# WHT

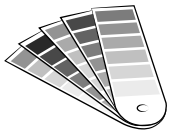
CE
ETA 11/0086

## Angle bracket for tensile loads

Bright zinc plated carbon steel three-dimensional perforated plate

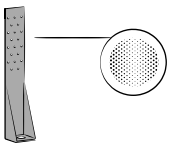
### COMPLETE RANGE

4 sizes combined with 4 different washers determine 10 possible configurations, that can meet any static performance target



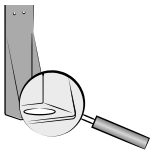
### SPECIAL STEEL

S355 (Fe510) steel ensures high tensile strength



### OVERSIZED HOLES

Holes with increased diameter permit to obtain higher strength values and facilitate the installation of the fastener



### CERTIFIED SAFETY

Quality is proven by testing on the product and the related fasteners (nails, screws, threaded rods and resins)

FIELD OF USE

Timber-to-concrete and timber-to-timber tension joints for panels and timber beams

- CLT (Cross Laminated Timber) Framed structures (platform frame)
- wood-based panels
- LVL (Laminated Veneer Lumber)
- solid wood
- glulam (Glued Laminated Timber)

## STRENGTH

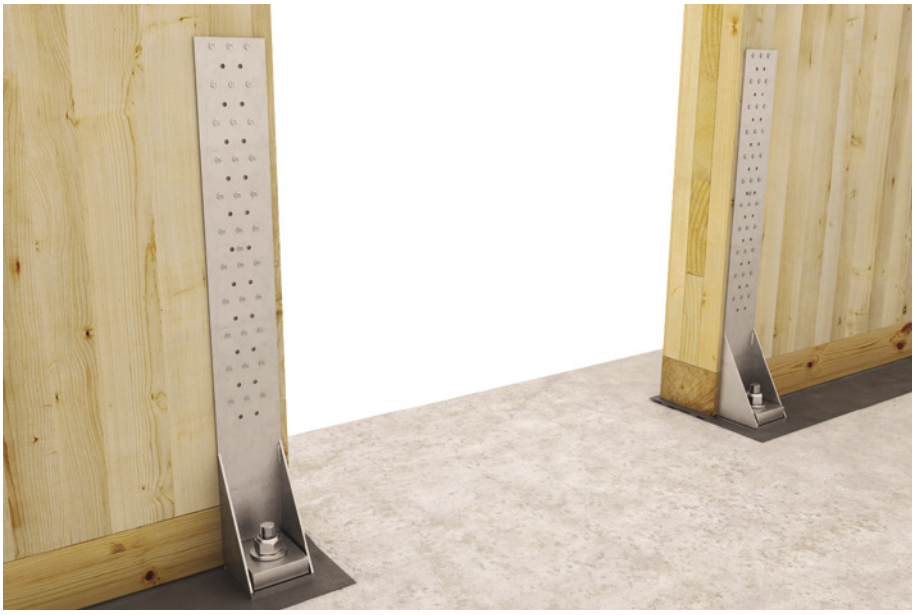
S355 steel, lateral reinforcing flanges, bigger holes and the increased number of nails on the flange ensure high strength values also in case of partial nailing

## SEISMIC AND STIFFNESS

Within the X-REV research project framework, the product and the related fixing elements were tested under static and cyclic loading, providing stiffness parameters ($K_{ser}$) and ductility levels

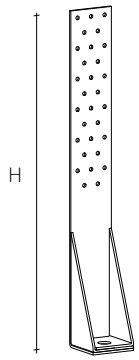
## OPTIMIZED APPLICATIONS

The 4 versions can be combined with one or more washers to allow designers and carpenters to find the suitable application, on both solidwood (CLT - Cross Laminated Timber) and framed (platform frame) panels.



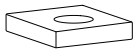
# CODES AND DIMENSIONS

WHT



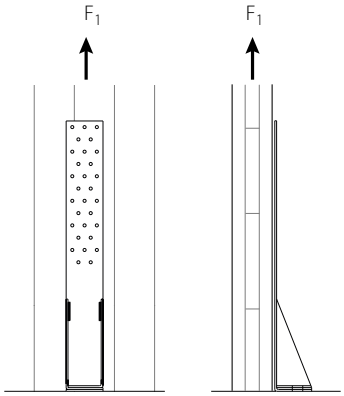

| code | type | H [in] | hole [in] | $n_v$ Ø5 [pcs] | s [in] | pcs/box |
|---|---|---|---|---|---|---|
| **WHT340** | **WHT340** | 13.4 | 11/16 | 20 | 0.118 | 10 |
| **WHT440** | **WHT440** | 17.33 | 11/16 | 30 | 0.118 | 10 |
| **WHT540** | **WHT540** | 21.26 | 14/16 | 45 | 0.118 | 10 |
| **WHT620** | **WHT620** | 24.41 | 15/16 | 55 | 0.118 | 10 |

