



### TIMBER-TO-CONCRETE JOINT SYSTEM

#### HYBRID STRUCTURES

The VGS, VGZ and RTR full-thread connectors are now certified for any type of application where a timber element (wall, ceiling, etc.) must transmit stresses to a concrete element (bracing core, foundation, etc.).

#### PREFABRICATION

The concrete prefabrication combines with timber prefabrication: the reinforcing bars inserted into the concrete casting accommodate the full thread timber connectors; the supplementary casting carried out after installing the timber components completes the connection.

#### POST AND SLAB SYSTEMS

It allows connections between CLT panels with exceptional strength and stiffness for shear, bending moment and axial stress. It is the natural complement to the SPIDER and PILLAR systems.



USA, Canada and more design values available online.



#### CHARACTERISTICS

|               |                                                             |
|---------------|-------------------------------------------------------------|
| FOCUS         | timber-to-concrete joints with resistance in all directions |
| DIAMETER      | screws Ø9 mm, Ø11 mm, Ø13 mm, Ø16 mm                        |
| FASTENERS     | VGS, VGZ and RTR                                            |
| CERTIFICATION | CE marking in accordance with ETA-22/0806                   |



VGS



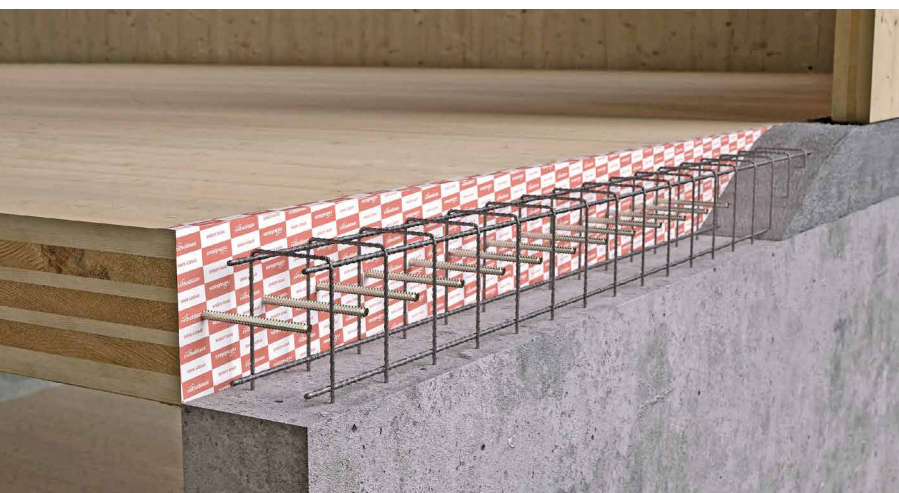
VGZ



RTR

#### VIDEO

Scan the QR Code and watch the video on our YouTube channel

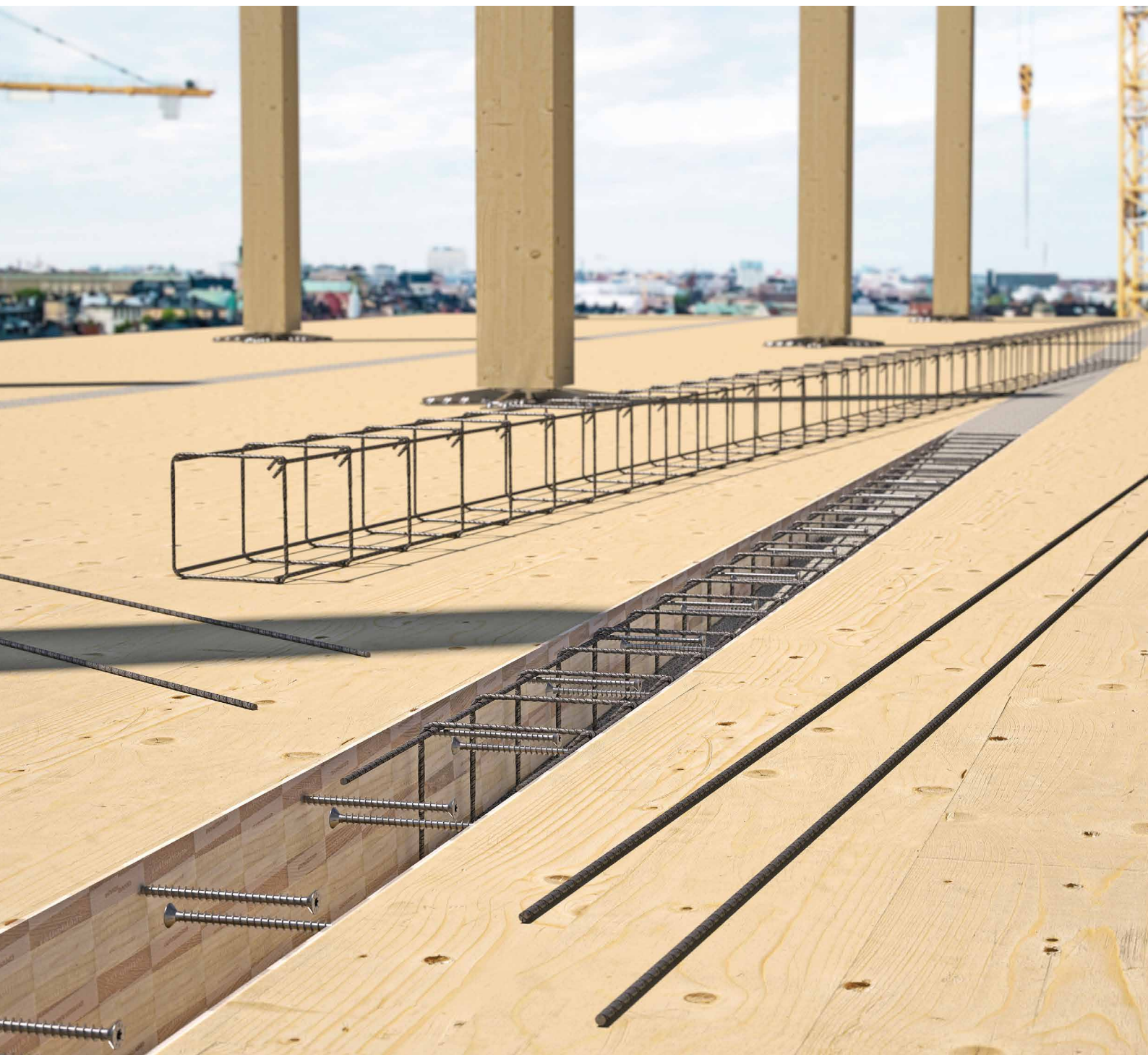


#### FIELDS OF USE

Moment, shear and axial load resistant connections for CLT panels. The high stiffness of reinforced concrete allows for strong resistant connections in all directions with high stiffness.

Can be applied to:

- floors or walls with CLT or LVL panels.



## SPIDER AND PILLAR

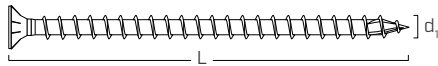
TC FUSION complements the SPIDER and PILLAR systems, allowing the implementation of moment connections between panels. Rothoblaas waterproofing systems make it possible to separate timber and concrete.

## CONSTRUCTION JOINTS

TC FUSION can be used in conjunction with construction joint systems to connect panel floors and the bracing core with a small addition to the casting.

