 80-100   | 3 1/8 - 4       | 2 1/16  | 1/8            | 218           | 255           | 290           | 319           | 1/8               | 174           | 204           | 232           | 255           |
|              | 120-140  | 4 3/4 - 5 1/2   | 2 3/8   |                | 218           | 255           | 290           | 319           |                   | 174           | 204           | 232           | 255           |
|              | 160-280  | 6 1/4 - 11      | 3 1/8   |                | 218           | 255           | 290           | 319           |                   | 174           | 204           | 232           | 255           |
|              | 300-400  | 11 3/4 - 15 3/4 | 4       |                | 218           | 255           | 290           | 319           |                   | 174           | 204           | 232           | 255           |
|              | 440-600  | 17 1/4 - 23 5/8 | 4       |                | 235           | 274           | 313           | 344           |                   | 188           | 220           | 250           | 275           |
| 10<br>0.40   | 80       | 3 1/8           | 2 1/16  | 1/4            | 330           | 387           | 418           | 440           | 1/4               | 191           | 237           | 287           | 324           |
|              | 100      | 4               | 2 1/16  |                | 361           | 391           | 418           | 440           |                   | 236           | 273           | 302           | 324           |
|              | 120-140  | 4 3/4 - 5 1/2   | 2 3/8   |                | 361           | 391           | 418           | 440           |                   | 242           | 273           | 302           | 324           |
|              | 160-280  | 6 1/4 - 11      | 3 1/8   |                | 361           | 391           | 418           | 440           |                   | 242           | 273           | 302           | 324           |
|              | 300-400  | 11 3/4 - 15 3/4 | 4       |                | 361           | 391           | 418           | 440           |                   | 242           | 273           | 302           | 324           |
|              | 440-600  | 17 1/4 - 23 5/8 | 4       |                | 419           | 455           | 486           | 511           |                   | 276           | 311           | 343           | 370           |
| 12<br>0.48   | 120-280  | 4 3/4 - 11      | 3 1/8   | 1/4            | 403           | 437           | 467           | 491           | 1/4               | 267           | 301           | 332           | 358           |
|              | 320-480  | 12 5/8 - 19     | 4 3/4   |                | 403           | 437           | 467           | 491           |                   | 267           | 301           | 332           | 358           |
|              | 520-1000 | 20 1/2 - 39 3/8 | 4 3/4   |                | 533           | 578           | 619           | 651           |                   | 339           | 383           | 424           | 457           |

(1) Main member loaded parallel to the grain.

(2) Main member loaded perpendicular to the grain.

NOTES and GENERAL PRINCIPLES on page 48.

