MyTiCon Timber Connectors

DESIGN EXAMPLE

MyTiCon Timber Connectors

PRE-ENGINEERED CONNECTOR SYSTEMS

GIGANT concealed connectors offer a wide variety of advantages to designers and contractors. As a system, GIGANT connectors provide a universal connector for wood-wood, wood-steel and wood-concrete connections. They allow for simple screwing without pre-drilling, and easy beam hanging is achievable. Additionally, when concealed housings are provided, suitable fire ratings can be achieved.

GIGANT connectors are suitable for main and secondary beam connections, yet their flexibility allows for use in a wide variety of applications such as in porches, pergolas, sun rooms and prefabricated house systems.

Even though, these connectors are easily mounted and installed the details of design must be understood. The following design examples help designers to understand the applicable design procedure.

The CSA 086 allows for alternative design solutions under its "New or Special Systems of Design and Construction" section. In this example we use this clause and will follow the connectors design methods outlined in the respective approvals.

WOOD you like to **CONNECT?**

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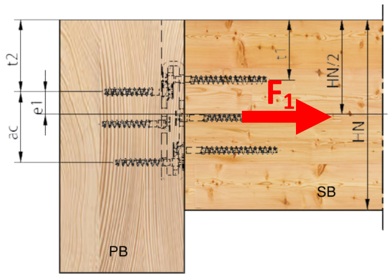
GIGANT® 180/40 Design Example #1

DESIGN EXAMPLE #1: Design of Joint subjected to a Tensile Force (F_1) using KNAPP® GIGANT 180/40 Connector (without Reinforcing Uplift Clip Lock)

Design Assumptions and

Connection Geometry Check:



General Joint Geometry with Connector “Housed” in PB

Joint:

Rectangular glulam timber members (D.Fir) with a Secondary Beam (SB) to Primary Beam (PB) Connection.

Cross section dimensions to follow requirements for minimum cross section dimensions in accordance with [1] and [2].

Secondary Beam:

Use 80x228[mm] **OK**

Table 1—Minimum Cross Section Requirements[1]

Connector	Minimum Cross Section Requirements			
	PB Width [mm]		SB Width [mm]	SB Depth [mm]
	Face Mounted	“Housed” in PB		
GIGANT 120/40	80	130	60	152
GIGANT 150/40				190
GIGANT 180/40				228

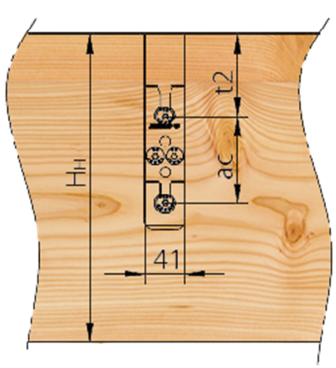
Primary Beam:

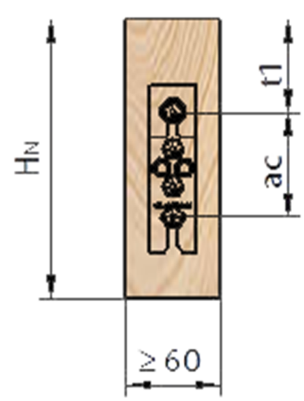
Min. depth of SB ≥ 228 [mm]
Min. width of PB to be greater than full length of Fully Threaded screws driven into PB.
This example with 10x80[mm] screws in PB.

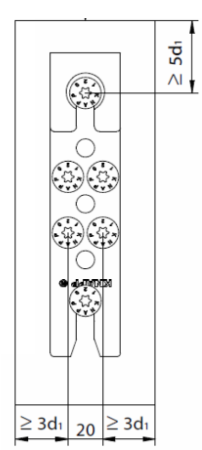
Use: 130x304 [mm] **OK**
Any beam deeper than 228mm may be adequate. Using this section as an example. Connector assumed to be “housed” in PB

Table 2—Design Factors[3]

Connector	Design Factors without reinforcing clip lock[3]	
	$F_{1,KCC,Rd}$[kN]	a_c [mm]
GIGANT 120/40	6.2	58
GIGANT 150/40		90
GIGANT 180/40		122