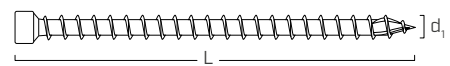
## CODES AND DIMENSIONS

VGS - full thread screw with countersunk or hexagonal head



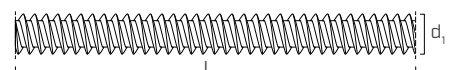
| d <sub>1</sub><br>[mm] | CODE      | L<br>[mm] | b<br>[mm] | pcs |  |
|------------------------|-----------|-----------|-----------|-----|--|
| 9<br>TX 40             | VGS9200   | 200       | 190       | 25  |  |
|                        | VGS9220   | 220       | 210       | 25  |  |
|                        | VGS9240   | 240       | 230       | 25  |  |
|                        | VGS9260   | 260       | 250       | 25  |  |
|                        | VGS9280   | 280       | 270       | 25  |  |
|                        | VGS9300   | 300       | 290       | 25  |  |
|                        | VGS9320   | 320       | 310       | 25  |  |
|                        | VGS9340   | 340       | 330       | 25  |  |
|                        | VGS9360   | 360       | 350       | 25  |  |
|                        | VGS9380   | 380       | 370       | 25  |  |
|                        | VGS9400   | 400       | 390       | 25  |  |
|                        | VGS9440   | 440       | 430       | 25  |  |
|                        | VGS9480   | 480       | 470       | 25  |  |
|                        | VGS9520   | 520       | 510       | 25  |  |
|                        | VGS9560   | 560       | 550       | 25  |  |
|                        | VGS9600   | 600       | 590       | 25  |  |
| 11<br>TX 50            | VGS11200  | 200       | 190       | 25  |  |
|                        | VGS11225  | 225       | 215       | 25  |  |
|                        | VGS11250  | 250       | 240       | 25  |  |
|                        | VGS11275  | 275       | 265       | 25  |  |
|                        | VGS11300  | 300       | 290       | 25  |  |
|                        | VGS11325  | 325       | 315       | 25  |  |
|                        | VGS11350  | 350       | 340       | 25  |  |
|                        | VGS11375  | 375       | 365       | 25  |  |
|                        | VGS11400  | 400       | 390       | 25  |  |
|                        | VGS11425  | 425       | 415       | 25  |  |
|                        | VGS11450  | 450       | 440       | 25  |  |
|                        | VGS11475  | 475       | 465       | 25  |  |
|                        | VGS11500  | 500       | 490       | 25  |  |
|                        | VGS11525  | 525       | 515       | 25  |  |
|                        | VGS11550  | 550       | 540       | 25  |  |
|                        | VGS11575  | 575       | 565       | 25  |  |
| 11<br>SW 17<br>TX 50   | VGS11600  | 600       | 590       | 25  |  |
|                        | VGS11650  | 650       | 630       | 25  |  |
|                        | VGS11700  | 700       | 680       | 25  |  |
|                        | VGS11750  | 750       | 680       | 25  |  |
|                        | VGS11800  | 800       | 780       | 25  |  |
|                        | VGS11850  | 850       | 830       | 25  |  |
|                        | VGS11900  | 900       | 880       | 25  |  |
|                        | VGS11950  | 950       | 930       | 25  |  |
|                        | VGS111000 | 1000      | 980       | 25  |  |
|                        | VGS13200  | 200       | 190       | 25  |  |
| 13<br>TX 50            | VGS13250  | 250       | 240       | 25  |  |
|                        | VGS13300  | 300       | 280       | 25  |  |
|                        | VGS13350  | 350       | 330       | 25  |  |
|                        | VGS13400  | 400       | 380       | 25  |  |
|                        | VGS13450  | 450       | 430       | 25  |  |
|                        | VGS13500  | 500       | 480       | 25  |  |
|                        | VGS13550  | 550       | 530       | 25  |  |
|                        | VGS13600  | 600       | 580       | 25  |  |
| 13<br>SW 19<br>TX 50   | VGS13650  | 650       | 630       | 25  |  |
|                        | VGS13700  | 700       | 680       | 25  |  |
|                        | VGS13750  | 750       | 730       | 25  |  |
|                        | VGS13800  | 800       | 780       | 25  |  |
|                        | VGS13850  | 850       | 830       | 25  |  |
|                        | VGS13900  | 900       | 880       | 25  |  |
|                        | VGS13950  | 950       | 930       | 25  |  |
|                        | VGS131000 | 1000      | 980       | 25  |  |
|                        | VGS131100 | 1100      | 1080      | 25  |  |
|                        | VGS131200 | 1200      | 1180      | 25  |  |
|                        | VGS131300 | 1300      | 1280      | 25  |  |
|                        | VGS131400 | 1400      | 1380      | 25  |  |
|                        | VGS131500 | 1500      | 1480      | 25  |  |

VGZ - mini full threaded screw with cylindrical head



| d <sub>1</sub><br>[mm] | CODE      | L<br>[mm] | b<br>[mm] | pcs |  |
|------------------------|-----------|-----------|-----------|-----|--|
| 9<br>TX 40             | VGZ9200   | 200       | 190       | 25  |  |
|                        | VGZ9220   | 220       | 210       | 25  |  |
|                        | VGZ9240   | 240       | 230       | 25  |  |
|                        | VGZ9260   | 260       | 250       | 25  |  |
|                        | VGZ9280   | 280       | 270       | 25  |  |
|                        | VGZ9300   | 300       | 290       | 25  |  |
|                        | VGZ9320   | 320       | 310       | 25  |  |
|                        | VGZ9340   | 340       | 330       | 25  |  |
|                        | VGZ9360   | 360       | 350       | 25  |  |
|                        | VGZ9380   | 380       | 370       | 25  |  |
|                        | VGZ9400   | 400       | 390       | 25  |  |
|                        | VGZ9440   | 440       | 430       | 25  |  |
|                        | VGZ9480   | 480       | 470       | 25  |  |
|                        | VGZ9520   | 520       | 510       | 25  |  |
|                        | VGZ9560   | 560       | 550       | 25  |  |
|                        | VGZ9600   | 600       | 590       | 25  |  |
| 11<br>TX 50            | VGZ11200  | 200       | 190       | 25  |  |
|                        | VGZ11250  | 250       | 240       | 25  |  |
|                        | VGZ11275  | 275       | 265       | 25  |  |
|                        | VGZ11300  | 300       | 290       | 25  |  |
|                        | VGZ11325  | 325       | 315       | 25  |  |
|                        | VGZ11350  | 350       | 340       | 25  |  |
|                        | VGZ11375  | 375       | 365       | 25  |  |
|                        | VGZ11400  | 400       | 390       | 25  |  |
|                        | VGZ11425  | 425       | 415       | 25  |  |
|                        | VGZ11450  | 450       | 440       | 25  |  |
|                        | VGZ11475  | 475       | 465       | 25  |  |
|                        | VGZ11500  | 500       | 490       | 25  |  |
|                        | VGZ11525  | 525       | 515       | 25  |  |
|                        | VGZ11550  | 550       | 540       | 25  |  |
|                        | VGZ11575  | 575       | 565       | 25  |  |
|                        | VGZ11600  | 600       | 590       | 25  |  |
|                        | VGZ11650  | 650       | 640       | 25  |  |
|                        | VGZ11700  | 700       | 690       | 25  |  |
|                        | VGZ11750  | 750       | 740       | 25  |  |
|                        | VGZ11800  | 800       | 790       | 25  |  |
|                        | VGZ11850  | 850       | 840       | 25  |  |
|                        | VGZ11900  | 900       | 890       | 25  |  |
|                        | VGZ11950  | 950       | 940       | 25  |  |
|                        | VGZ111000 | 1000      | 990       | 25  |  |

RTR - structural reinforcement system



| d <sub>1</sub><br>[mm] | CODE      | L<br>[mm] | pcs |
|------------------------|-----------|-----------|-----|
| 16                     | RTR162200 | 2200      | 10  |

## ■ GEOMETRY AND MECHANICAL CHARACTERISTICS

### VGS - VGZ

| Nominal diameter                          | d <sub>1</sub>      | [mm]                 | VGS   |          |          |          |          | VGZ   |       |
|-------------------------------------------|---------------------|----------------------|-------|----------|----------|----------|----------|-------|-------|
|                                           |                     |                      | 9     | 11       | 11       | 13       | 13       | 9     | 11    |
| Length                                    | L                   | [mm]                 | -     | ≤ 600 mm | > 600 mm | ≤ 600 mm | > 600 mm | -     | -     |
| Countersunk head diameter                 | d <sub>K</sub>      | [mm]                 | 16,00 | 19,30    | -        | 22,00    | -        | 11,50 | 13,50 |
| Countersunk head thickness                | t <sub>1</sub>      | [mm]                 | 6,50  | 8,20     | -        | 9,40     | -        | -     | -     |
| Wrench size                               | SW                  | -                    | -     | -        | SW 17    | -        | SW 19    | -     | -     |
| Hexagonal head thickness                  | t <sub>s</sub>      | [mm]                 | -     | -        | 6,40     | -        | 7,50     | -     | -     |
| Internal thread diameter                  | d <sub>2</sub>      | [mm]                 | 5,90  | 6,60     | 6,60     | 8,00     | 8,00     | 5,90  | 6,60  |
| Pre-drilling hole diameter <sup>(1)</sup> | d <sub>V,S</sub>    | [mm]                 | 5,0   | 6,0      | 6,0      | 8,0      | 8,0      | 5,0   | 6,0   |
| Pre-drilling hole diameter <sup>(2)</sup> | d <sub>V,H</sub>    | [mm]                 | 6,0   | 7,0      | 7,0      | 9,0      | 9,0      | 6,0   | 7,0   |
| Characteristic tensile strength           | f <sub>tens,k</sub> | [kN]                 | 25,4  | 38,0     | 38,0     | 53,0     | 53,0     | 25,4  | 38,0  |
| Characteristic yield moment               | M <sub>y,k</sub>    | [Nm]                 | 27,2  | 45,9     | 45,9     | 70,9     | 70,9     | 27,2  | 45,9  |
| Characteristic yield strength             | f <sub>y,k</sub>    | [N/mm <sup>2</sup> ] | 1000  | 1000     | 1000     | 1000     | 1000     | 1000  | 1000  |

<sup>(1)</sup> Pre-drilling valid for softwood.