## THREAD WITHDRAWAL (W) | WOOD

| geometry                                                                          |          |                                 |         | thread withdrawal $\alpha = 90^\circ$                                             |      |      |      | thread withdrawal $\alpha = 45^\circ$                                              |      |      |      | thread withdrawal $\alpha = 0^\circ$                                                |      |      |      |
|-----------------------------------------------------------------------------------|----------|---------------------------------|---------|-----------------------------------------------------------------------------------|------|------|------|------------------------------------------------------------------------------------|------|------|------|-------------------------------------------------------------------------------------|------|------|------|
|  |          |                                 |         |  |      |      |      |  |      |      |      |  |      |      |      |
| d <sub>1</sub>                                                                    | L        |                                 | b       | G                                                                                 |      |      |      | G                                                                                  |      |      |      | G                                                                                   |      |      |      |
|                                                                                   | [mm]     | [in]                            |         | 0.35                                                                              | 0.42 | 0.49 | 0.55 | 0.35                                                                               | 0.42 | 0.49 | 0.55 | 0.35                                                                                | 0.42 | 0.49 | 0.55 |
| 3,5<br>0.14                                                                       | 40       | 1 9/16 <sup>(1)</sup>           | 11/16   | 49                                                                                | 57   | 63   | 69   | 45                                                                                 | 51   | 58   | 63   | 15                                                                                  | 17   | 19   | 21   |
|                                                                                   | 45-50    | 1 3/4 - 1 15/16 <sup>(1)</sup>  | 15/16   | 69                                                                                | 80   | 90   | 98   | 63                                                                                 | 73   | 82   | 89   | 21                                                                                  | 24   | 27   | 29   |
| 4<br>0.16                                                                         | 30-35    | 1 3/16 - 1 3/8 <sup>(1)</sup>   | 11/16   | 47                                                                                | 55   | 61   | 67   | 43                                                                                 | 50   | 56   | 61   | 14                                                                                  | 16   | 18   | 20   |
|                                                                                   | 40       | 1 9/16 <sup>(1)</sup>           | 15/16   | 68                                                                                | 78   | 87   | 95   | 62                                                                                 | 71   | 80   | 87   | 20                                                                                  | 23   | 26   | 29   |
|                                                                                   | 45-50    | 1 3/4 - 1 15/16 <sup>(2)</sup>  | 1 3/16  | 88                                                                                | 101  | 114  | 124  | 80                                                                                 | 92   | 103  | 113  | 26                                                                                  | 30   | 34   | 37   |
|                                                                                   | 60       | 2 3/8 <sup>(2)</sup>            | 1 3/8   | 105                                                                               | 121  | 135  | 148  | 96                                                                                 | 110  | 123  | 134  | 31                                                                                  | 36   | 41   | 44   |
|                                                                                   | 70-80    | 2 3/4 - 3 1/8                   | 1 9/16  | 122                                                                               | 140  | 157  | 171  | 111                                                                                | 128  | 143  | 156  | 37                                                                                  | 42   | 47   | 51   |
| 4,5<br>0.18                                                                       | 40       | 1 9/16 <sup>(1)</sup>           | 15/16   | 66                                                                                | 76   | 85   | 93   | 60                                                                                 | 69   | 78   | 85   | 20                                                                                  | 23   | 26   | 28   |
|                                                                                   | 45-50    | 1 3/4 - 1 15/16 <sup>(1)</sup>  | 1 3/16  | 86                                                                                | 99   | 111  | 121  | 79                                                                                 | 90   | 101  | 111  | 26                                                                                  | 30   | 33   | 36   |
|                                                                                   | 60       | 2 3/8 <sup>(2)</sup>            | 1 3/8   | 103                                                                               | 119  | 133  | 145  | 94                                                                                 | 108  | 121  | 132  | 31                                                                                  | 36   | 40   | 44   |
|                                                                                   | 70-80    | 2 3/4 - 3 1/8 <sup>(2)</sup>    | 1 9/16  | 120                                                                               | 138  | 155  | 169  | 109                                                                                | 126  | 141  | 154  | 36                                                                                  | 42   | 47   | 51   |
| 5<br>0.20                                                                         | 40-50    | 1 9/16 - 1 15/16 <sup>(1)</sup> | 15/16   | 77                                                                                | 89   | 99   | 109  | 70                                                                                 | 81   | 91   | 99   | 23                                                                                  | 27   | 30   | 33   |
|                                                                                   | 60       | 2 3/8 <sup>(1)</sup>            | 1 3/16  | 101                                                                               | 117  | 131  | 144  | 92                                                                                 | 107  | 119  | 131  | 30                                                                                  | 35   | 39   | 43   |
|                                                                                   | 70       | 2 3/4 <sup>(1)</sup>            | 1 3/8   | 122                                                                               | 141  | 157  | 172  | 111                                                                                | 128  | 143  | 157  | 36                                                                                  | 42   | 47   | 52   |
|                                                                                   | 80       | 3 1/8 <sup>(2)</sup>            | 1 9/16  | 142                                                                               | 164  | 183  | 201  | 129                                                                                | 149  | 167  | 183  | 43                                                                                  | 49   | 55   | 60   |