[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada; [3] ETA Report 10/0189

DESIGN EXAMPLE #1: Design of Joint subjected to a Tensile Force (F_1) using KNAPP® GIGANT 180/40 Connector (without Reinforcing Uplift Clip Lock)

Calculation of Factored Tensile Resistance F_1 of the Joint:

F_1: Tensile Load acting perpendicular to the plane of the connector plate

(Assumed acting fully concentric for this example)

Note:

Relative Density refers to the adjusted Mean -oven Dry Relative Density as per recommendations in Table 3-7a of the Wood Handbook.

$\rho = 1{,}000 \cdot (G_m = \rho_k) \cdot (1+MC/100)$

$\rho = 490$ kg/m^3 at service conditions (assumed MC=19%)

MC = 19%

Solving -> $\rho_k = \rho \cdot (1 / 1.19) = \rho \cdot 0.84$

In this example pull-out resistance of fasteners in force direction F1 was considered in PB due to its governing value. In case of permanent or long term loading in force direction F1 the designer must apply appropriate reduction factors in the PB and SB. Long term loading or permanent loading in force direction F1 of the SB is not suggested.

"KNAPP GIGANT Pre–Engineered Connectors"
"Design Capacities in Wood–to–Wood Joints"
"--

GIGANT 180/40 Pre-Engineered Connector

F_{1Rd} (Load acting perpendicular to the plane of connector plate)

Input data for: KNAPP 10x80 FT screw

$d := 10 \quad mm$ (outer thread diameter)

$l_{thread} := 54 \quad mm$ (effective thread length = effective penetration length)

$\rho_k := 490 \cdot .84 = 411.6 \quad \frac{kg}{m^3}$ (Relative Density adjustement for wood members)

Angle between grain direction in PB and direction of the force:

$\alpha := 90 \quad deg$

$$\alpha := 90 \cdot \left(\frac{\pi}{180}\right) = 1.571$$

Calculation of effective number of screws:

$a_c := 122 \quad mm$ Spacing between tensile screws, Table 2.

$e_1 := 61 \quad mm$ Distance between load F1 and Tensile screw considered.

(e1 is positive if it acts within ac, it is negative if it is outside)

(Assuming concentric loading acting at mid-point of ac)

$$n_{ef} := \frac{a_c}{a_c - e_1} = 2$$

Unfactored Withdrawal Resistance of KNAPP 10x80mm FT screws:

$$F_{axRk} := \frac{0.52 \cdot \sqrt{d} \cdot l_{thread}^{\ 0.9} \cdot \rho_k^{\ 0.8}}{1.2 \cdot (\cos(\alpha))^2 + (\sin(\alpha))^2} \cdot \frac{1}{1000} = 7.358 \quad kN$$

$F_{tRd} := (0.8) \cdot 30 = 24 \quad kN$ (Design Factored Tensile Resistance of screw, [2])

$F_{1KCCRd} := 6.2 \quad kN$ (Design Factored Resistance of GIGANT connector, [3])

GIGANT 180/40 Calculation of F1: Design Factored Tensile Resistance

Design Capacity: $\phi := 0.615$

Reduction factor for timber connections, assuming standard duration of load and dry in-service moisture conditions, as per [1] and [3].

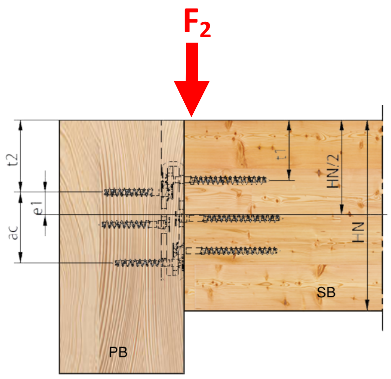
$$F_{1Rd} := \min\left(\phi \cdot n_{ef} \cdot F_{axRk}, n_{ef} \cdot F_{tRd}, n_{ef} \cdot F_{1KCCRd}\right) = 9.05 \quad kN$$

[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

GIGANT® 180/40 Design Example #2

DESIGN EXAMPLE #2: Design of Joint subjected to a Vertical Shear Force (F_2) using KNAPP® GIGANT 180/40 Connector (without Reinforcing Uplift Clip Lock)

Design Assumptions and Connection Geometry Check:



General Joint Geometry with Connector "Housed" in PB

Joint:

Rectangular glulam timber members (D.Fir) with a Secondary Beam (SB) to Primary Beam (PB) Connection.

