MyTiCon Timber Connectors

DESIGN EXAMPLE

MyTiCon Timber Connectors

PRE-ENGINEERED CONNECTOR SYSTEMS

RICON S VS concealed connectors offer a wide variety of advantages to designers and timber framers. As a system, RICON S VS (S60 & S80) connectors provide a universally applicable connector for wood-wood connections, as well as wood-steel and wood-concrete. They allow for simple screwing without pre-drilling, and due to their V-shaping, easy beam hanging is achievable. Additionally, as they are concealed within the timber joints, a fire rating is also attainable.

Even though, these connectors are very flexible and provide great advantages to designers, their correct design and sizing can seem to be a daunting task. The following design examples show the applicable design procedure in detail.

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 European Technical Approvals (ETA).

WOOD you like to **CONNECT?**

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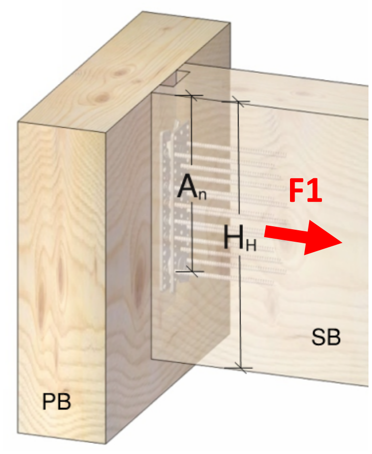
RICON® 140/60 S VS Design Example #1

DESIGN EXAMPLE #1: Design of Joint subjected to a Tensile Force (F_1) using KNAPP® RICON 140/60 S VS Connector (without Tension perpendicular to grain reinforcement)

Design Assumptions and

Connection Geometry Check:



General Joint Geometry

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 130x190[mm] **OK**

Primary Beam:

Min. depth of SB 160[mm]
Min. width of PB to be greater than full length of FT ASSY® screws driven into PB.
This example with 8x80[mm] screws in PB.
Use: 130x305[mm]* **OK**

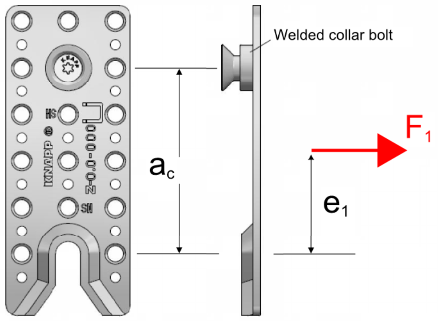
Table 1—Minimum Cross Section Requirements[1]

Connector	Minimum Cross Section Requirements		
	PB Width [mm]	SB Width [mm]	SB Depth [mm]
RICON 140/60 S VS	80	100	160
RICON 200/60 S VS	80	100	220
RICON 200/80 S VS	100	120	230
RICON 290/80 S VS	100	120	320

Table 2—Design Factors[3]

Connector	Design Factors	
	$F_{1,KCC,Rd}$ [kN]	a_c [mm]
RICON 140/60 S VS	9.0	60
RICON 200/60 S VS		120
RICON 200/80 S VS		120
RICON 290/80 S VS		210

* A 80x305[mm] glulam PB would also suit this example. The RICON S VS connector plate is 5mm thick, thus allowing for use of the 80mm PB width as an alternative.



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[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® RICON 140/60 S VS Connector (without Tension perpendicular to grain reinforcement)

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)

<u>Note</u>:

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 Clip Connectors"
"Design Capacities of Timber–to–Timber Connector Joints"
"——————————————————————————————————————"

"RICON S VS 140/60 "

F_{1Rd} "Load acting perpendicular to the connector plate"

"input data:"
"For: ASSY SWG 8x80 FT Screw"
$d := 8$ mm "outer thread diameter"

"thread length"
$l_{thread} := 72$ mm "effective penetration length"

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

"angle between grain direction and direction of the force"
$\alpha := 90$ deg

"effective number of screws"

$a_c := 60$ mm "spacing between tensile screws, Table 2"
$e_1 := 30$ mm "distance between load F1 and tensile screw considered"
"e1 is positive if it acts within ac, negative if outside"
$n_{ef} := \frac{2 \cdot a_c}{a_c - e_1} = 4$ "assume concentric loading acting at mid–point of ac"