|                                                                                   | 90       | 3 1/2 <sup>(2)</sup>            | 1 3/4   | 162                                                                               | 187  | 209  | 230  | 148                                                                                | 171  | 191  | 209  | 49                                                                                  | 56   | 63   | 69   |
|                                                                                   | 100      | 4                               | 1 15/16 | 182                                                                               | 211  | 236  | 259  | 166                                                                                | 192  | 214  | 235  | 55                                                                                  | 63   | 71   | 78   |
|                                                                                   | 120      | 4 3/4                           | 2 3/8   | 223                                                                               | 258  | 288  | 316  | 203                                                                                | 234  | 262  | 288  | 67                                                                                  | 77   | 86   | 95   |
| 6<br>0.24                                                                         | 40-50    | 1 9/16 - 1 15/16 <sup>(1)</sup> | 1 3/8   | 150                                                                               | 172  | 195  | 215  | 136                                                                                | 157  | 178  | 195  | 45                                                                                  | 52   | 59   | 64   |
|                                                                                   | 60       | 2 3/8 <sup>(1)</sup>            | 1 3/16  | 124                                                                               | 143  | 162  | 178  | 113                                                                                | 130  | 147  | 162  | 37                                                                                  | 43   | 48   | 53   |
|                                                                                   | 70-80    | 2 3/4 - 3 1/8 <sup>(1)</sup>    | 1 9/16  | 175                                                                               | 202  | 229  | 252  | 160                                                                                | 184  | 208  | 229  | 53                                                                                  | 61   | 69   | 75   |
|                                                                                   | 90-100   | 3 1/2 - 4 <sup>(2)</sup>        | 1 15/16 | 227                                                                               | 262  | 296  | 326  | 207                                                                                | 238  | 270  | 296  | 68                                                                                  | 78   | 89   | 98   |
|                                                                                   | 110-130  | 4 3/8 - 5 1/8                   | 2 3/8   | 279                                                                               | 321  | 364  | 400  | 253                                                                                | 292  | 331  | 364  | 84                                                                                  | 96   | 109  | 120  |
|                                                                                   | 140-400  | 5 1/2 - 15 3/4                  | 2 15/16 | 356                                                                               | 410  | 465  | 511  | 324                                                                                | 373  | 423  | 465  | 107                                                                                 | 123  | 139  | 153  |
| 8<br>0.32                                                                         | 80-100   | 3 1/8 - 4 <sup>(1)</sup>        | 2 1/16  | 298                                                                               | 345  | 390  | 428  | 271                                                                                | 314  | 355  | 389  | 89                                                                                  | 103  | 117  | 128  |
|                                                                                   | 120-140  | 4 3/4 - 5 1/2 <sup>(2)</sup>    | 2 3/8   | 352                                                                               | 407  | 461  | 506  | 320                                                                                | 371  | 419  | 460  | 106                                                                                 | 122  | 138  | 152  |
|                                                                                   | 160-280  | 6 1/4 - 11                      | 3 1/8   | 488                                                                               | 564  | 638  | 700  | 444                                                                                | 513  | 580  | 637  | 146                                                                                 | 169  | 191  | 210  |
|                                                                                   | 300-600  | 11 3/4 - 23 5/8                 | 4       | 623                                                                               | 721  | 815  | 895  | 567                                                                                | 656  | 742  | 814  | 187                                                                                 | 216  | 244  | 268  |
| 10<br>0.40                                                                        | 80-100   | 3 1/8 - 4 <sup>(1)</sup>        | 2 1/16  | 341                                                                               | 395  | 446  | 489  | 310                                                                                | 360  | 406  | 445  | 102                                                                                 | 119  | 134  | 147  |
|                                                                                   | 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  |
|                                                                                   | 160-280  | 6 1/4 - 11 <sup>(2)</sup>       | 3 1/8   | 568                                                                               | 659  | 744  | 816  | 517                                                                                | 599  | 677  | 742  | 170                                                                                 | 198  | 223  | 245  |
|                                                                                   | 300-600  | 11 3/4 - 23 5/8                 | 4       | 730                                                                               | 847  | 957  | 1049 | 664                                                                                | 771  | 871  | 954  | 219                                                                                 | 254  | 287  | 315  |
| 12<br>0.48                                                                        | 120-280  | 4 3/4 - 11 <sup>(1)</sup>       | 3 1/8   | 589                                                                               | 683  | 771  | 846  | 536                                                                                | 621  | 702  | 770  | 177                                                                                 | 205  | 231  | 254  |
|                                                                                   | 320-1000 | 12 5/8 - 39 3/8                 | 4 3/4   | 935                                                                               | 1084 | 1225 | 1344 | 851                                                                                | 987  | 1114 | 1223 | 281                                                                                 | 325  | 367  | 403  |

<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).