Cross section dimensions to follow requirements for minimum cross section dimensions in accordance with [1] and [2].

Secondary Beam:

Use 80x228 [mm] **OK**

Primary Beam:

Use: 130x304 [mm]* **OK**

Table 3—Minimum Cross Section Requirements[1]

Connector	Minimum Cross Section Requirements			
	PB Width [mm]		SB Width [mm]	SB Depth [mm]
	Face Mounted	"Housed" in PB		
GIGANT 120/40	80	130	60	152
GIGANT 150/40				190
GIGANT 180/40				228

Table 4—Design Factors[3]

Connector	Design Factors without reinforcing clip lock[3]	
	$F_{2,KCC,Rd}$ [kN]	$K_{h,2}$ [mm]
GIGANT 120/40	17.0	2.55
GIGANT 150/40	24.0	4.74
GIGANT 180/40	33.0	8.84

Reinforcement check:

Depending on the location of the connector within the element's cross section, radial tension reinforcement with an KNAPP® FT screw is required.

If $A_n/H_H < 0.70$, radial tension reinforcement is required.

$\mathbf{w_{SB}}$ = 80[mm] *(min) ;* $\mathbf{w_{PB}}$ =130[mm] *(connector assumed to be "housed" in PB);*

$\mathbf{H_H}$=$\mathbf{H_{SB}}$ = 228[mm] *(min) ;*

$\mathbf{H_{PB}}$ = 304[mm] ;

$\mathbf{A_N}$ = 160[mm] (distance from top edge to centroid of bottom screw in SB)

Required location to ensure *$A_n/H_H \geq 0.70$ = 160 / 228 = 0.70* ***ok***

(Locate centre of axis of bottom tensile screw in SB, 160mm from top edge of Beam)

Radial tension reinforcement to avoid splitting is ***not*** required.

[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

DESIGN EXAMPLE #2: Design of Joint subjected to a Vertical Shear Force (F_2) using KNAPP® GIGANT 180/40 Connector (without Reinforcing Uplift Clip Lock)

Relevant input information:

Note:

Relative Density refers to the adjusted Mean-oven Dry Relative Density as per recommendations in Table 3-7a of the Wood Handbook.

ρ = 1,000 · (G_m = ρ_k) · (1+MC/100)

ρ = 490 kg/m^3 at service conditions (assumed MC=19%)

MC = 19%

Solving -> $\rho_k = \rho \cdot (1 / 1.19) = \rho \cdot 0.84$

GIGANT 180/40 Pre-Engineered Connector: without reinforcing clip-lock

Calculation of Factored Vertical Shear Resistance (F2):
Following ETA Report [1] Design Provisions

Input Data for:
KNAPP 10x80 FT screw to be used in PB (Header)

$d := 10$ mm (outer thread diameter)
$l_{thread10x80} := 56$ mm (effective thread length)

$\rho_{header} := 490 \cdot .84 = 411.6 \ \frac{kg}{m^3}$ "Relative Density adjustment"

KNAPP 10x120 FT screw to be used in SB (Joist)

$d := 10$ mm (outer thread diameter)
$l_{thread10x120} := 86$ mm (effective thread length)

$\rho_{joist} := 490 \cdot .84 = 411.6 \ \frac{kg}{m^3}$ "Relative Density adjustment"

Number of screws per connector plate:

$n := 6$

$n_{ef} := n = 6$ "Group Effect Factor"

Unfactored Torsional Resistance of fasteners [3]:

$M_{yrk} := 30000 \ N \cdot mm$

Calculation of Unfactored Shear Resistance $F_{V,H,Rk}$ *of GIGANT 180/40 Connector into PB (Header)*

Note:

Terms A_h, B_h and C_h, correspond to Section 8.2.3 in [1].