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

$$F_{axRk} := \frac{0.52 \cdot \sqrt{d} \cdot l_{thread}^{\ 0.9} \cdot \rho_k^{\ 0.8}}{1.2 \cdot (\cos(\alpha))^2 + (\sin(\alpha))^2} \cdot \frac{1}{1000} = 8.526 \quad kN$$

$F_{tRd} := 15.12$ kN "Design Factored Tensile Resistance of screw; [2]"

$F_{1KCCRd} := 9.0$ kN "Design Factored Resistance of Knapp Clip Connector; [3]"

"RICON S VS 140/60 Calculation of F1 –Design Factored Tensile Resistance"

"Design Capacity:" "Reduction factor for timber connections, assuming"
$\phi := 0.615$ "standard duration of load and dry in–service "
"conditions, as per [1] and [3]"

$F_{1Rd} := min\left(\phi \cdot n_{ef} \cdot F_{axRk}, n_{ef} \cdot F_{tRd}, n_{ef}\ F_{1KCCRd}\right) = 20.973$ 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

RICON® 140/60 S VS Design Example #2

DESIGN EXAMPLE #2: Design of Joint subjected to a Vertical Shear Force (F_2) using KNAPP® RICON 140/60 S VS Connector (without Tension perpendicular to grain reinforcement)

Design Assumptions and

Connection Geometry Check:

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:

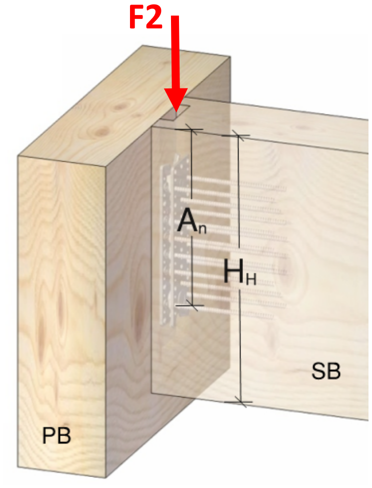
Use 130x190[mm] **OK**

Primary Beam:

Use: 130x305[mm]* **OK**

Table 3—Minimum Cross Section Requirements[1]

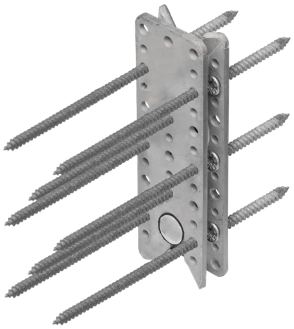
Connector	Minimum Cross Section Requirements		
	PB Width [mm]	SB Width [mm]	SB Depth [mm]
RICON 140/60 S VS	80	100	160
RICON 200/60 S VS	80	100	220
RICON 200/80 S VS	100	120	230
RICON 290/80 S VS	100	120	320



General Joint Geometry

Table 4—Design Factors[3]

Connector	Design Factors	
	$F_{2,KCC,Rd}$ [kN]	$K_{h,2}$ [mm]
RICON 140/60 S VS	60	10.7
RICON 200/60 S VS		27.8
RICON 200/80 S VS	99	27.8
RICON 290/80 S VS		68.4



* A 80x305[mm] glulam PB would also suit this example. The RICON S VS connector plate is 5mm thick, thus allowing for use of the 80mm PB width as an alternative.

Reinforcement check:

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

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

$\mathbf{w_{SB}}$ = 130[mm] *(min)* ; $\mathbf{w_{PB}}$ =130[mm] ;

$\mathbf{H_H}$=$\mathbf{H_{SB}}$ = 190[mm] *(min)* ;

$\mathbf{H_{PB}}$ = 305[mm] ;

$\mathbf{A_N}$ = 133[mm] (distance from top edge to centroid of bottom screw in SB)

Required location to ensure $A_n/H_H \geq 0.70 = 133 / 190 = 0.70$ ***ok***

(Locate centre of axis of bottom tensile screw in SB, 133mm 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® RICON 140/60 S VS Connector (without Tension perpendicular to grain reinforcement)

Relevant input information:

Note:

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

“input data:”

“For: ASSY VG CSK 8x80 Screw to be used in PB (header)”

“---”

$d := 8 \quad mm$ “outer thread diameter”

$l_{thread8x80} := 72 \quad mm$ “thread length”

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

“For: ASSY VG CSK 8x160 Screw to be used in SB (joist)”

“---”

$d := 8 \quad mm$ “outer thread diameter”

$l_{thread8x160} := 143 \quad mm$ “thread length”