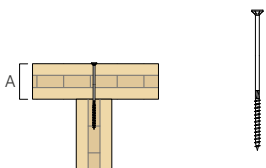
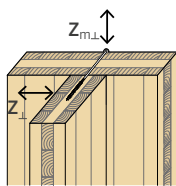
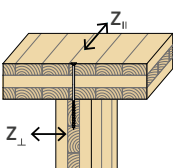
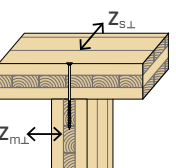
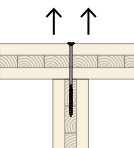
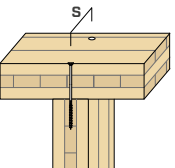
<sup>(2)</sup> The embedded thread length does not comply with the minimum requirement of ESR-4645 (8 times the outer thread diameter for screws installed at an angle  $0^\circ \leq \alpha < 90^\circ$  to the grain).

## HEAD PULL-THROUGH (W<sub>H</sub>) | WOOD

| geometry       |                |      | head pull through $90^\circ \leq \alpha \leq 30^\circ$ |       |       |       |
|----------------|----------------|------|--------------------------------------------------------|-------|-------|-------|
| d <sub>1</sub> | d <sub>k</sub> |      | G                                                      |       |       |       |
|                |                |      | 0.35                                                   | 0.42  | 0.49  | 0.55  |
| [mm]           | [in]           | [in] | [lbf]                                                  | [lbf] | [lbf] | [lbf] |
| 3,5            | 0.14           | 0.28 | 51                                                     | 59    | 67    | 73    |
| 4              | 0.16           | 0.31 | 75                                                     | 87    | 98    | 108   |
| 4,5            | 0.18           | 0.35 | 95                                                     | 110   | 124   | 136   |
| 5              | 0.20           | 0.39 | 117                                                    | 136   | 153   | 168   |
| 6              | 0.24           | 0.47 | 142                                                    | 165   | 186   | 204   |
| 8              | 0.32           | 0.57 | 220                                                    | 264   | 298   | 327   |
| 10             | 0.40           | 0.72 | 273                                                    | 316   | 357   | 392   |
| 12             | 0.48           | 0.82 | 392                                                    | 453   | 513   | 562   |

NOTES and GENERAL PRINCIPLES on page 48.

# 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]                                                                               | [lbF]   |
| 3 PLY                                                                             | 60   | 2 3/8              | HBS6120  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8120  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10120 | 122                                                                               | 145             | 122                                                                               | 208            | 145                                                                                | 143             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12160 | 158                                                                               | 189             | 158                                                                               | 258            | 189                                                                                | 168             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 79   | 3 1/8              | HBS6160  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8160  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10160 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12160 | 167                                                                               | 188             | 167                                                                               | 259            | 188                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 105  | 4 1/8              | HBS6180  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8200  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10200 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12200 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 120  | 4 3/4              | HBS6200  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8200  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10200 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12200 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
| 5 PLY                                                                             | 100  | 3 15/16            | HBS6180  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8180  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10180 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12200 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 140  | 5 1/2              | HBS6220  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8220  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10220 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12240 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 175  | 6 7/8              | HBS6260  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8260  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10260 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12280 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 200  | 7 7/8              | HBS6280  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8280  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10280 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12280 | 175                                                                               | 188             | 175                                                                               | 259            | 188                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
| 7 PLY                                                                             | 140  | 5 1/2              | HBS6220  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8220  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10220 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12240 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 191  | 7 1/2              | HBS6280  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8280  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10280 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12280 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 244  | 9 5/8              | HBS6320  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8360  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10360 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12400 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |
|                                                                                   | 280  | 11                 | HBS6360  | 110                                                                               | 110             | 110                                                                               | 110            | 110                                                                                | 110             | 165                                                                                 | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8380  | 131                                                                               | 131             | 131                                                                               | 164            | 131                                                                                | 131             | 264                                                                                 | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10380 | 155                                                                               | 167             | 155                                                                               | 226            | 167                                                                                | 167             | 316                                                                                 | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12400 | 175                                                                               | 189             | 175                                                                               | 259            | 189                                                                                | 189             | 453                                                                                 | 4 3/4                                                                               | 10      |

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

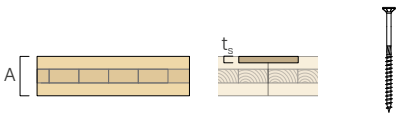
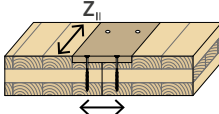
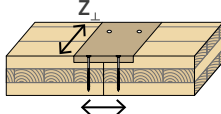
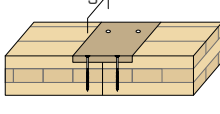
NOTES and GENERAL PRINCIPLES on page 48.