<sup>(2)</sup> Pre-drilling valid for hardwood and beech LVL.

### RTR

| Nominal diameter                          | d <sub>1</sub>      | [mm]                 | 16    |
|-------------------------------------------|---------------------|----------------------|-------|
| Internal thread diameter                  | d <sub>2</sub>      | [mm]                 | 12,00 |
| Pre-drilling hole diameter <sup>(1)</sup> | d <sub>V,S</sub>    | [mm]                 | 13,0  |
| Characteristic tensile strength           | f <sub>tens,k</sub> | [kN]                 | 100,0 |
| Characteristic yield moment               | M <sub>y,k</sub>    | [Nm]                 | 200,0 |
| Characteristic yield strength             | f <sub>y,k</sub>    | [N/mm <sup>2</sup> ] | 640   |

<sup>(1)</sup> Pre-drilling valid for softwood.

## ■ MECHANICAL CHARACTERISTICS OF TC FUSION SYSTEM

| Nominal diameter                                   | d <sub>1</sub>   | [mm]                 | VGS/VGZ |      |      | RTR |
|----------------------------------------------------|------------------|----------------------|---------|------|------|-----|
|                                                    |                  |                      | 9       | 11   | 13   | 16  |
| Tangential strength of adhesion in concrete C25/30 | f <sub>b,k</sub> | [N/mm <sup>2</sup> ] | 12,5    | 12,5 | 12,5 | 9,0 |

For applications with different materials please see ETA-22/0806.

## ■ RELATED PRODUCTS



**D 38 RLE**  
4-SPEED DRILL DRIVER



**SPEEDY BAND**  
UNIVERSAL SINGLE-SIDED TAPE WITHOUT  
RELEASE LINER



**FLUID MEMBRANE**  
SYNTHETIC SEALING MEMBRANE FOR BRUSH  
AND SPRAY APPLICATION



**INVISI BAND**  
TRANSPARENT SINGLE-SIDED ADHESIVE TAPE  
WITHOUT LINER, RESISTANT TO UV AND HIGH  
TEMPERATURES

Find out more at [www.rothoblaas.com](http://www.rothoblaas.com)

## FIELD OF USE

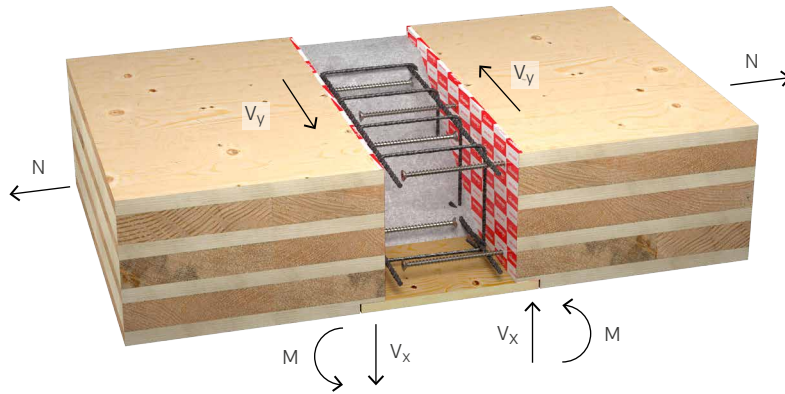
**ETA-22/0806** is specifically for timber-to-concrete applications with VGS, VGZ and RTR fully threaded connectors.

The calculation method for evaluating both joint strength and stiffness is made explicit.

The connection allows the transfer of shear, tensile and bending moment stresses between timber elements (CLT, LVL, GL) and concrete, both at floor and wall level.

The TC FUSION system was tested and validated at the Arbeitsbereich für Holzbau of the University of Innsbruck as part of a research project co-funded by the Österreichische Forschungsförderungsgesellschaft (FFG).

### EXTERNAL LOADS



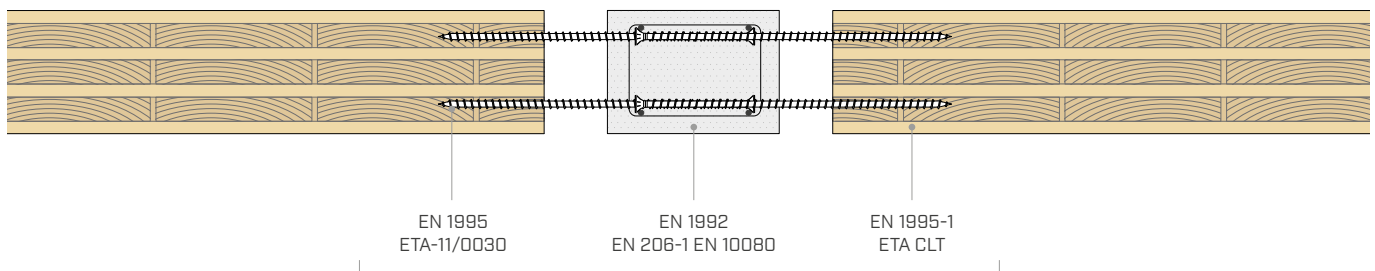
#### Rigid joint:

- cut in the panel plane ( $V_y$ )
- out-of-plane cutting ( $V_x$ )
- tension (N)
- bending moment (M)

#### Hinge joint:

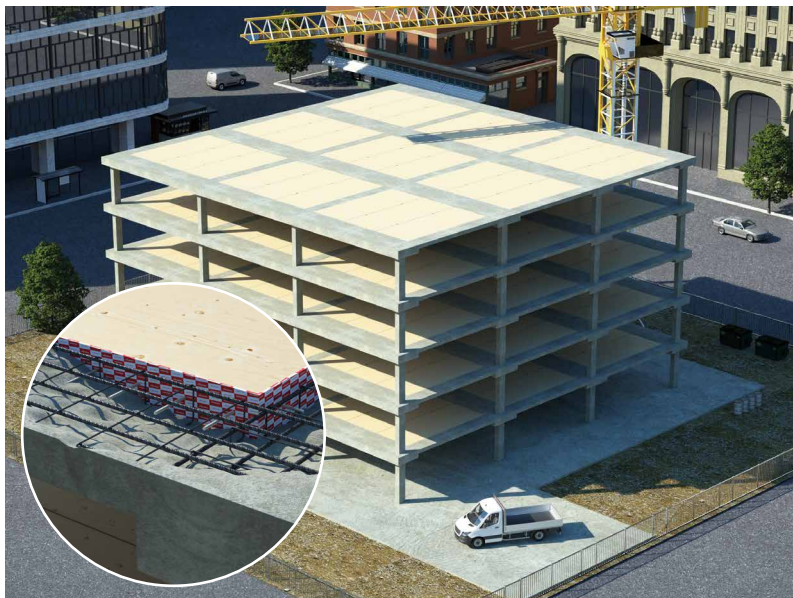
- cut in the panel plane ( $V_y$ )
- out-of-plane cutting ( $V_x$ )
- tension (N)