$\rho_{joist} := 490 \cdot .84 = 411.6$

$n := 10$ “number of screws per connector plate”

“Calculation of effective number of fasteners:”

$n_{ef} := n^{0.9} = 7.943$ “Group Effect Factor”

“Unfactored Torsional Resistance[3] of fasteners:”

$M_{yrk} := 20000 \quad N \cdot mm$

Calculation of Unfactored Shear Resistance $F_{V,H,Rk}$ *of RICON 140/60 S VS 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 Lateral Load Resistance for PB (header):”

“---”

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

$$f_{hk} := \left(0.033 + 0.049 \cdot \frac{90}{90}\right) \cdot \rho_{header} \cdot d^{-0.3} = 18.087 \quad MPa$$

“Unfactored Withdrawal Resistance of ASSY Fastener into PB (header)”

$$F_{axRHk} := \frac{0.52 \cdot \sqrt{d} \cdot l_{thread8x80}^{\ 0.9} \cdot \rho_{header}^{\ 0.8}}{1.2 \cdot (\cos(\alpha_h))^2 + (\sin(\alpha_h))^2} = 8.526 \cdot 10^3 \quad N$$

“Unfactored Shear Resistance of RICON 140/60 S VS Connector in PB”
“in accordance with the design provisions outlined 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 Header:” $t1 := l_{thread8x80} = 72 \quad mm$

$$A_h := \left(f_{hk} \cdot t1 \cdot d \cdot \left(\left(\sqrt{2 + \frac{4 \cdot M_{yrk}}{f_{hk} \cdot d \cdot t1^2}} - 1\right)\right)\right) = 4.703 \cdot 10^3 \quad N$$

$$A := \frac{F_{axRHk}}{4} = 2.131 \cdot 10^3 \qquad A_{hk} := A_h + (A) = 6.834 \cdot 10^3$$

[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® RICON 140/60 S VS Connector (without Tension perpendicular to grain reinforcement)

Calculation of Unfactored Shear Resistance ***$F_{V,H,Rk}$*** *of RICON 140/60 S VS Connector into PB (Header)* *(cont'd)*	$B_h := \left(2.3 \cdot \left(\sqrt{M_{yrk} \cdot f_{hk} \cdot d}\right)\right) = 3.913 \cdot 10^3 \quad N$ $B := \frac{F_{axRHk}}{4} = 2.131 \cdot 10^3 \qquad B_{hk} := B_h + (B) = 6.044 \cdot 10^3$ $C_{hk} := f_{hk} \cdot t1 \cdot d = 1.042 \cdot 10^4 \quad N$ $F_{vHRk} := min\left(A_{hk}, B_{hk}, C_{hk}\right) = 6.044 \cdot 10^3 \, N$
Calculation of Unfactored Shear Resistance ***$F_{V,J,Rk}$*** *of RICON 140/60 S VS 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 Lateral Load Resistance for SB (joist):" "——————————————————————————————————— "Unfactored Embedment Strength of timber" $\alpha_j := 0 \cdot \frac{\pi}{180} = 0$ $f_{Jk} := \left(0.033 + 0.049 \cdot \frac{0}{90}\right) \cdot \rho_{joist} \cdot d^{-0.3} = 7.279 \quad MPa$ "Unfactored Withdrawal Resistance of ASSY Fastener into SB (joist)" $F_{axRk} := \frac{0.52 \cdot \sqrt{d} \cdot l_{thread8x160}{}^{0.9} \cdot \rho_{joist}{}^{0.8}}{1.2 \cdot \left(\cos\left(\alpha_j\right)\right)^2 + \left(\sin\left(\alpha_j\right)\right)^2} = 1.317 \cdot 10^4 \quad N$ "Unfactored Shear Resistance of RICON 140/60 S VS Connector in SB" "in accordance with the design provisions outlined 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 Joist:" $t2 := l_{thread8x160} = 143 \quad mm$ $A_j := \left(f_{Jk} \cdot t2 \cdot d \cdot \left(\left(\sqrt{2 + \frac{4 \cdot M_{yrk}}{f_{Jk} \cdot d \cdot t2^2}} - 1\right)\right)\right) = 3.645 \cdot 10^3 \quad N$ $A := \frac{F_{axRk}}{4} = 3.294 \cdot 10^3 \qquad A_{jk} := A_j + (A) = 6.939 \cdot 10^3$ $B_j := \left(2.3 \cdot \left(\sqrt{M_{yrk} \cdot f_{Jk} \cdot d}\right)\right) = 2.482 \cdot 10^3 \quad N$ $B := \frac{F_{axRk}}{4} = 3.294 \cdot 10^3 \qquad B_{jk} := B_j + B = 5.776 \cdot 10^3$ $C_{jk} := f_{Jk} \cdot t2 \cdot d = 8.327 \cdot 10^3 \quad N$ $F_{vJRk} := min\left(A_{jk}, B_{jk}, C_{jk}\right) = 5.776 \cdot 10^3 \quad N$