# CLT | FLOOR-TO-BEAM

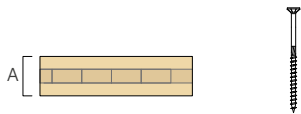
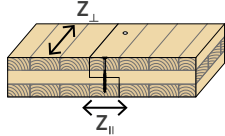
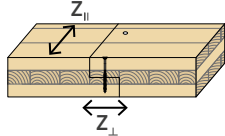
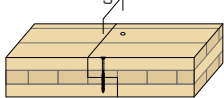
|                                              |       |                    |          | SHEAR                          |                 |                                |                 |                                               |                 |                                               |                 | 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            | HBS6180  | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 165                               | 3 1/2                | 6       |
|                                              |       |                    | HBS8180  | 196                            | 245             | 196                            | 196             | 196                                           | 245             | 196                                           | 196             | 264                               | 3 1/8                | 6       |
|                                              |       |                    | HBS10180 | 232                            | 338             | 249                            | 249             | 232                                           | 338             | 167                                           | 249             | 316                               | 4                    | 8       |
|                                              |       |                    | HBS12200 | 261                            | 387             | 282                            | 282             | 261                                           | 387             | 282                                           | 282             | 453                               | 4 3/4                | 10      |
|                                              | 140   | 5 1/2              | HBS6220  | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 165                               | 3 1/2                | 6       |
|                                              |       |                    | HBS8220  | 196                            | 245             | 196                            | 196             | 196                                           | 245             | 196                                           | 196             | 264                               | 3 1/8                | 6       |
|                                              |       |                    | HBS10220 | 232                            | 338             | 249                            | 249             | 232                                           | 338             | 249                                           | 249             | 316                               | 4                    | 8       |
|                                              |       |                    | HBS12240 | 261                            | 387             | 282                            | 282             | 261                                           | 387             | 282                                           | 282             | 453                               | 4 3/4                | 10      |
|                                              | 175   | 6 7/8              | HBS6260  | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 165                               | 3 1/2                | 6       |
|                                              |       |                    | HBS8260  | 196                            | 245             | 196                            | 196             | 196                                           | 245             | 196                                           | 196             | 264                               | 3 1/8                | 6       |
|                                              |       |                    | HBS10260 | 232                            | 338             | 167                            | 249             | 232                                           | 338             | 167                                           | 249             | 316                               | 4                    | 8       |
|                                              |       |                    | HBS12240 | 237                            | 387             | 252                            | 282             | 237                                           | 387             | 252                                           | 282             | 453                               | 4 3/4                | 10      |
|                                              |       |                    | HBS12280 | 261                            | 387             | 282                            | 282             | -                                             | -               | -                                             | -               | 453                               | 4 3/4                | 10      |
|                                              | 200   | 7 7/8              | HBS6280  | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 165                               | 3 1/2                | 6       |
|                                              |       |                    | HBS8280  | 196                            | 245             | 196                            | 196             | 196                                           | 245             | 196                                           | 196             | 264                               | 3 1/8                | 6       |
|                                              |       |                    | HBS10280 | 232                            | 338             | 249                            | 249             | 232                                           | 338             | 249                                           | 249             | 316                               | 4                    | 8       |
|                                              |       |                    | HBS12280 | 261                            | 387             | 281                            | 282             | 261                                           | 387             | 281                                           | 282             | 453                               | 4 3/4                | 10      |
|                                              | 140   | 5 1/2              | HBS6220  | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 165                               | 3 1/2                | 6       |
|                                              |       |                    | HBS8220  | 196                            | 245             | 196                            | 196             | 196                                           | 245             | 196                                           | 196             | 264                               | 3 1/8                | 6       |
|                                              |       |                    | HBS10220 | 232                            | 338             | 249                            | 249             | 232                                           | 338             | 249                                           | 249             | 316                               | 4                    | 8       |
| HBS12240                                     |       |                    | 261      | 387                            | 282             | 282                            | 261             | 387                                           | 282             | 282                                           | 453             | 4 3/4                             | 10                   |         |
| 191                                          | 7 1/2 | HBS6280            | 165      | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 3 1/2                             | 6                    |         |
|                                              |       | HBS8280            | 196      | 245                            | 196             | 196                            | 196             | 245                                           | 196             | 196                                           | 264             | 3 1/8                             | 6                    |         |
|                                              |       | HBS10280           | 232      | 338                            | 249             | 249                            | 232             | 338                                           | 249             | 249                                           | 316             | 4                                 | 8                    |         |
|                                              |       | HBS12280           | 261      | 387                            | 282             | 282                            | 261             | 387                                           | 282             | 282                                           | 453             | 4 3/4                             | 10                   |         |
| 244                                          | 9 5/8 | HBS6320            | 165      | 165                            | 110             | 165                            | 165             | 165                                           | 110             | 165                                           | 165             | 3 1/2                             | 6                    |         |
|                                              |       | HBS8340            | 196      | 245                            | 196             | 196                            | 196             | 245                                           | 196             | 196                                           | 264             | 3 1/8                             | 6                    |         |
|                                              |       | HBS8360            | 196      | 245                            | 131             | 196                            | -               | -                                             | -               | -                                             | 264             | 3 1/8                             | 6                    |         |
|                                              |       | HBS10340           | 232      | 338                            | 249             | 249                            | 232             | 338                                           | 249             | 249                                           | 316             | 4                                 | 8                    |         |
|                                              |       | HBS10360           | 232      | 338                            | 249             | 249                            | -               | -                                             | -               | -                                             | 316             | 4                                 | 8                    |         |
|                                              |       | HBS12320           | 258      | 387                            | 183             | 282                            | 258             | 387                                           | 183             | 282                                           | 453             | 4 3/4                             | 10                   |         |
|                                              |       | HBS12400           | 261      | 387                            | 282             | 282                            | -               | -                                             | -               | -                                             | 453             | 4 3/4                             | 10                   |         |
| 280                                          | 11    | HBS6360            | 165      | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 3 1/2                             | 6                    |         |
|                                              |       | HBS8380            | 196      | 245                            | 196             | 196                            | 196             | 245                                           | 196             | 196                                           | 264             | 3 1/8                             | 6                    |         |
|                                              |       | HBS10380           | 232      | 338                            | 167             | 249                            | 232             | 338                                           | 167             | 249                                           | 316             | 4                                 | 8                    |         |
|                                              |       | HBS12360           | 261      | 387                            | 282             | 282                            | 261             | 387                                           | 282             | 282                                           | 453             | 4 3/4                             | 10                   |         |
|                                              |       | HBS12400           | 261      | 387                            | 282             | 282                            | -               | -                                             | -               | -                                             | 453             | 4 3/4                             | 10                   |         |
| 9 PLY                                        | 180   | 7 1/16             | HBS6260  | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 165                               | 3 1/2                | 6       |
|                                              |       |                    | HBS8260  | 196                            | 245             | 196                            | 196             | 196                                           | 245             | 196                                           | 196             | 264                               | 3 1/8                | 6       |
|                                              |       |                    | HBS10260 | 232                            | 338             | 249                            | 249             | 232                                           | 338             | 249                                           | 249             | 316                               | 4                    | 8       |
|                                              |       |                    | HBS12280 | 261                            | 387             | 282                            | 282             | 261                                           | 387             | 282                                           | 282             | 453                               | 4 3/4                | 10      |
|                                              | 267   | 10 1/2             | HBS6360  | 165                            | 165             | 165                            | 165             | 165                                           | 165             | 165                                           | 165             | 165                               | 3 1/2                | 6       |
|                                              |       |                    | HBS8360  | 196                            | 245             | 196                            | 196             | 196                                           | 245             | 196                                           | 196             | 264                               | 3 1/8                | 6       |
|                                              |       |                    | HBS8380  | 196                            | 245             | 196                            | 196             | -                                             | -               | -                                             | -               | 264                               | 3 1/8                | 6       |
|                                              |       |                    | HBS10360 | 232                            | 338             | 249                            | 249             | 232                                           | 338             | 249                                           | 249             | 316                               | 4                    | 8       |
|                                              |       |                    | HBS10380 | 232                            | 338             | 249                            | 249             | -                                             | -               | -                                             | -               | 316                               | 4                    | 8       |
|                                              |       |                    | HBS12360 | 261                            | 387             | 282                            | 282             | 261                                           | 387             | 282                                           | 282             | 453                               | 4 3/4                | 10      |
|                                              |       |                    | HBS12400 | 261                            | 387             | 189                            | 282             | -                                             | -               | -                                             | -               | 453                               | 4 3/4                | 10      |