WHT WASHER



| code | type | hole [in] | s [in] | WHT340 | WHT440 | WHT540 | WHT620 | pcs/box |
|---|---|---|---|---|---|---|---|---|
| **ULS505610** | **WHTBS50** | 23/32 | 0.393 | - | ● | • | - | 1 |
| **ULS505610L** | **WHTBS50L** | 14/16 | 0.393 | - | - | ● | - | 1 |
| **ULS707720** | **WHTBS70** | 14/16 | 0.787 | - | - | - | • | 1 |
| **ULS707720L** | **WHTBS70L** | 15/16 | 0.787 | - | - | - | ● | 1 |

## EXTERNAL LOADS

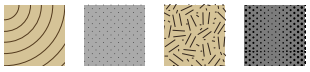



## MATERIAL AND DURABILITY

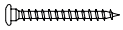
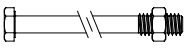
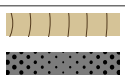
WHT: S355 bright zinc plated Fe/Zn 12c carbon steel.
WHT WASHER: S235 bright zinc plated Fe/Zn 12c carbon steel. To be used in Service class 1 and 2 (EN 1995:2008).

## FIELD OF USE

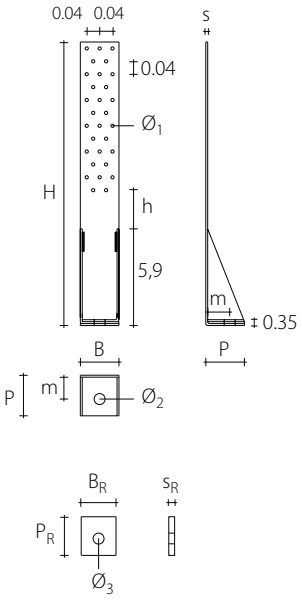
Timber to concrete joints
OSB to concrete joints
Timber to timber joints
OSB to timber joints
Steel to timber joints



## ADDITIONAL PRODUCTS - FIXINGS

| type | description | | d [mm] | support |
|---|---|---|---|---|
| LBA | anker nail |  | 4 |  |
| LBS | screw for plates |  | 5 |  |
| VIN-FIX PRO | chemical anchor |  | M16 - M20 - M24 |  |
| EPO-FIX PLUS | chemical anchor |  | M16 - M20 - M24 |  |
| KOS | bolt |  | M16 - M20 |  |

# GEOMETRY

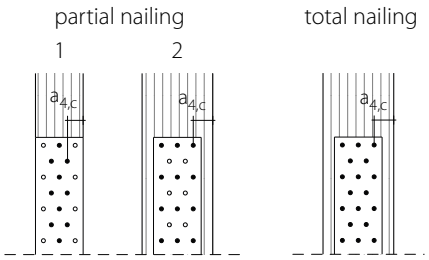



| WHT ANGLE BRACKET | | | WHT340 | WHT440 | WHT540 | WHT620 |
|---|---|---|---|---|---|---|
| Height | **H** | [in] | 13.386 | 17.323 | 21.260 | 24.409 |
| Width | **B** | [in] | 2.362 | 2.362 | 2.362 | 3.150 |
| Depth | **P** | [in] | 2.480 | 2.480 | 2.480 | 3.268 |
| Thickness | **s** | [in] | 0.118 | 0.118 | 0.118 | 0.118 |
| Hole position in timber | **h** | [in] | 1.575 | 2.362 | 1.575 | 1.575 |
| Hole position in concrete | **m** | [in] | 1.378 | 1.378 | 1.378 | 1.496 |
| Flange holes | **$Ø_1$** | [in] | 0.197 | 0.197 | 0,197 | 0.197 |
| Base hole | **$Ø_2$** | [in] | 0.669 | 0.669 | 0.866 | 1.024 |
| WHT washer | **type** | | - | WHTBS50 | WHTBS50L<br>WHTBS50 | WHTBS70L<br>WHTBS70 |