[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® RICON 140/60 S VS Connector (without Tension perpendicular to grain reinforcement)

Calculation of Factored Shear Resistance $F_{2,Rd}$ *of the Joint*

"Design Factors for RICON 140/60 S VS:"

$k_{h2} := 10.7$ "(For RICON S VS Connectors with welded collar bolt)"

$F_{2KCCrd} := 60 \ kN$

"Summary of calculated Unfactored Resistances:"

$$F_{axRHk} := \frac{F_{axRHk}}{1000} = 8.526 \ kN \qquad F_{vHRk} := \frac{F_{vHRk}}{1000} = 6.044 \ kN \qquad F_{vJRk} := \frac{F_{vJRk}}{1000} = 5.776 \ kN$$

"Unfactored Shear Resistances:"

$$JoistResist := \left(n_{ef}\right) \cdot F_{vJRk} = 45.879 \quad kN$$

$$HeaderResist := \frac{1}{\sqrt[2]{\left(\left(\frac{1}{\left(n_{ef}\right) \cdot F_{vHRk}}\right)^2\right) + \left(\left(\frac{1}{k_{h2} \cdot F_{axRHk}}\right)^2\right)}} = 42.485 \quad kN$$

"RICON S VS 140/60 Calculation of F2"

"Design Capacity:"

$\phi := 0.615$

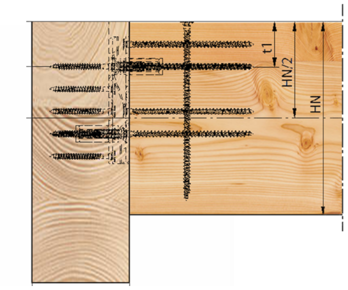
"Reduction factor for timber connections, assuming"
"standard duration of load and dry in−service "
"conditions, in accordance with [1]"

$$F_{2Rd} := min\left(\phi \cdot JoistResist, \phi \cdot HeaderResist, F_{2KCCrd}\right) = 26.128 \quad kN$$

[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

RICON® 140/60 S VS Design Example #3

DESIGN EXAMPLE #3: Design of radial tension (perpendicular to grain) reinforcement for joint using KNAPP® RICON 140/60 S VS Connector

Design Assumptions:	Rectangular *glue-laminated* timber members (D.Fir) with a typical SB to PB connection. For RICON 140/60 S VS : Min SB dimensions: 100 x 160mm Min. PB width : 80mm
Connection Geometry: **w_{SB}** = 130mm ; **w_{PB}** =130mm ; **H_H=H_{SB}** = 190mm ; **H_{PB}** = 305mm ; **A_N** = 114mm (min) *$A_n/H_J \geq 0.70$ (required) —> 114 / 190 = 0.60* ***NOT OK*** *Radial tension reinforcement with ASSY Full Thread screw is required.*	"input data:" "For: ASSY VG CSK 8x80 Screw to be used in Principal Beam (Header)" "____" $d := 8$ mm "outer thread diameter" $l_{thread8x80} := 72$ mm "thread length" $\rho_{header} := 490 \cdot .84 = 411.6$ $\frac{kg}{m^3}$ "Relative Density Adjustment" "For: ASSY VG CSK 8x160 Screw to be used in Secondary Beam (Joist)" "____" $d := 8$ mm "outer thread diameter" $l_{thread8x160} := 143$ mm "thread length" $\rho_{joist} := 490 \cdot .84 = 411.6$ "Relative Density adjustment" $n := 10$ "number of screws per connector plate" "Joint Geometry:" "Location from top of secondary beam to outer tensile screw" $An := 114$ mm "SB Height:" $Hh := 190$ mm "SB Width:" $b_{SB} := 120$ mm $Ratio := \frac{An}{Hh} = 0.6$ "<0.70 Tensione Perp. to Grain" "Reinforcement is required" "Shear Force on Joint, F2:" $F2 := 15$ kN  "Following Eurocode 5–1995–1.1 Provisions:" "Use 2– ASSY VG CYL 8x180" $d_{reinf} := 8$ $ScrewLength := 180$ $\alpha := Ratio = 0.6$ $l_{eff} := ScrewLength - An - d_{reinf} = 58$ mm "Tensile Force to be transmitted by the reinforcing ASSY CYL VG screw:" $V := F2 = 15$ kN "[EC5, Eqn. 8.30], where:" $\alpha = 0.6$ $k_\alpha := 1.3 \cdot \left(3 \cdot (1-\alpha)^2 - 2 \cdot (1-\alpha)^3\right) = 0.458$ $F_{axED} := k_\alpha \cdot V = 6.864$ kN "as per CCMC Report 13677:" $P_{rw} := \frac{1.60}{20} \cdot l_{eff} = 4.64$ kN "per screw" $F_{tn} := 15.2$ kN "Factored Tensile Resistance of screw" $W := min\left(P_{rw}, F_{tn}\right) = 4.64$ kN $n_{screws} := \left(\sqrt{\frac{F_{axED}}{P_{rw}}}\right)^{0.9} = 1.193$ "2 ASSY VG CYL 8x180 OK"