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

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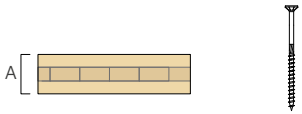
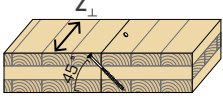
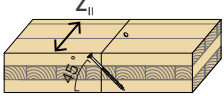
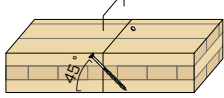
|                                                                                   |      |                           |                    | SHEAR                                                                             |        |                                                                                    |        | SPACING                                                                             |         |
|-----------------------------------------------------------------------------------|------|---------------------------|--------------------|-----------------------------------------------------------------------------------|--------|------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------|---------|
| geometry                                                                          |      |                           |                    | spline joint<br>orientation 1                                                     |        | spline joint<br>orientation 2                                                      |        | fastener<br>in a row                                                                |         |
|  |      |                           |                    |  |        |  |        |  |         |
| panel thickness<br>(wall/floor) = A                                               |      | spline<br>thickness = t_s | suggested<br>screw | Z_                                                                                | Z_perp | Z_                                                                                 | Z_perp | minimum                                                                             | typical |
| [mm]                                                                              | [in] | [in]                      | CODE               | [lbf]                                                                             | [lbf]  | [lbf]                                                                              | [lbf]  | [in]                                                                                | [in]    |
| 3 PLY                                                                             | 79   | 1/2                       | HBS550             | 91                                                                                | 91     | 91                                                                                 | 91     | 2 15/16                                                                             | 3       |
|                                                                                   |      |                           | HBS650             | 107                                                                               | 107    | 107                                                                                | 107    | 3 1/2                                                                               | 4       |
|                                                                                   |      | 3/4                       | HBS560             | 95                                                                                | 95     | 95                                                                                 | 95     | 2 15/16                                                                             | 3       |
|                                                                                   |      |                           | HBS660             | 120                                                                               | 120    | 120                                                                                | 120    | 3 1/2                                                                               | 4       |
|                                                                                   |      | 1                         | HBS570             | 103                                                                               | 103    | 103                                                                                | 103    | 2 15/16                                                                             | 3       |
|                                                                                   |      |                           | HBS670             | 128                                                                               | 128    | 128                                                                                | 128    | 3 1/2                                                                               | 4       |
|                                                                                   | 86   | 1/2                       | HBS560             | 91                                                                                | 91     | 91                                                                                 | 91     | 2 15/16                                                                             | 3       |
|                                                                                   |      |                           | HBS660             | 116                                                                               | 116    | 116                                                                                | 116    | 3 1/2                                                                               | 4       |
|                                                                                   |      | 3/4                       | HBS570             | 95                                                                                | 95     | 95                                                                                 | 95     | 2 15/16                                                                             | 3       |
|                                                                                   |      |                           | HBS670             | 120                                                                               | 120    | 120                                                                                | 120    | 3 1/2                                                                               | 4       |
|                                                                                   |      | 1                         | HBS680             | 128                                                                               | 128    | 128                                                                                | 128    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS880             | 179                                                                               | 143    | 179                                                                                | 143    | 3 1/8                                                                               | 4       |
|                                                                                   | 105  | 1/2                       | HBS670             | 91                                                                                | 91     | 91                                                                                 | 91     | 2 15/16                                                                             | 3       |
|                                                                                   |      |                           | HBS870             | 116                                                                               | 116    | 116                                                                                | 116    | 3 1/2                                                                               | 4       |
|                                                                                   |      | 3/4                       | HBS680             | 120                                                                               | 120    | 120                                                                                | 120    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS880             | 173                                                                               | 139    | 173                                                                                | 139    | 3 1/8                                                                               | 4       |
|                                                                                   |      | 1                         | HBS690             | 128                                                                               | 128    | 128                                                                                | 128    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS890             | 179                                                                               | 143    | 179                                                                                | 143    | 3 1/8                                                                               | 4       |
| 5 PLY                                                                             | 130  | 3/4                       | HBS680             | 120                                                                               | 120    | 120                                                                                | 120    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS880             | 173                                                                               | 139    | 173                                                                                | 139    | 3 1/8                                                                               | 4       |
|                                                                                   |      | 1                         | HBS690             | 128                                                                               | 128    | 128                                                                                | 128    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS880             | 179                                                                               | 143    | 179                                                                                | 143    | 3 1/8                                                                               | 4       |
|                                                                                   |      |                           | HBS1080            | 202                                                                               | 128    | 202                                                                                | 128    | 4                                                                                   | 6       |
|                                                                                   | 140  | 3/4                       | HBS690             | 120                                                                               | 120    | 120                                                                                | 120    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS8100            | 173                                                                               | 139    | 173                                                                                | 139    | 3 1/8                                                                               | 4       |
|                                                                                   |      | 1                         | HBS6100            | 128                                                                               | 128    | 128                                                                                | 128    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS8100            | 179                                                                               | 143    | 179                                                                                | 143    | 3 1/8                                                                               | 4       |
|                                                                                   | 175  | 3/4                       | HBS10100           | 211                                                                               | 164    | 211                                                                                | 164    | 4                                                                                   | 6       |
|                                                                                   |      |                           |                    |                                                                                   |        |                                                                                    |        |                                                                                     |         |
|                                                                                   |      | 1                         | HBS6100            | 120                                                                               | 120    | 120                                                                                | 120    | 3 1/2                                                                               | 4       |
| HBS8100                                                                           |      |                           | 173                | 139                                                                               | 173    | 139                                                                                | 3 1/8  | 4                                                                                   |         |
| HBS6120                                                                           |      |                           | 128                | 128                                                                               | 128    | 128                                                                                | 3 1/2  | 4                                                                                   |         |
| 7 PLY                                                                             | 191  | 3/4                       | HBS8120            | 179                                                                               | 143    | 179                                                                                | 143    | 3 1/8                                                                               | 4       |
|                                                                                   |      |                           | HBS10120           | 211                                                                               | 164    | 211                                                                                | 164    | 4                                                                                   | 6       |
|                                                                                   |      | 1                         | HBS6100            | 120                                                                               | 120    | 120                                                                                | 120    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS8100            | 173                                                                               | 139    | 173                                                                                | 139    | 3 1/8                                                                               | 4       |
|                                                                                   |      |                           | HBS6120            | 128                                                                               | 128    | 128                                                                                | 128    | 3 1/2                                                                               | 4       |
|                                                                                   | 220  | 3/4                       | HBS8120            | 179                                                                               | 143    | 179                                                                                | 143    | 3 1/8                                                                               | 4       |
|                                                                                   |      |                           | HBS10140           | 211                                                                               | 164    | 211                                                                                | 164    | 4                                                                                   | 6       |
|                                                                                   |      | 1                         | HBS6100            | 120                                                                               | 120    | 120                                                                                | 120    | 3 1/2                                                                               | 4       |
|                                                                                   |      |                           | HBS8100            | 173                                                                               | 139    | 173                                                                                | 139    | 3 1/8                                                                               | 4       |
|                                                                                   |      |                           | HBS6120            | 128                                                                               | 128    | 128                                                                                | 128    | 3 1/2                                                                               | 4       |
|                                                                                   | 244  | 3/4                       | HBS8120            | 179                                                                               | 143    | 179                                                                                | 143    | 3 1/8                                                                               | 4       |
|                                                                                   |      |                           | HBS10140           | 211                                                                               | 164    | 211                                                                                | 164    | 4                                                                                   | 6       |
| 1                                                                                 |      | HBS6100                   | 120                | 120                                                                               | 120    | 120                                                                                | 3 1/2  | 4                                                                                   |         |
|                                                                                   |      | HBS8100                   | 173                | 139                                                                               | 173    | 139                                                                                | 3 1/8  | 4                                                                                   |         |
|                                                                                   |      | HBS6120                   | 128                | 128                                                                               | 128    | 128                                                                                | 3 1/2  | 4                                                                                   |         |

NOTES and GENERAL PRINCIPLES on page 48.