Specifically terms A_h, B_h check for fastener yielding failure mode, and C_h checks for wood-related failure as per Johansen's Yield Model.

"Unfactored Embedment Strength of timber" $\alpha_h := 90 \cdot \left(\frac{\pi}{180}\right) = 1.571$

$$f_{hk} := \left(0.033 + 0.049 \cdot \frac{90}{90}\right) \cdot \rho_{header} \cdot d^{-0.3} = 16.916 \quad MPa$$

"Unfactored Withdrawal Resistance of KNAPP Fastener into PB (header)"

$$F_{axRHk} := \frac{0.52 \cdot \sqrt{d} \cdot l_{thread10x80}^{\ 0.9} \cdot \rho_{header}^{\ 0.8}}{1.2 \cdot (\cos(\alpha_h))^2 + (\sin(\alpha_h))^2} = 7.602 \cdot 10^3 \ N$$

Unfactored Shear Resistance of GIGANT 180/40 Connector in PB in accordance with the design provisions outliend in Section 8.2.3 and Equation 8.10 of [1] for single shear connections with thick outer steel plates.
(The unfactored shear resistance is the minimum of terms Ah, Bh and Ch)

t1: penetration of screw into PB: $t1 := l_{thread10x80} = 56 \ mm$

$$A_h := \left(f_{hk} \cdot t1 \cdot d \cdot \left(\left(\sqrt{2 + \frac{4 \cdot M_{yrk}}{f_{hk} \cdot d \cdot t1^2}} - 1\right)\right)\right) = 4.661 \cdot 10^3 \quad N$$

$$A := \frac{F_{axRHk}}{4} = 1.901 \cdot 10^3 \qquad A_{hk} := A_h + (A) = 6.562 \cdot 10^3$$

[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

DESIGN EXAMPLE #2: Design of Joint subjected to a Vertical Shear Force (F_2) using KNAPP® GIGANT 180/40 Connector (without Reinforcing Uplift Clip Lock)	
Calculation of Unfactored Shear Resistance $F_{V,H,Rk}$ of GIGANT 180/40 Connector into PB (Header) *(cont'd)*	$B_h := \left(2.3 \cdot \left(\sqrt{M_{yrk} \cdot f_{hk} \cdot d}\right)\right) = 5.181 \cdot 10^3$ N $B := \frac{F_{axRHk}}{4} = 1.901 \cdot 10^3$ $\quad B_{hk} := B_h + (B) = 7.082 \cdot 10^3$ N $C_{hk} := f_{hk} \cdot t1 \cdot d = 9.473 \cdot 10^3$ N $F_{vHRk} := min(A_{hk}, B_{hk}, C_{hk}) = 6.562 \cdot 10^3\ N$
Calculation of Unfactored Shear Resistance $F_{V,J,Rk}$ of GIGANT 180/40 Connector into SB (Joist) Note: Terms A_j, B_j and C_j, correspond to Section 8.2.3 in [1]. Specifically terms A_j, B_j check for fastener yielding failure mode, and C_j checks for wood-related failure as per Johansen's Model.	**Unfactored Shear Resistance for SB (Joist):** "____" "Unfactored Embedment Strength of timber" $\quad \alpha_j := 0 \cdot \frac{\pi}{180} = 0$ $f_{Jk} := \left(0.033 + 0.049 \cdot \frac{0}{90}\right) \cdot \rho_{joist} \cdot d^{-0.3} = 6.808$ MPa "Unfactored Withdrawal Resistance of KNAPP Fastener into SB (joist)" $F_{axRk} := \frac{0.52 \cdot \sqrt{d} \cdot l_{thread10x120}^{0.9} \cdot \rho_{joist}^{0.8}}{1.2 \cdot (\cos(\alpha_j))^2 + (\sin(\alpha_j))^2} = 9.321 \cdot 10^3$ N Unfactored Shear Resistance of GIGANT 180/40 Connector in SB in accordance with the design provisions outliend in Section 8.2.3 and Equation 8.10 of [1] for single shear connections with thick outer steel plates. (The unfactored shear resistance is the minimum of terms Aj, Bj and Cj) t2: penetration of screw into SB: $\quad t2 := l_{thread10x120} = 86$ mm $A_j := \left(f_{Jk} \cdot t2 \cdot d \cdot \left(\left(\sqrt{2 + \frac{4 \cdot M_{yrk}}{f_{Jk} \cdot d \cdot t2^2}} - 1\right)\right)\right) = 2.904 \cdot 10^3$ N $A := \frac{F_{axRk}}{4} = 2.33 \cdot 10^3$ $\quad A_{jk} := A_j + (A) = 5.235 \cdot 10^3$ $B_j := \left(2.3 \cdot \left(\sqrt{M_{yrk} \cdot f_{Jk} \cdot d}\right)\right) = 3.287 \cdot 10^3$ N $B := \frac{F_{axRk}}{4} = 2.33 \cdot 10^3$ $\quad B_{jk} := B_j + B = 5.617 \cdot 10^3$ $C_{jk} := f_{Jk} \cdot t2 \cdot d = 5.854 \cdot 10^3$ N $F_{vJRk} := min(A_{jk}, B_{jk}, C_{jk}) = 5.235 \cdot 10^3$ N