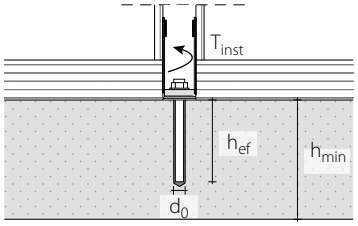
| WHTBS WASHER | | | WHTBS50 | WHTBS50L | WHTBS70 | WHTBS70L |
|---|---|---|---|---|---|---|
| WHT Angle bracket | **type** | | WHT440 / WHT540 | WHT540 | WHT620 | WHT620 |
| Width | **$B_R$** | [in] | 1.969 | 1.969 | 2.756 | 2.756 |
| Depth | **$P_R$** | [in] | 2.205 | 2.205 | 3.031 | 3.031 |
| Thickness | **$s_R$** | [in] | 0.394 | 0.394 | 0.787 | 0,787 |
| Washer hole | **$Ø_3$** | [in] | 0.709 | 0.866 | 0.866 | 1.024 |

# INSTALLATION

## MINIMUM DISTANCES



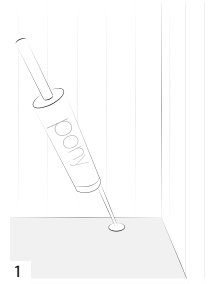

| TIMBER | | | | anker nail LBA Ø4 | screw LBS Ø5 |
|---|---|---|---|---|---|
| Lateral connector - Unloaded edge | $a_{4,c}$ | [in] | ≥ 5 d | ≥ 0.787 | ≥ 0.984 |



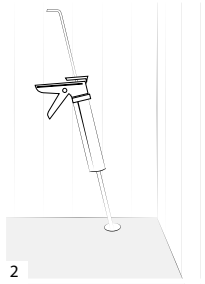

| CONCRETE | | | chemical anchor VIN-FIX PRO / EPO-FIX PLUS | | |
|---|---|---|---|---|---|
| | | | M16 | M20 | M24 |
| Minimum support thickness | $h_{min}$ | [in] | $h_{ef} + 2\,d_0$ | | |
| Hole diameter in concrete | $d_0$ | [in] | 0.708 | 0.945 | 1.102 |
| Tightening torque | $T_{inst}$ | [in lbf] | 708.06 | 1062.09 | 1416.12 |

$h_{ef}$ = effective anchorage length on concrete

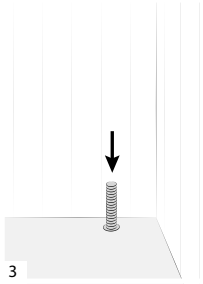
## ASSEMBLING ON CONCRETE



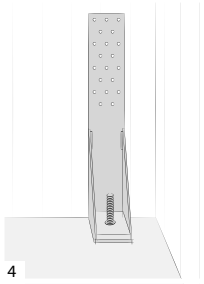

Drilling of the concrete support and hole cleaning



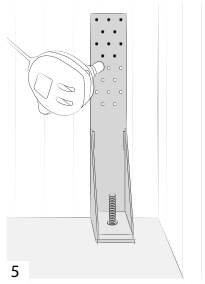

Injection of the chemical anchor into the hole



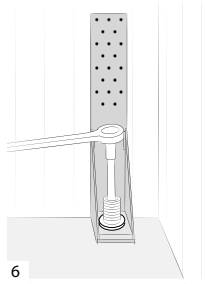

Positioning of the threaded rod




Installation of WHT angle bracket (with washer if prescribed)