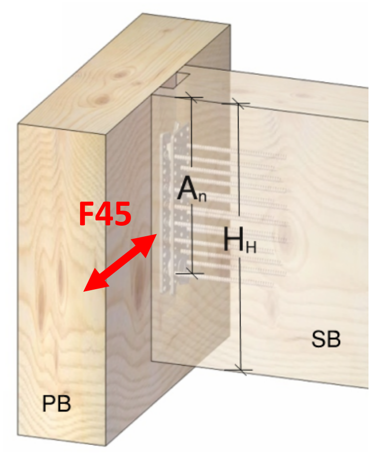
[1] EN 1995-1-1:2004, Eurocode 5: Design of Timber Structures Part 1-1 ; [2] CCMC Report 13677-R SWG ASSY® Fasteners Code Approval - Canada ; [3] ETA Report 10/0189

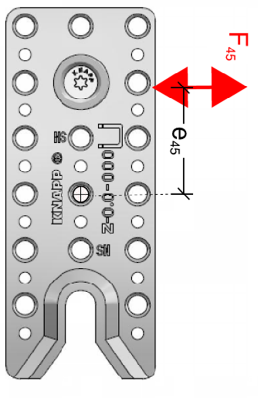
RICON® 140/60 S VS Design Example #4

DESIGN EXAMPLE #4: Design of Joint subjected to a Lateral Shear Force (F_{45}) using KNAPP® RICON 140/60 S VS Connector (without Tension perpendicular to grain reinforcement)

Design Assumptions and

Connection Geometry Check:





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 130x190[mm] **OK**

Primary Beam:

Use: 130x305[mm]* **OK**

Table 5—Minimum Cross Section Requirements[1]

Connector	Minimum Cross Section Requirements	
	Width [mm]	Depth [mm]
RICON 140/60 S VS	100	160
RICON 200/60 S VS	100	220
RICON 200/80 S VS	120	230
RICON 290/80 S VS	120	320

Table 6—Design Factors[3]

Connector	Design Factors [3]								
	$F_{45,KCC,Rd}$ [kN]	n_{45}** (min)	$K_{h,45}$ ** (min)	$a_{1,min}$ ** [mm]	$a_{2,min}$ ** [mm]	n_{45}** (max)	$K_{h,45}$ ** (max)	$a_{1,max}$ ** [mm]	$a_{2,max}$ ** [mm]
RICON 140/60 S VS	34	7	5.9	247	529	10	8.25	313	683
RICON 200/60 S VS	34	8	6.48	318	868	16	13.0	590	2061
RICON 200/80 S VS	50	8	8.67	360	720	16	17.3	665	1678
RICON 290/80 S VS	50	8	9.52	566	1980	25	26.8	1284	5189

* A 80x305[mm] glulam PB would also suit this example. The RICON S VS connector plate is 5mm thick, thus allowing for use of the 80mm PB width as an alternative.