### STANDARDS AND CERTIFICATIONS INVOLVED



**ETA-22/0806 Rothoblaas**  
FOR TIMBER-TO-CONCRETE CONNECTIONS

### USE FOR HYBRID TIMBER-CONCRETE STRUCTURES



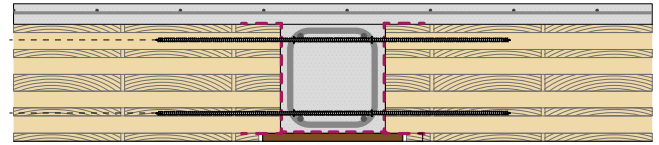
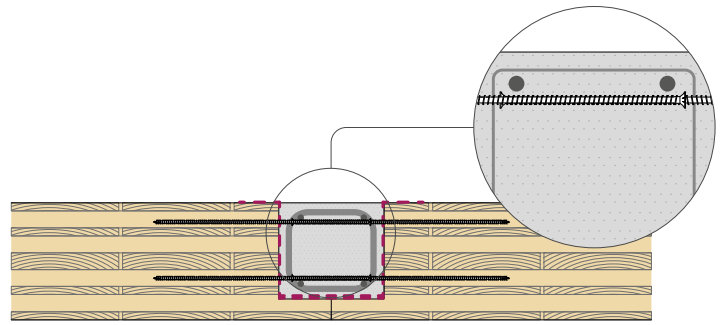
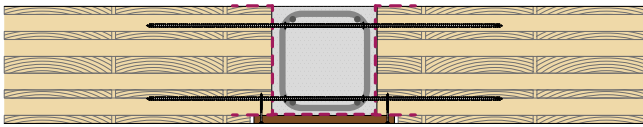
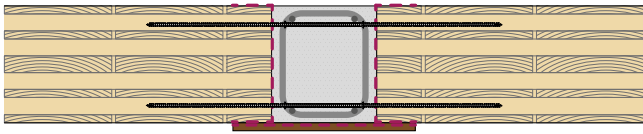
Using the TC FUSION system with screws and threaded rods offers an exceptional level of versatility for the construction of timber-concrete hybrid structures.

The connection is perfectly suited to situations where hinged or semi-rigid constraints are required. Screws and concrete can effectively transfer tension, shear and bending moment. The stiffness and moment of resistance increase progressively with increasing internal torque arm between tensioned side screws and compressed concrete.

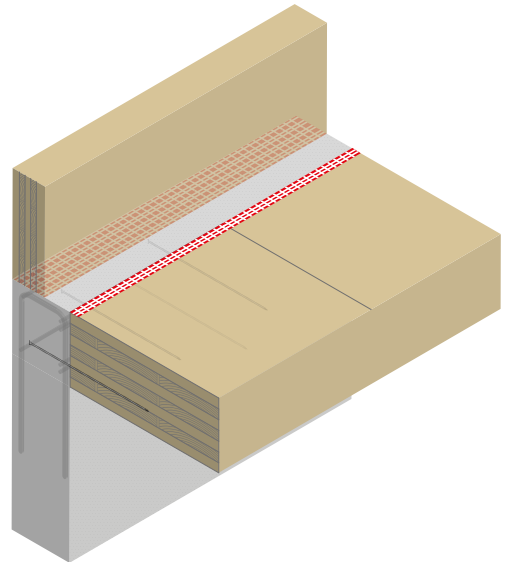
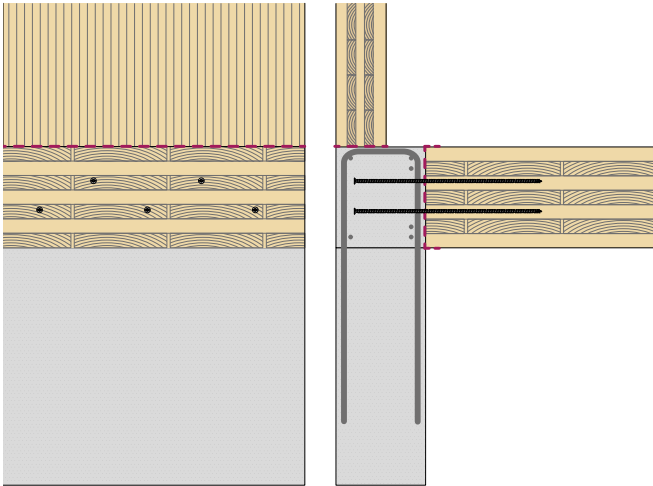
Combining the two materials creates a significant increase in stiffness and reduces structural tolerance issues.

## ■ INSTALLATION

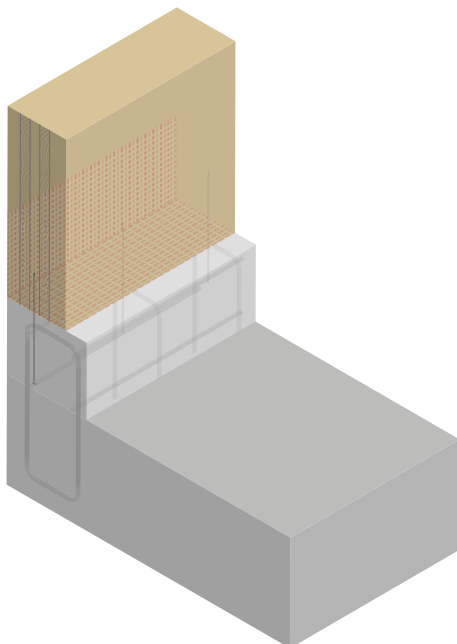
### PANEL-PANEL CONNECTION



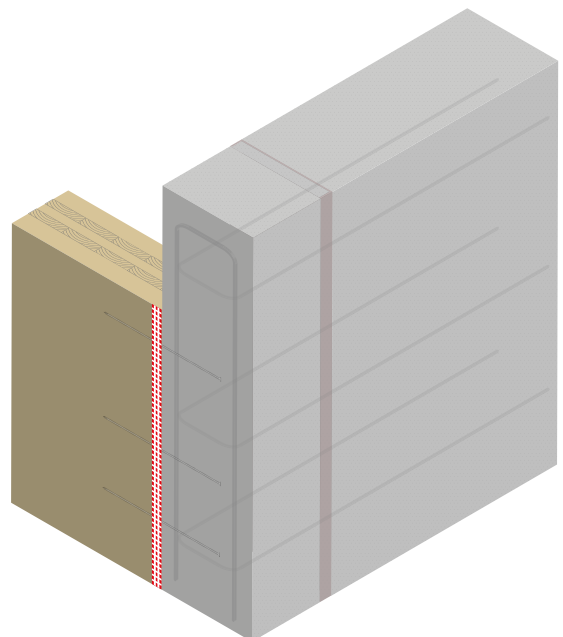
### FLOOR-WALL CONNECTION



### WALL-FOUNDATION CONNECTION



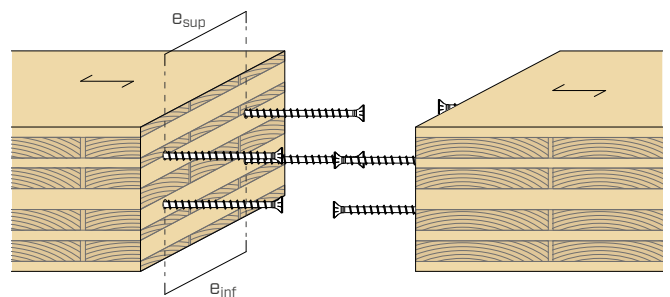
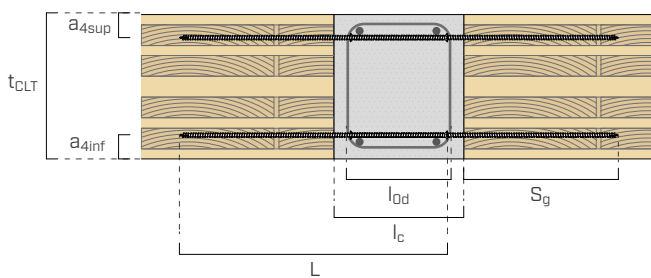
### WALL-WALL CONNECTION