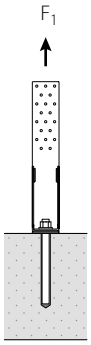

Nailing of the angle bracket




Positioning of the nut by adequate tightening

# STATIC VALUES - TENSION JOINT - TIMBER-TO-CONCRETE

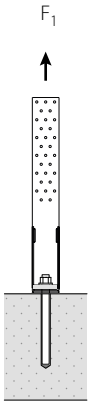
## WHT340




**CHARACTERISTIC VALUES**

| configuration | Holes Ø 6/32 ″ | | | $Z_{Timber}$ [lbs] | | | $Z_{Steel}$ [lbs] | |
|---|---|---|---|---|---|---|---|---|
| | type | Ø x L [in] | $n_v$ [pcs] | G = 0.42 | G = 0.49 | G = 0.55 | Washer | $Z_{steel}$ [lbs] |
| • total nailing<br>• anchor M16<br>• without washer | LBA Nails | 5/32 ″x 1 5/8 ″ | 20 | 2550 | 2881 | 3149 | - | 9442 |
| | | 5/32 ″x 2 3/8 ″ | 20 | 2550 | 2881 | 3149 | | |
| | LBS Screws | 6/32 ″x 1 5/8 ″ | 20 | 1792 | 2025 | 2214 | | |
| | | 6/32 ″x 2 ″ | 20 | 1792 | 2025 | 2214 | | |
| • partial nailing<br>• anchor M16<br>• without washer | LBA Nails | 5/32 ″x 1 5/8 ″ | 14 | 1785 | 2017 | 2205 | - | 9442 |
| | | 5/32 ″x 2 3/8 ″ | 14 | 1785 | 2017 | 2205 | | |
| | LBS Screws | 6/32 ″x 1 5/8 ″ | 14 | 1255 | 1417 | 1550 | | |
| | | 6/32 ″x 2 ″ | 14 | 1255 | 1417 | 1550 | | |

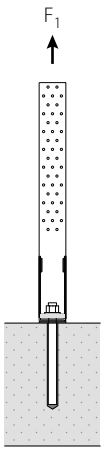
## WHT440




**CHARACTERISTIC VALUES**

| configuration | Holes Ø 6/32 ″ | | | $Z_{timber}$ [lbs] | | | $Z_{Steel}$ [lbs] | |
|---|---|---|---|---|---|---|---|---|
| | type | Ø x L [in] | $n_v$ [pcs] | G = 0.42 | G = 0.49 | G = 0.55 | Washer | $Z_{steel}$ [lbs] |
| • total fixing<br>• washer WHTBS50<br>• M16 anchor | LBA Nails | 5/32 ″x 1 5/8 ″ | 30 | 3826 | 4321 | 4724 | WHTBS50 | 14253 |
| | | 5/32 ″x 2 3/8 ″ | 30 | 3826 | 4321 | 4724 | | |
| | LBS Screws | 6/32 ″x 1 5/8 ″ | 30 | 2688 | 3037 | 3321 | | |
| | | 6/32 ″x 2 ″ | 30 | 2688 | 3037 | 3321 | | |
| • partial fixing<br>• washer WHTBS50<br>• M16 anchor | LBA Nails | 5/32 ″x 1 5/8 ″ | 20 | 2550 | 2881 | 3149 | WHTBS50 | 14253 |
| | | 5/32 ″x 2 3/8 ″ | 20 | 2550 | 2881 | 3149 | | |
| | LBS Screws | 6/32 ″x 1 5/8 ″ | 20 | 1792 | 2025 | 2214 | | |
| | | 6/32 ″x 2 ″ | 20 | 1792 | 2025 | 2214 | | |
| • partial fixing<br>• without washer<br>• M16 anchor | LBA Nails | 5/32 ″x 1 5/8 ″ | 20 | 2550 | 2881 | 3149 | - | 9442 |
| | | 5/32 ″x 2 3/8 ″ | 20 | 2550 | 2881 | 3149 | | |
| | LBS Screws | 6/32 ″x 1 5/8 ″ | 20 | 1792 | 2025 | 2214 | | |
| | | 6/32 ″x 2 ″ | 20 | 1792 | 2025 | 2214 | | |