| 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                                                                |                          |                                                                                    |                          |                                                                                     |                 |    |
| [mm]      [in]                                                                    |     | CODE    | Z <sub>⊥</sub><br>[lbf]                                                           | Z <sub>  </sub><br>[lbf] | Z <sub>⊥</sub><br>[lbf]                                                            | Z <sub>  </sub><br>[lbf] | minimum<br>[in]                                                                     | typical<br>[in] |    |
| 3 PLY                                                                             | 105 | 4 1/8   | HBS690                                                                            | 144                      | 144                                                                                | 144                      | 144                                                                                 | 3 1/2           | 6  |
|                                                                                   |     |         | HBS8100                                                                           | 174                      | 218                                                                                | 174                      | 218                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10100                                                                          | 153                      | 261                                                                                | 153                      | 261                                                                                 | 4               | 8  |
|                                                                                   | 120 | 4 3/4   | HBS6110                                                                           | 165                      | 165                                                                                | 165                      | 165                                                                                 | 3 1/2           | 6  |
|                                                                                   |     |         | HBS8100                                                                           | 160                      | 200                                                                                | 160                      | 200                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10100                                                                          | 160                      | 272                                                                                | 160                      | 272                                                                                 | 4               | 8  |
| 5 PLY                                                                             | 100 | 3 15/16 | HBS690                                                                            | 149                      | 149                                                                                | 149                      | 149                                                                                 | 3 1/2           | 6  |
|                                                                                   |     |         | HBS880                                                                            | 143                      | 179                                                                                | 143                      | 179                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS1080                                                                           | 129                      | 220                                                                                | 129                      | 220                                                                                 | 4               | 8  |
|                                                                                   | 140 | 5 1/2   | HBS6130                                                                           | 165                      | 165                                                                                | 165                      | 165                                                                                 | 3 1/2           | 6  |
|                                                                                   |     |         | HBS8120                                                                           | 178                      | 222                                                                                | 178                      | 222                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10120                                                                          | 189                      | 301                                                                                | 189                      | 301                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12120                                                                          | 194                      | 329                                                                                | 194                      | 329                                                                                 | 4 3/4           | 10 |
|                                                                                   | 175 | 6 7/8   | HBS6160                                                                           | 165                      | 165                                                                                | 165                      | 165                                                                                 | 3 1/2           | 6  |
|                                                                                   |     |         | HBS8160                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10160                                                                          | 232                      | 338                                                                                | 232                      | 338                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12160                                                                          | 248                      | 387                                                                                | 248                      | 387                                                                                 | 4 3/4           | 10 |
|                                                                                   | 200 | 7 7/8   | HBS6180                                                                           | 165                      | 165                                                                                | 165                      | 165                                                                                 | 3 1/2           | 6  |
|                                                                                   |     |         | HBS8180                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10180                                                                          | 232                      | 338                                                                                | 232                      | 338                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12160                                                                          | 221                      | 357                                                                                | 221                      | 357                                                                                 | 4 3/4           | 10 |
| 7 PLY                                                                             | 140 | 5 1/2   | HBS6130                                                                           | 165                      | 165                                                                                | 165                      | 165                                                                                 | 3 1/2           | 6  |
|                                                                                   |     |         | HBS8120                                                                           | 178                      | 222                                                                                | 178                      | 222                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10120                                                                          | 189                      | 301                                                                                | 189                      | 301                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12120                                                                          | 194                      | 328                                                                                | 194                      | 328                                                                                 | 4 3/4           | 10 |
|                                                                                   | 191 | 7 1/2   | HBS8180                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10180                                                                          | 232                      | 338                                                                                | 232                      | 338                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12160                                                                          | 231                      | 376                                                                                | 231                      | 376                                                                                 | 4 3/4           | 10 |
|                                                                                   | 244 | 9 5/8   | HBS8220                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10220                                                                          | 232                      | 338                                                                                | 232                      | 338                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12240                                                                          | 261                      | 387                                                                                | 261                      | 387                                                                                 | 4 3/4           | 10 |
|                                                                                   | 280 | 11      | HBS8260                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10260                                                                          | 232                      | 338                                                                                | 232                      | 338                                                                                 | 4               | 8  |
| HBS12240                                                                          |     |         | 261                                                                               | 387                      | 261                                                                                | 387                      | 4 3/4                                                                               | 10              |    |
| 9 PLY                                                                             | 180 | 7 1/16  | HBS6160                                                                           | 165                      | 165                                                                                | 165                      | 165                                                                                 | 3 1/2           | 6  |
|                                                                                   |     |         | HBS8160                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10160                                                                          | 228                      | 338                                                                                | 228                      | 338                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12160                                                                          | 242                      | 387                                                                                | 242                      | 387                                                                                 | 4 3/4           | 10 |
|                                                                                   | 267 | 10 1/2  | HBS8260                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10260                                                                          | 232                      | 338                                                                                | 232                      | 338                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12240                                                                          | 261                      | 387                                                                                | 261                      | 387                                                                                 | 4 3/4           | 10 |
|                                                                                   | 314 | 12 3/8  | HBS8300                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10300                                                                          | 232                      | 338                                                                                | 232                      | 338                                                                                 | 4               | 8  |
|                                                                                   |     |         | HBS12280                                                                          | 261                      | 387                                                                                | 261                      | 387                                                                                 | 4 3/4           | 10 |
|                                                                                   | 360 | 14 3/16 | HBS8340                                                                           | 196                      | 245                                                                                | 196                      | 245                                                                                 | 3 1/8           | 6  |
|                                                                                   |     |         | HBS10340                                                                          | 232                      | 338                                                                                | 232                      | 338                                                                                 | 4               | 8  |
| HBS12320                                                                          |     |         | 261                                                                               | 387                      | 261                                                                                | 387                      | 4 3/4                                                                               | 10              |    |

NOTES and GENERAL PRINCIPLES on page 48.

# CLT | BUTT JOINT

| geometry                                                                          |      |                    | SHEAR                                                                             |                                                                                    | SPACING                                                                             |         |
|-----------------------------------------------------------------------------------|------|--------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------|
|                                                                                   |      |                    | butt joint<br>orientation 1                                                       | butt joint<br>orientation 2                                                        | fastener<br>in a row                                                                |         |
|  |      |                    |  |  |  |         |
| panel thickness<br>(wall/floor) = A                                               |      | suggested<br>screw | Z <sub>⊥</sub>                                                                    | Z <sub>  </sub>                                                                    | minimum                                                                             | typical |
| [mm]                                                                              | [in] | CODE               | [lbf]                                                                             | [lbf]                                                                              | [in]                                                                                | [in]    |
| 3 PLY                                                                             | 105  | 4 1/8              | HBS6120                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8120                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10120                                                                          | 122                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12120                                                                          | 125                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 120  | 4 3/4              | HBS6150                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8140                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10140                                                                          | 143                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12160                                                                          | 167                                                                                | 4 3/4                                                                               | 10      |
| 5 PLY                                                                             | 100  | 3 15/16            | HBS6120                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8120                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10120                                                                          | 122                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12120                                                                          | 125                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 140  | 5 1/2              | HBS6180                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8180                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10180                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12160                                                                          | 167                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 175  | 6 7/8              | HBS6220                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8220                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10220                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12200                                                                          | 175                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 200  | 7 7/8              | HBS6260                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8260                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10260                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12240                                                                          | 175                                                                                | 4 3/4                                                                               | 10      |
| 7 PLY                                                                             | 140  | 5 1/2              | HBS6180                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8180                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10180                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12160                                                                          | 167                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 191  | 7 1/2              | HBS6240                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8240                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10240                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12240                                                                          | 175                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 244  | 9 5/8              | HBS8320                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10320                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12320                                                                          | 175                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 280  | 11                 | HBS8380                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10380                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12360                                                                          | 175                                                                                | 4 3/4                                                                               | 10      |
| 9 PLY                                                                             | 180  | 7 1/16             | HBS6240                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8240                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10240                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12240                                                                          | 175                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 267  | 10 1/2             | HBS8360                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10360                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12360                                                                          | 175                                                                                | 4 3/4                                                                               | 10      |
|                                                                                   | 314  | 12 3/8             | HBS6400                                                                           | 110                                                                                | 3 1/2                                                                               | 6       |
|                                                                                   |      |                    | HBS8400                                                                           | 131                                                                                | 3 1/8                                                                               | 6       |
|                                                                                   |      |                    | HBS10400                                                                          | 155                                                                                | 4                                                                                   | 8       |
|                                                                                   |      |                    | HBS12400                                                                          | 175                                                                                | 4 3/4                                                                               | 10      |