[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

DESIGN EXAMPLE #2: Design of Joint subjected to a Vertical Shear Force (F_2) using KNAPP® GIGANT 180/40 Connector (without Reinforcing Uplift Clip Lock)	
Calculation of Factored Shear Resistance $F_{2,Rd}$ *of the Joint:*	**Design Factors for GIGANT 180/40 (without reinforcing clip lock):** $k_{h2} := 8.84$ "(For GIGANT Connectors)" $F_{2KCCrd} := 33 \ kN$ Summary of Unfactored Resistances: $F_{axRHk} := \frac{F_{axRHk}}{1000} = 7.602 \ kN$ $F_{vHRk} := \frac{F_{vHRk}}{1000} = 6.562 \ kN$ $F_{vJRk} := \frac{F_{vJRk}}{1000} = 5.235 \ kN$ **Unfactored Shear Resistances:** $JoistResist := (n_{ef}) \cdot F_{vJRk} = 31.408 \ kN$ $HeaderResist := \frac{1}{\sqrt[2]{\left(\left(\frac{1}{(n_{ef}) \cdot F_{vHRk}}\right)^2\right) + \left(\left(\frac{1}{k_{h2} \cdot F_{axRHk}}\right)^2\right)}} = 33.97 \ kN$ **Calculation of Factored Vertical Shear Resistance (F2) for GIGANT 180/40 Connector:** "Design Capacity:" $\phi := 0.615$ — Reduction factor for timber connections, assuming standard duration of load and dry in-service moisture conditions, in accordance with [1]. $F_{2Rd} := min(\phi \cdot JoistResist, \phi \cdot HeaderResist, F_{2KCCrd}) = 19.316 \ kN$

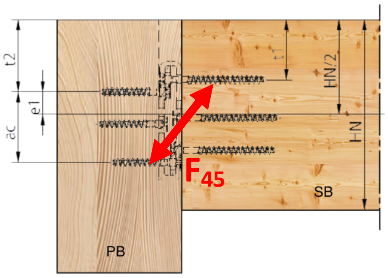
[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

GIGANT® 180/40 Design Example #3

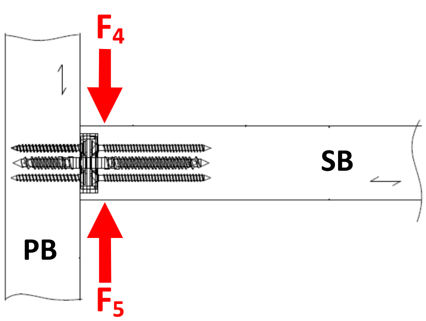
DESIGN EXAMPLE #3: Design of Joint subjected to a Lateral Shear Force (F_{45}) using KNAPP® GIGANT 180/40 Connector (without Reinforcing Uplift Clip Lock)

Design Assumptions and

Connection Geometry Check:



General Joint Geometry with Connector "Housed" in PB



Joint:

Rectangular glulam timber members (D.Fir) with a Secondary Beam (SB) to Primary Beam (PB) Connection.