** n_{45} = number of screws per connector plate ; $k_{h,45}$ varies with the selected number of screws[3]; 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 #4: Design of Joint subjected to a Lateral Shear Force (F_{45}) using KNAPP® RICON 140/60 S VS Connector (without Tension perpendicular to grain reinforcement)

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*	“RICON S VS 140/60 Calculation of F45” “-- “input information specific to F45” $n_{45} := 10$ $k_{h45} := 8.25$ $e_{J45} := 0$ mm $e_{H45} := 0$ mm $a_1 := 313\,mm$ “[3]” $a_2 := 683\,mm$ “[3]” $F_{axRHk} = 8.526$ kN $F_{vHRk} = 6.044$ kN $F_{vJRk} = 5.776$ kN “Calculation of Unfactored Resistances:” $JoistResist45 := \left(\dfrac{(F_{vJRk})}{\sqrt[2]{\left(\dfrac{1}{n_{45}} + \dfrac{e_{J45}}{a_1} \right)^2 + \left(\left(\dfrac{e_{J45}}{a_2} \right)^2 \right)}} \right) = 57.758$ kN $HeaderResist45 := \dfrac{(F_{vHRk})}{\sqrt[2]{\left(\dfrac{1}{n_{45}} + \dfrac{e_{H45}}{a_1} \right)^2 + \left(\left(\dfrac{e_{H45}}{a_2} \right)^2 \right) + \left(\left(\dfrac{(F_{vHRk})}{k_{h45} \cdot (F_{axRHk})} \right)^2 \right)}} = 45.841$ kN
Calculation of Factored Lateral Shear Resistance F_{45} of the Joint:	“RICON S VS 140/60 Calculation of F2” “Design Capacity:” $\phi := 0.615$ “Reduction factor for timber connections, assuming” “standard duration of load and dry in−service ” “conditions, in accordance with [1]” $F_{2Rd} := min\,(\phi \cdot JoistResist, \phi \cdot HeaderResist, F_{2KCCrd}) = 26.128$ kN
Overall Connector Design Check: *(Final check for load interaction)*	**Example Loads:** F_1 force acting on joint = 5 kN F_2 force acting on joint = 15 kN F_{45} force acting on joint = 10 kN **Overall Capacity of Joint with 1 RICON 140/60 S VS Connector:** $(F_{1,Rd} / F_1)$ = 10 / 20.97 = 0.477 < 1.0 (***ok***) $(F_{2,Rd} / F_2)$ = 15 / 26.13 = 0.574 < 1.0 (***ok***) $(F_{2,Rd} / F_2)$ = 15 / 28.19 = 0.532 < 1.0 (***ok***) $(F_{1,Rd} / F_1)^2 + (F_{2,Rd} / F_2)^2 + (F_{45,Rd} / F_{45})^2$ = 0.228 + 0.330 + 0.283 = 0.841 < 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

RICON® 140/60 S VS Design Example #5

DESIGN EXAMPLE #5: Design of Joint resisting uplift forces using 2-ASSY FT screws

Design Assumptions and Connection Geometry Check:

* The angle to grain relationship must be checked in SB and PB. In this example the equivalent thread embedment in SB and PB was selected resulting in a controlling withdrawal resistance within the SB. This is due to the angle to grain relationship defined in the respective CCMC report. The angle is measured between the direction of the wood grain and the fastener axis. In this example this is:

α = 45° in SB and α = 90° in PB

"Design Example of Uplift Toe Screw"
"according to CCMC Report 13677–R Product Code Approval"

"Input Data:"

$\varphi := 0.90$ "Resistance Factor"

$\rho := 490 \ \frac{kg}{m^3}$ "D.Fir Glulam Mean Oven–Dry Rel. Density (CSAO86, Table A.10.1)"

$\delta := \mathbf{if}(\rho < 440, 85, 80) = 80$

$angle := 45$* "Angle of Screw Axis to Member Grain Orientation"

$K_D := 1.0$ "Standard Duration of Load Factor"

$K_{SF} := 1.0$ "In–Service conditions Factor"