## WHT540

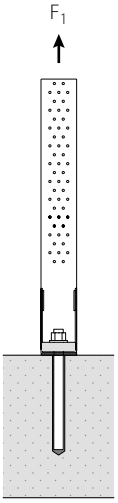



**CHARACTERISTIC VALUES**

| configuration | Holes Ø 6/32 ″ | | | $Z_{timber}$ [lbs] | | | $Z_{Steel}$ [lbs] | |
|---|---|---|---|---|---|---|---|---|
| | type | Ø x L [in] | $n_v$ [pcs] | G = 0.42 | G = 0.49 | G = 0.55 | Washer | $Z_{steel}$ [lbs] |
| • total nailing<br>• anchor M20<br>• washer WHTBS50L | LBA Nails | 5/32 ″ x 1 5/8 ″ | 45 | 5738 | 6482 | 7086 | WHTBS50L | 14253 |
| | | 5/32 ″ x 2 3/8 ″ | 45 | 5738 | 6482 | 7086 | | |
| | LBS Screws | 6/32 ″ x 1 5/8 ″ | 45 | 4032 | 4556 | 4982 | | |
| | | 6/32 ″ x 2 ″ | 45 | 4032 | 4556 | 4982 | | |
| • partial nailing<br>• anchor M20<br>• washer WHTBS50L | LBA Nails | 5/32 ″ x 1 5/8 ″ | 27 | 3443 | 3889 | 4252 | WHTBS50L | 14253 |
| | | 5/32 ″ x 2 3/8 ″ | 27 | 3443 | 3889 | 4252 | | |
| | LBS Screws | 6/32 ″ x 1 5/8 ″ | 27 | 2419 | 2734 | 2989 | | |
| | | 6/32 ″ x 2 ″ | 27 | 2419 | 2734 | 2989 | | |
| • total nailing<br>• anchor M16<br>• washer WHTBS50 | LBA Nails | 5/32 ″ x 1 5/8 ″ | 45 | 5738 | 6482 | 7086 | WHTBS50 | 14253 |
| | | 5/32 ″ x 2 3/8 ″ | 45 | 5738 | 6482 | 7086 | | |
| | LBS Screws | 6/32 ″ x 1 5/8 ″ | 45 | 4032 | 4556 | 4982 | | |
| | | 6/32 ″ x 2 ″ | 45 | 4032 | 4556 | 4982 | | |
| • partial nailing<br>• anchor M16<br>• washer WHTBS50 | LBA Nails | 5/32 ″ x 1 5/8 ″ | 27 | 3443 | 3889 | 4252 | WHTBS50 | 14253 |
| | | 5/32 ″ x 2 3/8 ″ | 27 | 3443 | 3889 | 4252 | | |
| | LBS Screws | 6/32 ″ x 1 5/8 ″ | 27 | 2419 | 2734 | 2989 | | |
| | | 6/32 ″ x 2 ″ | 27 | 2419 | 2734 | 2989 | | |

(1) Length obtainable from MGS threaded rods (to be cut to measure)

## WHT620



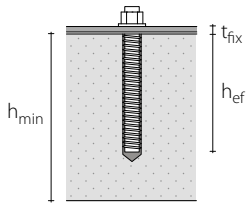

**CHARACTERISTIC VALUES**

| configuration | Holes Ø 6/32 ″ | | | $Z_{timber}$ | | | $Z_{Steel}$ [lbs] | |
|---|---|---|---|---|---|---|---|---|
| | type | Ø x L [in] | $n_v$ [pcs] | G = 0.42 | G = 0.49 | G = 0.55 | Washer | $Z_{steel}$ [lbs] |
| • total nailing<br>• anchor M24<br>• washer WHTBS70L | LBA Nails | 5/32 ″ x 1 5/8 ″ | 55 | 7013 | 7923 | 8661 | WHTBS70L | 19154 |
| | | 5/32 ″ x 2 3/8 ″ | 55 | 7013 | 7923 | 8661 | | |
| | LBS Screws | 6/32 ″ x 1 5/8 ″ | 55 | 4928 | 5568 | 6089 | | |
| | | 6/32 ″ x 2 ″ | 55 | 4928 | 5568 | 6089 | | |
| • partial nailing<br>• anchor M24<br>• washer WHTBS70L | LBA Nails | 5/32 ″ x 1 5/8 ″ | 33 | 4208 | 4754 | 5197 | WHTBS70L | 19154 |
| | | 5/32 ″ x 2 3/8 ″ | 33 | 4208 | 4754 | 5197 | | |
| | LBS Screws | 6/32 ″ x 1 5/8 ″ | 33 | 2957 | 3341 | 3653 | | |
| | | 6/32 ″ x 2 ″ | 33 | 2957 | 3341 | 3653 | | |
| • total nailing<br>• anchor M20<br>• washer WHTBS70 | LBA Nails | 5/32 ″ x 1 5/8 ″ | 55 | 7013 | 7923 | 8661 | WHTBS70 | 19154 |
| | | 5/32 ″ x 2 3/8 ″ | 55 | 7013 | 7923 | 8661 | | |
| | LBS Screws | 6/32 ″ x 1 5/8 ″ | 55 | 4928 | 5568 | 6089 | | |
| | | 6/32 ″ x 2 ″ | 55 | 4928 | 5568 | 6089 | | |
| • partial nailing<br>• anchor M20<br>• washer WHTBS70 | LBA Nails | 5/32 ″ x 1 5/8 ″ | 33 | 4208 | 4754 | 5197 | WHTBS70 | 19154 |
| | | 5/32 ″ x 2 3/8 ″ | 33 | 4208 | 4754 | 5197 | | |
| | LBS Screws | 6/32 ″ x 1 5/8 ″ | 33 | 2957 | 3341 | 3653 | | |
| | | 6/32 ″ x 2 ″ | 33 | 2957 | 3341 | 3653 | | |