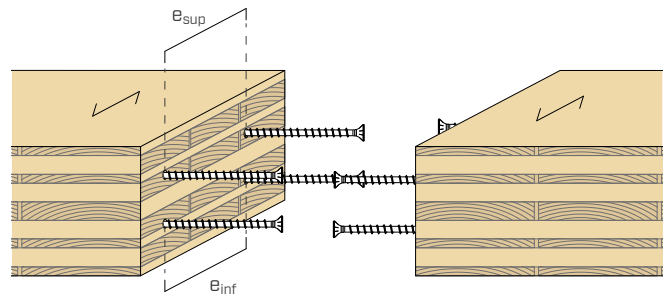
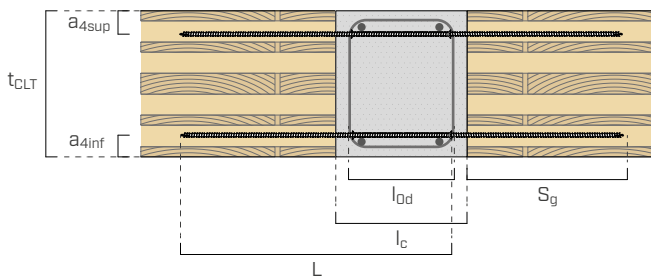
|          |      |       |                |       |                       |  | MOMENT                          |         |                                 |         |                                 |         |
|----------|------|-------|----------------|-------|-----------------------|--|---------------------------------|---------|---------------------------------|---------|---------------------------------|---------|
|          |      |       |                |       |                       |  | $M^*_{Rd}$                      |         |                                 |         |                                 |         |
| geometry |      |       |                |       |                       |  | 160                             |         | 180                             |         | 200                             |         |
|          |      |       |                |       |                       |  | (40-20-40-20-40) <sup>(1)</sup> |         | (40-30-40-30-40) <sup>(1)</sup> |         | (40-40-40-40-40) <sup>(1)</sup> |         |
| $d_1$    | L    | $l_c$ | $l_{od}^{(2)}$ | $S_g$ | $e_{inf}$   $e_{sup}$ |  | (L)                             | (T)     | (L)                             | (T)     | (L)                             | (T)     |
| [mm]     | [mm] | [mm]  | [mm]           | [mm]  | [mm]                  |  | [kNm/m]                         | [kNm/m] | [kNm/m]                         | [kNm/m] | [kNm/m]                         | [kNm/m] |
| 9        | 300  | 200   | 160            | 120   | 200                   |  | 3,5                             | 2,3     | 4,1                             | 2,9     | 4,7                             | 3,5     |
|          | 320  | 200   | 160            | 140   | 200                   |  | 4,1                             | 2,6     | 4,8                             | 3,3     | 5,5                             | 4,1     |
|          | 340  | 200   | 160            | 160   | 200                   |  | 4,6                             | 3,0     | 5,4                             | 3,8     | 6,2                             | 4,6     |
|          | 360  | 200   | 160            | 180   | 200                   |  | 5,1                             | 3,3     | 6,1                             | 4,2     | 7,0                             | 5,1     |
|          | 380  | 200   | 160            | 200   | 200                   |  | 5,7                             | 3,7     | 6,7                             | 4,7     | 7,7                             | 5,7     |
|          | 400  | 200   | 160            | 220   | 200                   |  | 6,2                             | 4,0     | 7,3                             | 5,1     | 8,4                             | 6,2     |
|          | 440  | 200   | 160            | 260   | 200                   |  | 7,2                             | 4,7     | 8,5                             | 6,0     | 9,8                             | 7,2     |
|          | 480  | 200   | 160            | 300   | 200                   |  | 8,2                             | 5,3     | 9,7                             | 6,8     | 11,2                            | 8,2     |
| 11       | 520  | 200   | 160            | 340   | 200                   |  | 9,2                             | 5,9     | 10,9                            | 7,6     | 12,5                            | 9,2     |
|          | 325  | 200   | 160            | 145   | 200                   |  | 4,9                             | 3,2     | 5,8                             | 4,0     | 6,6                             | 4,9     |
|          | 350  | 200   | 160            | 170   | 200                   |  | 5,7                             | 3,7     | 6,7                             | 4,7     | 7,7                             | 5,7     |
|          | 375  | 200   | 160            | 195   | 200                   |  | 6,5                             | 4,2     | 7,6                             | 5,3     | 8,8                             | 6,5     |
|          | 400  | 200   | 160            | 220   | 200                   |  | 7,3                             | 4,7     | 8,6                             | 6,0     | 9,8                             | 7,3     |
|          | 450  | 200   | 160            | 270   | 200                   |  | 8,8                             | 5,6     | 10,3                            | 7,2     | 11,9                            | 8,8     |
|          | 500  | 200   | 160            | 320   | 200                   |  | 10,2                            | 6,6     | 12,1                            | 8,4     | 13,9                            | 10,2    |
|          | 550  | 200   | 160            | 370   | 200                   |  | 11,7                            | 7,5     | 13,7                            | 9,6     | 15,8                            | 11,7    |
| 13       | 600  | 200   | 160            | 420   | 200                   |  | 13,0                            | 8,3     | 15,4                            | 10,7    | 17,8                            | 13,0    |
|          | 400  | 230   | 190            | 190   | 200                   |  | 7,2                             | 4,7     | 8,5                             | 5,9     | 9,8                             | 7,2     |
|          | 450  | 230   | 190            | 240   | 200                   |  | 9,0                             | 5,8     | 10,6                            | 7,4     | 12,2                            | 9,0     |
|          | 500  | 230   | 190            | 290   | 200                   |  | 10,7                            | 6,8     | 12,6                            | 8,7     | 14,5                            | 10,7    |
|          | 600  | 230   | 190            | 390   | 200                   |  | 13,9                            | 8,9     | 16,4                            | 11,4    | 18,9                            | 13,9    |
|          | 700  | 230   | 190            | 490   | 200                   |  | 17,0                            | 10,8    | 20,1                            | 13,9    | 23,2                            | 17,0    |
|          | 800  | 230   | 190            | 590   | 200                   |  | 19,9                            | 12,6    | 23,6                            | 16,3    | 27,3                            | 19,9    |
|          | 900  | 250   | 210            | 670   | 200                   |  | 22,2                            | 14,0    | 26,4                            | 18,1    | 30,5                            | 22,2    |
| 16       | 545  | 270   | 230            | 295   | 200                   |  | 9,6                             | 6,2     | 11,3                            | 7,9     | 13,0                            | 9,6     |
|          | 650  | 270   | 230            | 400   | 200                   |  | 12,6                            | 8,1     | 14,9                            | 10,4    | 17,2                            | 12,6    |
|          | 730  | 270   | 230            | 480   | 200                   |  | 14,8                            | 9,5     | 17,5                            | 12,2    | 20,2                            | 14,8    |
|          | 900  | 270   | 230            | 650   | 200                   |  | 19,3                            | 12,2    | 22,9                            | 15,8    | 26,4                            | 19,3    |
|          | 1095 | 270   | 230            | 845   | 200                   |  | 24,2                            | 15,1    | 28,7                            | 19,7    | 33,2                            | 24,2    |

## TIMBER-CONCRETE-TIMBER INSTALLATION

### CONFIGURATION (L)



### CONFIGURATION (T)



#### LEGEND

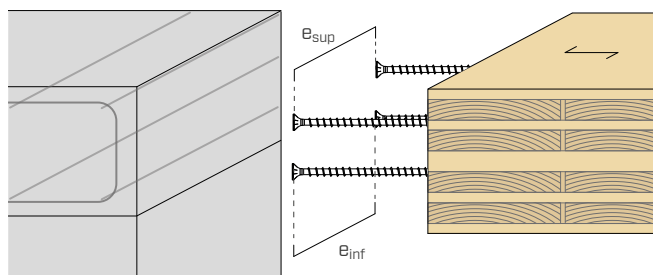
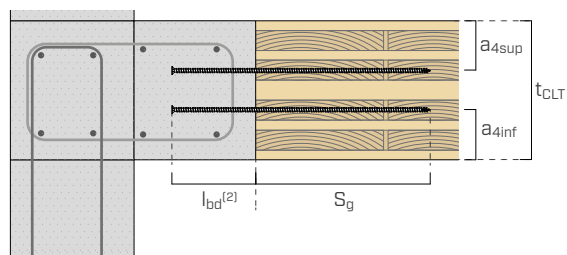
$t_{CLT}$  connected CLT panel thickness  
 $S_g$  screw pull-through length  
 $l_{od}$  overlap length  
 $l_c$  concrete element width

$e_{inf}$  lower screws spacing  
 $e_{sup}$  upper screws spacing  
 $a_{4inf}$  distance of the lower screws from the edge  
 $a_{4sup}$  distance of the upper screws from the edge