Cross section dimensions to follow requirements for minimum cross section dimensions in accordance with [1] and [2].

Secondary Beam:

Use 80x228mm] **OK**

Primary Beam:

Use: 130x304[mm]* **OK**

Table 5—Minimum Cross Section Requirements[1]

Connector	Minimum Cross Section Requirements			
	PB Width [mm]		SB Width [mm]	SB Depth [mm]
	Face Mounted	"Housed" in PB		
GIGANT 120/40	80	130	60	152
GIGANT 150/40				190
GIGANT 180/40				228

Table 6—Design Factors[3]

Connector	Design Factors without reinforcing clip lock[3]				
	$F_{45,KCC,Rd}$ [kN]	n_{45} ** (min)	$K_{h,45}$ (min)	$a_{1,min}$ ** [mm]	$a_{2,max}$ ** [mm]
GIGANT 120/40	12.0	3	2.22	56	∞
GIGANT 150/40	16.0	4	2.22	91	422
GIGANT 180/40	20.0	6	3.46	140	882

** n_{45} = number of screws per connector plate ; a_1 and a_2 are design factors used to calculate the connector`s polar moment of inertia.

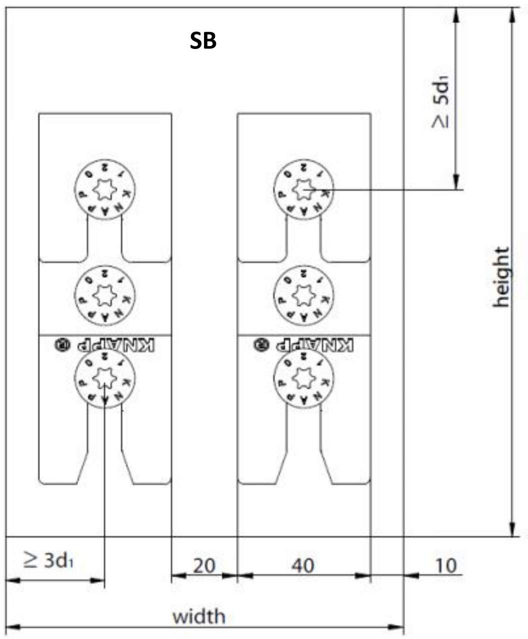
[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

DESIGN EXAMPLE #3: Design of Joint subjected to a Lateral Shear Force (F_{45}) using KNAPP® GIGANT 180/40 Connector (without Reinforcing Uplift Clip Lock)	
Relevant input values: *Unfactored shear resistance values as per design method for F2* *Assuming the F_{45} acts concentrically through the centre of gravity of connector*	"GIGANT 180/40 Calculation of F45" "____" "input information specific to F45" $n_{45} := 6$ $k_{h45} := 3.46$ $e_{J45} := 0$ mm $e_{H45} := 0$ mm $a_1 := 140\ mm$ "[3]" $a_2 := 882$ mm "[3]" $F_{axRHk} = 7.602$ kN $F_{vHRk} = 6.562$ kN $F_{vJRk} = 5.235$ kN "Calculation of Unfactored Resistances:" $JoistResist45 := \left(\frac{(F_{vJRk})}{\sqrt[2]{\left(\frac{1}{n_{45}} + \frac{e_{J45}}{a_1}\right)^2 + \left(\left(\frac{e_{J45}}{a_2}\right)^2\right)}} \right) = 31.408$ kN $HeaderResist45 := \frac{(F_{vHRk})}{\sqrt[2]{\left(\frac{1}{n_{45}} + \frac{e_{H45}}{a_1}\right)^2 + \left(\left(\frac{e_{H45}}{a_2}\right)^2\right) + \left(\left(\frac{(F_{vHRk})}{k_{h45} \cdot (F_{axRHk})}\right)^2\right)}} = 21.872$ kN
Calculation of Factored Lateral Shear Resistance F_{45} of the Joint:	"GIGANT 180/40 Calculation of F45" "Design Capacity:" $\phi := 0.615$ "Reduction factor for timber connections, assuming" "standard duratoin of load and dry in−service " "conditions, as per ETA Report[1]" $F_{45kccRd} := 20$ kN $F_{45Rd} := min\,(\phi \cdot JoistResist45, \phi \cdot HeaderResist45, F_{45kccRd}) = 13.451$ kN
Overall Connector Design Check: *(Final check for load interaction)*	**Example Loads:** F_1 force acting on joint = 5.0 kN F_2 force acting on joint = 12.5 kN F_{45} force acting on joint = 5.0 kN **Overall Capacity of Joint with 1 GIGANT 180/40 Connector:** $(F_{1,Rd} / F_1)$ = 5.0 / 9.05 = 0.552 < 1.0 (***ok***) $(F_{2,Rd} / F_2)$ = 12.5 / 19.31 = 0.647 < 1.0 (***ok***) $(F_{45,Rd} / F_{45})$ = 6.0 / 13.45 = 0.446 < 1.0 (***ok***) $(F_{1,Rd} / F_1)^2 + (F_{2,Rd} / F_2)^2 + (F_{45,Rd} / F_{45})^2$ = 0.305 + 0.419 + 0.199 = 0.923 < 1.0 (***ok***)