## 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. The design of connection with steel side plate must comply with Section 11.2.3 of the NDS.
- 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.
- HBS 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.

### STEEL-TO-WOOD

- The steel side member must have a minimum tensile strength equal to 58 ksi (400 MPa) and comply with the minimum requirements of ASTM A36.
- The wood main member thickness must be greater than the screw length minus the thickness of the steel side member.
- In case of steel-to-wood connection with a thick plate, it is necessary to assess the effects of wood deformations and install the connectors according to the assembly instructions.

## 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:

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

- $\alpha$  is the angle between the grain direction and screw axis.  
Tabulated values at page 42 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  $\alpha \leq 15^\circ$ .
- 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

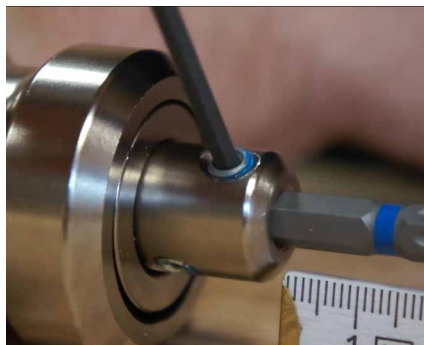
- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the machining's direction.
- The width of half-lap machining on CLT panel must comply with the minimum distance requirements.
- The proposed screw's length does not exceed the total thickness of the connection.

### BUTT JOINT

- The screw is considered inserted with an angle of 45° between the screw's axis and CLT plane face.
- 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.
- The axis of the connector on the shear plane is considered to run through the central layer of the panel.

## ■ INSTALLATION SUGGESTIONS

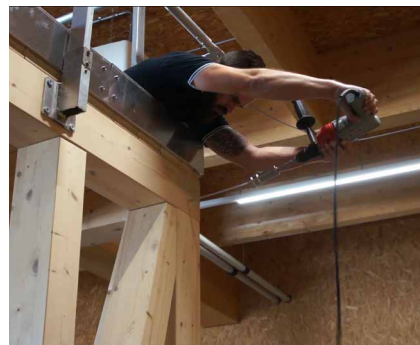
### SCREWING USING CATCH



Place the bit inside the CATCH screwing device and fasten it to the correct depth depending on the chosen connector.

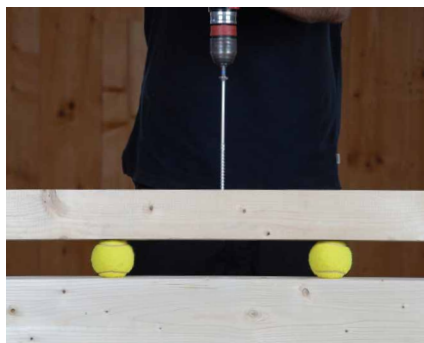


CATCH is suitable with long connectors where the insert would otherwise tend to come out of the screw head space.

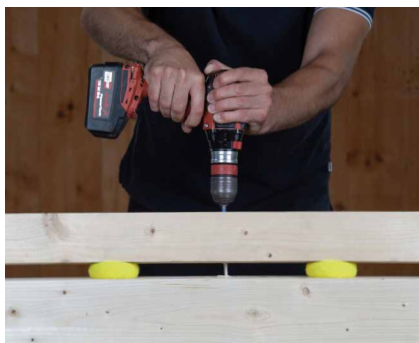


Useful in case of screwing in corners, which usually do not allow exerting a great screwing force.

### PARTIALLY THREADED SCREWS vs FULLY THREADED SCREW



Compressible elements are interposed between two timber beams and a screw is screwed centrally to evaluate its effect on the connection.

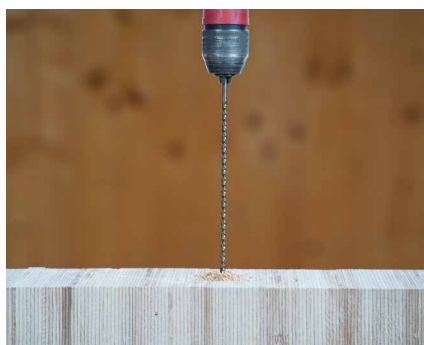


The partial thread screw (e.g. HBS) allows the joint to be closed. The threaded portion, inserted all the way inside the second element, allows the first element to slide on the smooth shank.



The fully threaded screw (e.g. VGZ) transfers the force by exploiting its axial strength and penetrates inside the timber elements without moving.

### APPLICATION ON HARDWOODS



Pre-drill a hole of the required diameter ( $d_{V,H}$ ) and length equal to the chosen connector size using the SNAIL tip.



Install the screw (e.g. HBS).



Alternatively, specific screws for hardwood applications (e.g. HBSH) can be used, which can be inserted without the aid of pre-drill hole

## ■ RELATED PRODUCTS



**CATCH**  
page 436



**LEWIS**  
page 442



**SNAIL**  
page 443



**A 18 | ASB 18**  
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