(1) Length obtainable from MGS threaded bars (to be cut to measure)

# STATIC VALUES - TENSION JOINT - TIMBER-TO-CONCRETE

## CHEMICAL ANCHOR INSTALLATION PARAMETERS

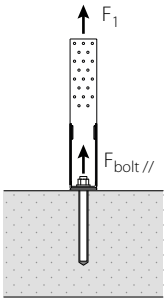



| type of bar L [in] | | code | steel class | type WHT | type of washer | $t_{fix}$ [in] | $h_{ef}$ [in] | $h_{min}$ [in] |
|---|---|---|---|---|---|---|---|---|
| M16 | 6.299 | FE210116 (2) | 5.8 | WHT340 | - | 0.354 | 5.079 | 9.449 |
| | 7.480 | FE210118 (2) | 5.8 | WHT340 / WHT440 | - | 0.354 | 6.260 | 9.449 |
| | | | | WHT440 / WHT540 | WHTBS50 | 0.748 | 5.866 | 9.449 |
| | 9.055 | FE210121 (2) | 5.8 | WHT440 | WHTBS50 | 0.748 | 7.441 | 9.449 |
| M20 | 9.449 | FE210117 (2) | 5.8 | WHT540 | - | 0.354 | 7.953 | 9.843 |
| | | | | WHT540 | WHTBS50L | 0.748 | 7.559 | 9.843 |
| | | | | WHT620 | WHTBS70 | 1.142 | 7.165 | 9.843 |
| | 11.417 | MGS M20 (3) | 4.8 / 8.8 | WHT540 | WHTBS50L | 0.748 | 9.449 | 11.811 |
| M24 | 10.630 | FE210122 (2) | 5.8 | WHT620 | - | 0.354 | 8.976 | 11.811 |
| | | | | WHT620 | WHTBS70L | 1.142 | 8.189 | 11.811 |
| | 12.992 | MGS M24 (3) | 4.8 / 8.8 | WHT620 | WHTBS70L | 1.142 | 10.551 | 12.992 |

(2) Precut INA threaded rod, with nut and washer
(3) When employing threaded rods that are cut on size, the use of MUT DIN934 nut and ULS DIN 125 washer is recommended

## DIMENSIONING OF ALTERNATIVE ANCHORS

Fixing elements to the concrete ringbeam by means of anchors that are not listed in the table, shall be verified according to the load acting on the anchor, which can be evaluated through the $k_{t//}$ coefficients. The axial load acting on the anchor can be obtained as follows:




$$F_{bolt//,d} = k_{t//} \cdot F_{1,d}$$

$k_{t//}$ = coefficient of eccentricity
$F_1$ = axial load on the WHT angle bracket

| | $k_{t//}$ |
|---|---|
| **WHT340** | 1.00 |
| **WHT440** | 1.00 |
| **WHT540** | 1.00 |
| **WHT620** | 1.00 |

The anchor check is satisfied if the design tensile strength, obtained considering the boundary effects, is greater than the design external load:

$$R_{bolt\,//,d} \geq F_{bolt\,//,d}$$

## NOTES

- Values based on the "Technical Design Guide USA", download from **www.rothoblaas.com**
- Download the latest version of this document from **www.rothoblaas.com**

## GENERAL PRINCIPLES

- For applications on CLT (Cross Laminated Timber) the use of nails/screws with length L ≥ 60 mm is recommended. Shorter fasteners may lead to brittle failure due to "group effect" as the reduced penetration depth affects exclusively the outer layer.
- Dimensioning and verification of timber elements must be carried out separately.
- The strength values of the connection system are valid under the calculation hypotheses listed in the table; different boundary conditions (e.g.. minimum edge distance) shall be verified.
- Thanks to validation via experimental testing, the strength values can be extended to the case where an OSB panel is placed between the WHT angle bracket and the timber support, providing that the minimum penetration depth and adequate OSB-to-framing fastening are guaranteed.
- The load carrying capacity of the nailed or screwed steel-to-timber connection was calculated according to NDS 2018.
- The load carrying capacity of the three-dimensional nailing plate was derived from calculation assisted by testing.
- The reference resistance values for connections shall be multiplied by all applicable adjustment factors (ref. NDS Table 11.3.1).
- The rope effect is not considered in the calculations.