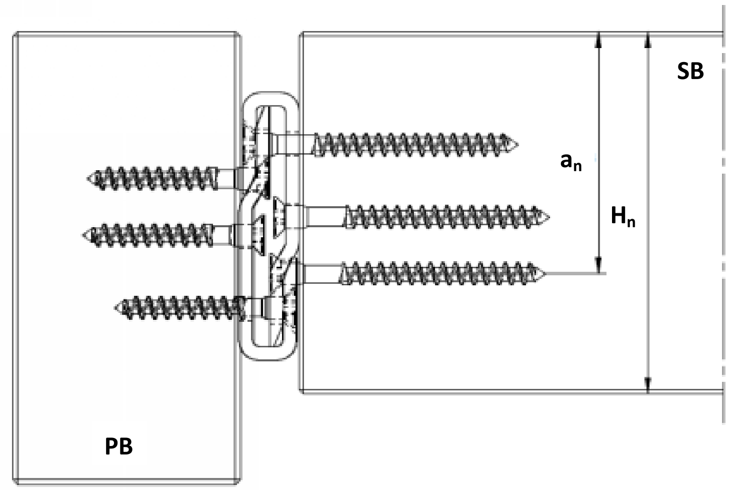
[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

ADDITIONAL MOUNTING OPTIONS FOR JOINTS USING GIGANT 180/40 CONNECTORS

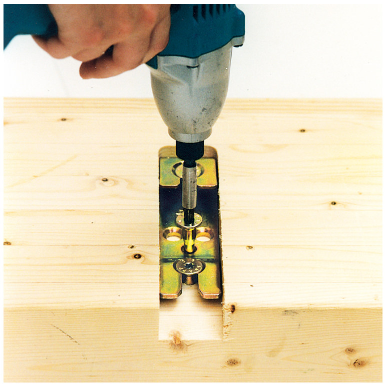
Double GIGANT Connection to Increase Shear Resistance in F2 direction

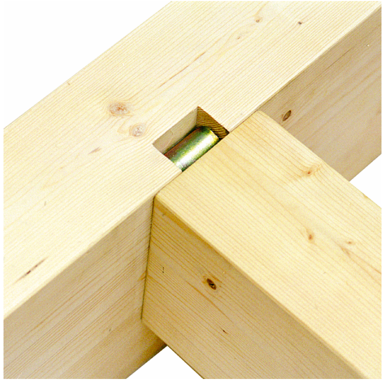


Joint with "Face Mounted" GIGANT Connector



Joint with "Housed" in GIGANT Connector in PB





[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

Find more resources for our modern timber connection systems, including technical design data, installation guides, CAD files, videos, research data and more white papers on our website

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