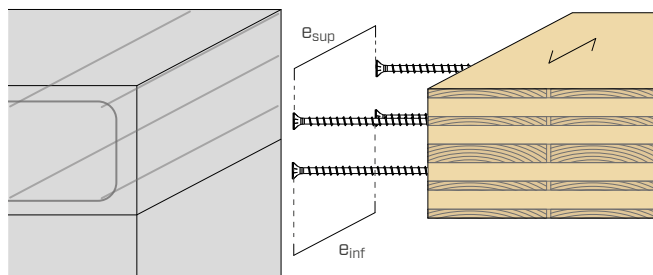
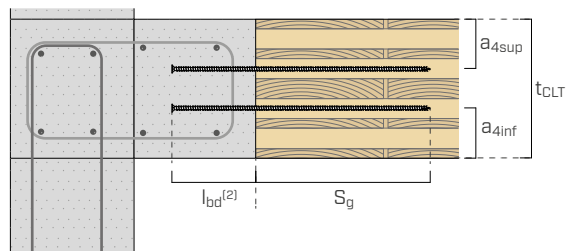
|  | MOMENT<br>M* <sub>Rd</sub>                   |         |                                              |         |                                              |         |                                              |         | SHEAR <sup>(3)</sup><br>V* <sub>Rd</sub> | TENSION<br>N* <sub>Rd</sub> |
|--|----------------------------------------------|---------|----------------------------------------------|---------|----------------------------------------------|---------|----------------------------------------------|---------|------------------------------------------|-----------------------------|
|  | 220<br>(40-40-20-20-20-40-40) <sup>(1)</sup> |         | 240<br>(40-40-20-40-20-40-40) <sup>(1)</sup> |         | 260<br>(40-40-30-40-30-40-40) <sup>(1)</sup> |         | 280<br>(40-40-40-40-40-40-40) <sup>(1)</sup> |         |                                          |                             |
|  | (L)                                          | (T)     | (L)                                          | (T)     | (L)                                          | (T)     | (L)                                          | (T)     |                                          |                             |
|  | [kNm/m]                                      | [kNm/m] | [kNm/m]                                      | [kNm/m] | [kNm/m]                                      | [kNm/m] | [kNm/m]                                      | [kNm/m] |                                          |                             |
|  | 5,3                                          | 4,1     | 5,9                                          | 4,7     | 6,6                                          | 5,3     | 7,2                                          | 5,9     | 3,8                                      | 6,1                         |
|  | 6,2                                          | 4,8     | 6,9                                          | 5,5     | 7,6                                          | 6,2     | 8,3                                          | 6,9     | 4,0                                      | 7,1                         |
|  | 7,0                                          | 5,4     | 7,8                                          | 6,2     | 8,7                                          | 7,0     | 9,5                                          | 7,8     | 4,3                                      | 8,1                         |
|  | 7,9                                          | 6,1     | 8,8                                          | 7,0     | 9,7                                          | 7,9     | 10,6                                         | 8,8     | 4,5                                      | 9,1                         |
|  | 8,7                                          | 6,7     | 9,7                                          | 7,7     | 10,7                                         | 8,7     | 11,7                                         | 9,7     | 4,5                                      | 10,0                        |
|  | 9,5                                          | 7,3     | 10,6                                         | 8,4     | 11,7                                         | 9,5     | 12,8                                         | 10,6    | 4,5                                      | 11,0                        |
|  | 11,1                                         | 8,5     | 12,4                                         | 9,8     | 13,7                                         | 11,1    | 14,9                                         | 12,4    | 4,5                                      | 12,8                        |
|  | 12,7                                         | 9,7     | 14,1                                         | 11,2    | 15,6                                         | 12,7    | 17,1                                         | 14,1    | 4,5                                      | 14,7                        |
|  | 14,2                                         | 10,9    | 15,8                                         | 12,5    | 17,5                                         | 14,2    | 19,1                                         | 15,8    | 4,5                                      | 16,5                        |
|  | 7,5                                          | 5,8     | 8,4                                          | 6,6     | 9,2                                          | 7,5     | 10,1                                         | 8,4     | 5,3                                      | 8,7                         |
|  | 8,7                                          | 6,7     | 9,7                                          | 7,7     | 10,8                                         | 8,7     | 11,8                                         | 9,7     | 5,6                                      | 10,1                        |
|  | 9,9                                          | 7,6     | 11,1                                         | 8,8     | 12,2                                         | 9,9     | 13,4                                         | 11,1    | 6,0                                      | 11,5                        |
|  | 11,1                                         | 8,6     | 12,4                                         | 9,8     | 13,7                                         | 11,1    | 15,0                                         | 12,4    | 6,2                                      | 12,9                        |
|  | 13,5                                         | 10,3    | 15,0                                         | 11,9    | 16,6                                         | 13,5    | 18,1                                         | 15,0    | 6,2                                      | 15,6                        |
|  | 15,7                                         | 12,1    | 17,5                                         | 13,9    | 19,4                                         | 15,7    | 21,2                                         | 17,5    | 6,2                                      | 18,3                        |
|  | 17,9                                         | 13,7    | 20,0                                         | 15,8    | 22,1                                         | 17,9    | 24,2                                         | 20,0    | 6,2                                      | 20,9                        |
|  | 20,1                                         | 15,4    | 22,5                                         | 17,8    | 24,8                                         | 20,1    | 27,2                                         | 22,5    | 6,2                                      | 23,5                        |
|  | 11,1                                         | 8,5     | 12,4                                         | 9,8     | 13,6                                         | 11,1    | 14,9                                         | 12,4    | 7,2                                      | 12,8                        |
|  | 13,8                                         | 10,6    | 15,4                                         | 12,2    | 17,0                                         | 13,8    | 18,6                                         | 15,4    | 8,0                                      | 16,0                        |
|  | 16,4                                         | 12,6    | 18,3                                         | 14,5    | 20,2                                         | 16,4    | 22,1                                         | 18,3    | 8,0                                      | 19,1                        |
|  | 21,4                                         | 16,4    | 23,9                                         | 18,9    | 26,4                                         | 21,4    | 29,0                                         | 23,9    | 8,0                                      | 25,1                        |
|  | 26,3                                         | 20,1    | 29,4                                         | 23,2    | 32,5                                         | 26,3    | 35,6                                         | 29,4    | 8,0                                      | 31,0                        |
|  | 31,0                                         | 23,6    | 34,6                                         | 27,3    | 38,3                                         | 31,0    | 42,0                                         | 34,6    | 8,0                                      | 36,8                        |
|  | 34,6                                         | 26,4    | 38,7                                         | 30,5    | 42,9                                         | 34,6    | 47,0                                         | 38,7    | 8,0                                      | 41,3                        |
|  | 14,8                                         | 11,3    | 16,5                                         | 13,0    | 18,2                                         | 14,8    | 19,9                                         | 16,5    | 11,4                                     | 17,2                        |
|  | 19,5                                         | 14,9    | 21,7                                         | 17,2    | 24,0                                         | 19,5    | 26,3                                         | 21,7    | 12,8                                     | 22,8                        |
|  | 22,9                                         | 17,5    | 25,6                                         | 20,2    | 28,3                                         | 22,9    | 31,0                                         | 25,6    | 13,8                                     | 26,9                        |
|  | 30,0                                         | 22,9    | 33,6                                         | 26,4    | 37,1                                         | 30,0    | 40,7                                         | 33,6    | 14,2                                     | 35,6                        |
|  | 37,7                                         | 28,7    | 42,3                                         | 33,2    | 46,8                                         | 37,7    | 51,3                                         | 42,3    | 14,2                                     | 45,2                        |

## TIMBER-TO-CONCRETE INSTALLATION

### CONFIGURATION (L)



### CONFIGURATION (T)



## NOTES

<sup>(1)</sup> Panel composition, thickness of overlapping layers with cross fibre orientation.

<sup>(2)</sup>  $l_{bd}$  represents the overlap length of the connectors. In the case of timber-to-concrete joints, this size is to be understood as anchorage length  $l_{bd}$ .

<sup>(3)</sup> If the edge distance of the panel is less than the prescribed edge distance for the screws (ETA-11/0030), the shear strength must be reduced in accordance with the "general principles" section. However, the geometric condition that the screws must be contained within the reinforcement rods of the reinforced concrete component and the minimum distance must be verified.

|          |      |       |                |       |           |           | ROTATIONAL STIFFNESS                   |             |                                        |             |                                        |             |
|----------|------|-------|----------------|-------|-----------|-----------|----------------------------------------|-------------|----------------------------------------|-------------|----------------------------------------|-------------|
|          |      |       |                |       |           |           | $k^*_{\varphi}$                        |             |                                        |             |                                        |             |
| geometry |      |       |                |       |           |           | 160<br>(40-20-40-20-40) <sup>(1)</sup> |             | 180<br>(40-30-40-30-40) <sup>(1)</sup> |             | 200<br>(40-40-40-40-40) <sup>(1)</sup> |             |
| $d_1$    | L    | $l_c$ | $l_{od}^{(2)}$ | $S_g$ | $e_{inf}$ | $e_{sup}$ | (L)                                    | (T)         | (L)                                    | (T)         | (L)                                    | (T)         |
| [mm]     | [mm] | [mm]  | [mm]           | [mm]  | [mm]      | [mm]      | [kNm/rad/m]                            | [kNm/rad/m] | [kNm/rad/m]                            | [kNm/rad/m] | [kNm/rad/m]                            | [kNm/rad/m] |
| 9        | 300  | 200   | 160            | 120   | 200       |           | 632                                    | 307         | 913                                    | 600         | 1246                                   | 838         |
|          | 320  | 200   | 160            | 140   | 200       |           | 732                                    | 355         | 1057                                   | 695         | 1443                                   | 970         |
|          | 340  | 200   | 160            | 160   | 200       |           | 830                                    | 403         | 1199                                   | 789         | 1636                                   | 1101        |
|          | 360  | 200   | 160            | 180   | 200       |           | 927                                    | 450         | 1339                                   | 881         | 1828                                   | 1229        |
|          | 380  | 200   | 160            | 200   | 200       |           | 927                                    | 450         | 1339                                   | 881         | 1828                                   | 1229        |
|          | 400  | 200   | 160            | 220   | 200       |           | 927                                    | 450         | 1339                                   | 881         | 1828                                   | 1229        |
|          | 440  | 200   | 160            | 260   | 200       |           | 927                                    | 450         | 1339                                   | 881         | 1828                                   | 1229        |
|          | 480  | 200   | 160            | 300   | 200       |           | 927                                    | 450         | 1339                                   | 881         | 1828                                   | 1229        |
|          | 520  | 200   | 160            | 340   | 200       |           | 927                                    | 450         | 1339                                   | 881         | 1828                                   | 1229        |
| 11       | 325  | 200   | 160            | 145   | 200       |           | 841                                    | 394         | 1233                                   | 798         | 1699                                   | 1128        |
|          | 350  | 200   | 160            | 170   | 200       |           | 975                                    | 457         | 1429                                   | 925         | 1970                                   | 1308        |
|          | 375  | 200   | 160            | 195   | 200       |           | 1107                                   | 518         | 1622                                   | 1049        | 2235                                   | 1484        |
|          | 400  | 200   | 160            | 220   | 200       |           | 1235                                   | 578         | 1810                                   | 1171        | 2494                                   | 1656        |
|          | 450  | 200   | 160            | 270   | 200       |           | 1235                                   | 578         | 1810                                   | 1171        | 2494                                   | 1656        |
|          | 500  | 200   | 160            | 320   | 200       |           | 1235                                   | 578         | 1810                                   | 1171        | 2494                                   | 1656        |
|          | 550  | 200   | 160            | 370   | 200       |           | 1235                                   | 578         | 1810                                   | 1171        | 2494                                   | 1656        |
|          | 600  | 200   | 160            | 420   | 200       |           | 1235                                   | 578         | 1810                                   | 1171        | 2494                                   | 1656        |
|          | 400  | 230   | 190            | 190   | 200       |           | 1258                                   | 589         | 1844                                   | 1193        | 2541                                   | 1687        |
| 13       | 450  | 230   | 190            | 240   | 200       |           | 1550                                   | 725         | 2271                                   | 1469        | 3129                                   | 2078        |
|          | 500  | 230   | 190            | 290   | 200       |           | 1662                                   | 778         | 2436                                   | 1576        | 3357                                   | 2229        |
|          | 600  | 230   | 190            | 390   | 200       |           | 1662                                   | 778         | 2436                                   | 1576        | 3357                                   | 2229        |
|          | 700  | 230   | 190            | 490   | 200       |           | 1662                                   | 778         | 2436                                   | 1576        | 3357                                   | 2229        |
|          | 800  | 230   | 190            | 590   | 200       |           | 1662                                   | 778         | 2436                                   | 1576        | 3357                                   | 2229        |
|          | 900  | 250   | 210            | 670   | 200       |           | 1662                                   | 778         | 2436                                   | 1576        | 3357                                   | 2229        |
|          | 545  | 270   | 230            | 295   | 200       |           | 2209                                   | 1034        | 3237                                   | 2094        | 4461                                   | 2962        |
| 16       | 650  | 270   | 230            | 400   | 200       |           | 2362                                   | 1106        | 3461                                   | 2239        | 4770                                   | 3167        |
|          | 730  | 270   | 230            | 480   | 200       |           | 2362                                   | 1106        | 3461                                   | 2239        | 4770                                   | 3167        |
|          | 900  | 270   | 230            | 650   | 200       |           | 2362                                   | 1106        | 3461                                   | 2239        | 4770                                   | 3167        |
|          | 1095 | 270   | 230            | 845   | 200       |           | 2362                                   | 1106        | 3461                                   | 2239        | 4770                                   | 3167        |

(\*) The table refers to the case of timber-concrete-timber connections. In the case of timber-to-concrete, the stiffness of the connection must be doubled.

## NOTES

- <sup>(1)</sup> Panel composition, thickness of overlapping layers with cross orientation.  
<sup>(2)</sup>  $l_{od}$  represents the overlap length of the connectors. In the case of timber-to-concrete joints, this size is to be understood as anchorage length  $l_{bd}$ .

## GENERAL PRINCIPLES

- The case of timber elements made of CLT was considered in the calculation. A compressive strength parallel to the fibres of  $f_{c0k} = 21$  Mpa and an average elastic modulus parallel to the fibres of  $E_{0m} = 11500$  Mpa. In the calculation of strengths and stiffnesses, the contribution of layers with fibres orthogonal to the stress is neglected. A concrete strength class of C25/30 is assumed, preferably with low shrinkage. If higher strength classes (max C50) are used, the adhesion stresses can be increased, according to ETA22/0806.
- For determining the flexural strength, the distance of the screws from the tensioned edge of the  $a_{4inf}$  panel was considered to be: 41 mm for Ø9 mm screws and 45 mm for Ø11, Ø13 screws and RTR bars.
- When using the system with other materials, the axial screw strengths must be calculated according to ETA-11/0030.
- Wood and concrete elements must be sized and checked separately. Minimum anchor and overlap lengths, minimum reinforcement arrangement and geometric requirements are indicated in ETA-22/0806.
- In the case of combined stresses, the guidelines in ETA-22/0806 must be followed.
- The safety coefficients  $\gamma_M$  must be taken according to the current regulations used for the calculation. The tables were developed assuming:  
 $k_{mod} = 1$  (short/instantaneous duration)  
 $\gamma_M = 1,3$  (connections)  
 $\gamma_{M,concrete} = 1,5$  (concrete)  
 $\alpha_{cc} = 0,85$  concrete viscosity coefficient in compression

## MOMENT OF RESISTANCE M

- Characteristic values are calculated in accordance with EN 1995-1-1 and in accordance with ETA-22/0806 and ETA-11/0030. Design resistance values can be obtained from the tabulated values as follows:

$$M_{Rd} = M^*_{Rd} \cdot \frac{200}{e} \cdot \frac{k_{mod}}{1,0} \cdot \frac{1,3}{\gamma_M}$$

where:

- $M_{Rd}$  moment of resistance referred to design pitch  
 $M^*_{Rd}$  moment of resistance referred to a standard pitch of 200 mm  
 $e$  screw pitch at the tensioned flap of the joint ( $e_{inf}$  or  $e_{sup}$ )

## SHEAR $V_y$

- The strength of the system is obtained from the formula:

$$V_{Rd} = V^*_{Rd} \cdot \left( \frac{1000}{e_{inf}} + \frac{1000}{e_{sup}} \right) \cdot \frac{k_{mod}}{1,0} \cdot \frac{1,3}{\gamma_M}$$

where:

- $V_{Rd}$  shear strength referred to design pitch  
 $V^*_{Rd}$  unitary resistant cut (1 screw per metre)  
 $e_{inf}$  pitch of the screws to the tensioned flap of the joint  
 $e_{sup}$  screw pitch at the compressed flap of the joint

|  | ROTATIONAL STIFFNESS<br>k* <sub>φ</sub>      |             |                                              |             |                                              |             |                                              |             | LATERAL STIFFNESS<br>k* <sub>ser</sub><br><br>[N/mm/mm] |
|--|----------------------------------------------|-------------|----------------------------------------------|-------------|----------------------------------------------|-------------|----------------------------------------------|-------------|---------------------------------------------------------|
|  | 220<br>(40-40-20-20-20-40-40) <sup>(1)</sup> |             | 240<br>(40-40-20-40-20-40-40) <sup>(1)</sup> |             | 260<br>(40-40-30-40-30-40-40) <sup>(1)</sup> |             | 280<br>(40-40-40-40-40-40-40) <sup>(1)</sup> |             |                                                         |
|  | (L)                                          | (T)         | (L)                                          | (T)         | (L)                                          | (T)         | (L)                                          | (T)         |                                                         |
|  | [kNm/rad/m]                                  | [kNm/rad/m] | [kNm/rad/m]                                  | [kNm/rad/m] | [kNm/rad/m]                                  | [kNm/rad/m] | [kNm/rad/m]                                  | [kNm/rad/m] |                                                         |
|  | 1630                                         | 1115        | 2066                                         | 1431        | 2553                                         | 1787        | 3092                                         | 2183        | 1371                                                    |
|  | 1887                                         | 1291        | 2392                                         | 1658        | 2957                                         | 2070        | 3581                                         | 2528        | 1371                                                    |
|  | 2141                                         | 1465        | 2714                                         | 1880        | 3354                                         | 2348        | 4062                                         | 2868        | 1371                                                    |
|  | 2391                                         | 1636        | 3031                                         | 2100        | 3746                                         | 2622        | 4537                                         | 3202        | 1371                                                    |
|  | 2391                                         | 1636        | 3031                                         | 2100        | 3746                                         | 2622        | 4537                                         | 3202        | 1371                                                    |
|  | 2391                                         | 1636        | 3031                                         | 2100        | 3746                                         | 2622        | 4537                                         | 3202        | 1371                                                    |
|  | 2391                                         | 1636        | 3031                                         | 2100        | 3746                                         | 2622        | 4537                                         | 3202        | 1371                                                    |
|  | 2391                                         | 1636        | 3031                                         | 2100        | 3746                                         | 2622        | 4537                                         | 3202        | 1371                                                    |
|  | 2391                                         | 1636        | 3031                                         | 2100        | 3746                                         | 2622        | 4537                                         | 3202        | 1371                                                    |
|  | 2391                                         | 1636        | 3031                                         | 2100        | 3746                                         | 2622        | 4537                                         | 3202        | 1371                                                    |
|  | 2240                                         | 1515        | 2855                                         | 1960        | 3545                                         | 2462        | 4309                                         | 3020        | 1928                                                    |
|  | 2597                                         | 1757        | 3310                                         | 2273        | 4110                                         | 2854        | 4996                                         | 3502        | 1928                                                    |
|  | 2946                                         | 1993        | 3755                                         | 2578        | 4663                                         | 3238        | 5668                                         | 3973        | 1928                                                    |
|  | 3288                                         | 2225        | 4191                                         | 2877        | 5204                                         | 3614        | 6326                                         | 4434        | 1928                                                    |
|  | 3288                                         | 2225        | 4191                                         | 2877        | 5204                                         | 3614        | 6326                                         | 4434        | 1928                                                    |
|  | 3288                                         | 2225        | 4191                                         | 2877        | 5204                                         | 3614        | 6326                                         | 4434        | 1928                                                    |
|  | 3288                                         | 2225        | 4191                                         | 2877        | 5204                                         | 3614        | 6326                                         | 4434        | 1928                                                    |
|  | 3288                                         | 2225        | 4191                                         | 2877        | 5204                                         | 3614        | 6326                                         | 4434        | 1928                                                    |
|  | 3349                                         | 2266        | 4269                                         | 2931        | 5301                                         | 3681        | 6444                                         | 4517        | 2562                                                    |
|  | 4125                                         | 2791        | 5259                                         | 3610        | 6529                                         | 4534        | 7937                                         | 5563        | 2562                                                    |
|  | 4425                                         | 2994        | 5641                                         | 3872        | 7004                                         | 4864        | 8514                                         | 5968        | 2562                                                    |
|  | 4425                                         | 2994        | 5641                                         | 3872        | 7004                                         | 4864        | 8514                                         | 5968        | 2562                                                    |
|  | 4425                                         | 2994        | 5641                                         | 3872        | 7004                                         | 4864        | 8514                                         | 5968        | 2562                                                    |
|  | 4425                                         | 2994        | 5641                                         | 3872        | 7004                                         | 4864        | 8514                                         | 5968        | 2562                                                    |
|  | 4425                                         | 2994        | 5641                                         | 3872        | 7004                                         | 4864        | 8514                                         | 5968        | 2562                                                    |
|  | 5881                                         | 3979        | 7496                                         | 5146        | 9307                                         | 6463        | 11314                                        | 7931        | 3646                                                    |
|  | 6288                                         | 4255        | 8016                                         | 5503        | 9952                                         | 6911        | 12099                                        | 8480        | 3646                                                    |
|  | 6288                                         | 4255        | 8016                                         | 5503        | 9952                                         | 6911        | 12099                                        | 8480        | 3646                                                    |
|  | 6288                                         | 4255        | 8016                                         | 5503        | 9952                                         | 6911        | 12099                                        | 8480        | 3646                                                    |
|  | 6288                                         | 4255        | 8016                                         | 5503        | 9952                                         | 6911        | 12099                                        | 8480        | 3646                                                    |

## SHEAR $V_x$

- The strength of the system is obtained from the formula:

$$V_{Rd} = V^*_{Rd} \cdot \left( \frac{1000 + 1000}{e_{inf} e_{sup}} \right) \cdot \beta \cdot \frac{k_{mod}}{1,0} \cdot \frac{1,3}{\gamma_M}$$

$$\beta = \min \left\{ \frac{a_{4,inf}}{a_{4,inf,min}}; \frac{a_{4,sup}}{a_{4,sup,min}}; 1 \right\}$$

where:

$V_{Rd}$  shear strength referred to design pitch  
 $V^*_{Rd}$  unitary resistant cut (1 screw per metre), with edge distance greater than the minimum according to ETA-11/0030  
 $e_{inf}$  pitch of the screws to the tensioned flap of the joint  
 $e_{sup}$  screw pitch at the compressed flap of the joint  
 $\beta$  coefficient for reducing the shear resistance of shear screws in case of deviation from the minimum distance specified in ETA-11/0030  
 $a_{4,inf,min}$  and  $a_{4,sup,min}$  are the minimum distances according to ETA-11/0030 from the lower and upper edge of the panel (6 d)  
 $a_{4,inf}$  and  $a_{4,sup}$  are the design distances from the bottom and top edge of the panel  
 In the previous formula, the assumption was made to reduce the strength of all screws according to the most penalising distance from the edge.

## TENSION $N$

- The strength of the system is obtained from the formula:

$$N_{Rd} = N^*_{Rd} \cdot \left( \frac{1000 + 1000}{e_{inf} e_{sup}} \right) \cdot \frac{k_{mod}}{1,0} \cdot \frac{1,3}{\gamma_M}$$

where:

$N_{Rd}$  tensile strength referred to the design pitch  
 $N^*_{Rd}$  unit tensile strength (1 screw per metre)  
 $e_{inf}$  pitch of the screws to the tensioned flap of the joint  
 $e_{sup}$  screw pitch at the compressed flap of the joint

## ROTATIONAL STIFFNESS

- In the calculation of the system an effective length limited to a value of 20d was assumed, as stated in ETA-22/0806. In the case of timber-to-concrete-to-timber connections, the rotational stiffness must be calculated using the following formula; for timber-to-concrete connections this value must be doubled.

$$k_{\varphi} = k^*_{\varphi} \cdot \frac{200}{e}$$

where:

$k_{\varphi}$  rotational stiffness referred to the design pitch  
 $k^*_{\varphi}$  rotational stiffness based on a standard pitch of 200 mm  
 $e$  screw pitch at the tensioned flap of the joint

## PLANE/OFF-PLANE STIFFNESS

- In the case of timber-concrete-timber connections, the lateral stiffness must be calculated using the following formula; for timber-to-concrete connections this value must be doubled. The stiffness of the system is obtained from the formula.

$$k_{ser} = k^*_{ser} \cdot \left( \frac{1000 + 1000}{e_{inf} e_{sup}} \right)$$

where:

$k_{ser}$  connection stiffness per linear metre  
 $k^*_{ser}$  single screw lateral stiffness  
 $e_{inf}$  pitch of the screws to the tensioned flap of the joint  
 $e_{sup}$  screw pitch at the compressed flap of the joint

## AXIAL STIFFNESS

- For evaluation of axial stiffness, refer to ETA-22/0806.