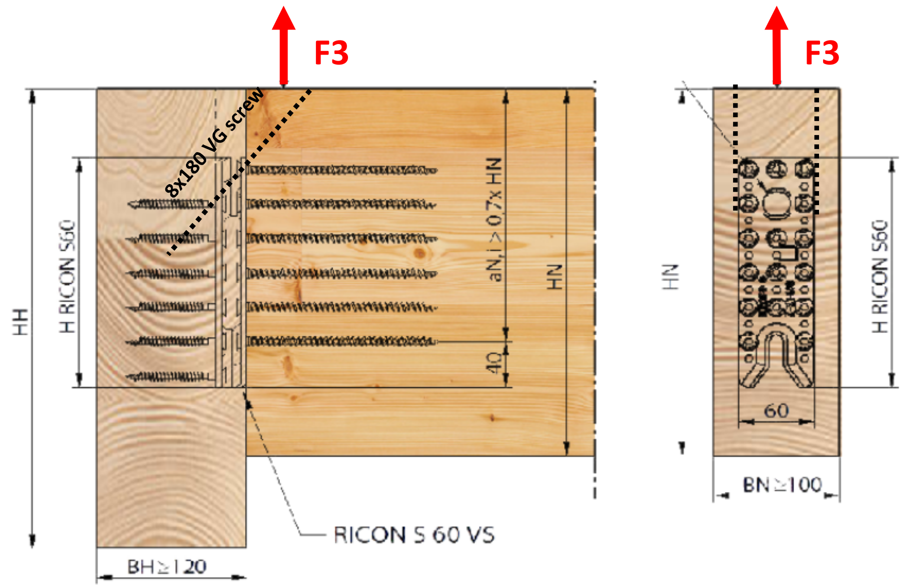
$d := 8 \ mm$ "Screw Diameter"

$l_{tot} := 180 \ mm$ "Screw total length"

$l_{ef} := 165 \ mm$ "Screw effective thread length (Length – Tip)"

"Assuming half of effective thread length will be embedded in each of the members:"

$$p := \frac{l_{ef}}{2} = 82.5 \ mm$$



[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 #5: Design of Joint resisting uplift forces using 2-ASSY FT screws

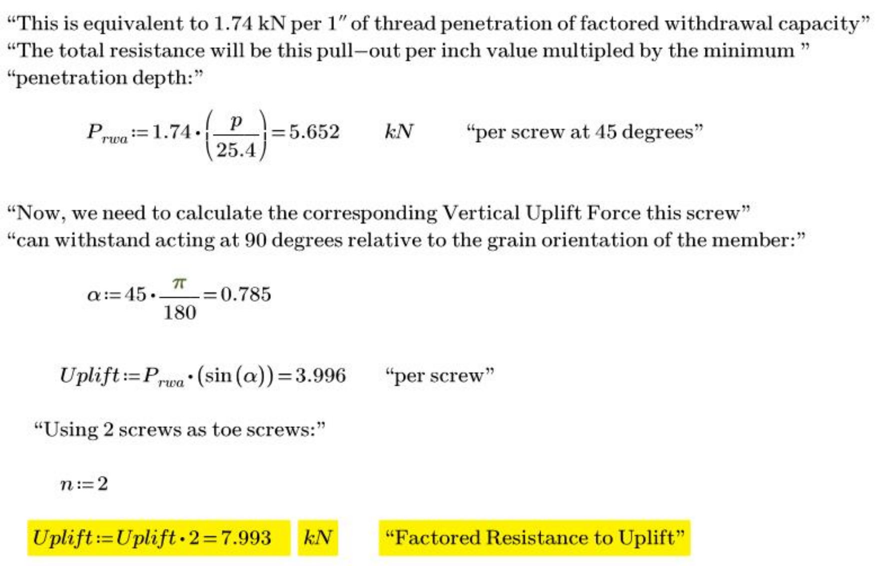
Design of toe screw withdrawal resistance

The withdrawal resistance in this example (1.74kN/1”) is controlled within the SB and the screw in angle α = 45°

Nominal Diameter	Factored Withdrawal Resistance Values (P’rw) see notes *[kN per 25.4mm thread penetration] (kN/1”)*						
	Relative Density Values :						
	0.35	**0.42**	**0.44**	**0.46**	**0.49**	**0.5 PSL**	**0.55**
				α = 90°			
6mm	0.81	1.16	1.24	1.35	1.53	0.89	1.92
8mm	1.08	1.55	1.64	1.80	**2.04**	1.20	2.57
10mm	1.35	1.94	2.05	2.24	2.54	1.49	3.21
12mm	1.62	2.33	2.47	2.70	3.05	1.80	3.84
				α = 45°			
6mm	0.69	1.00	1.06	1.16	1.31	0.77	1.66
8mm	0.93	1.33	1.41	1.54	**1.74**	1.02	2.20
10mm	1.20	1.67	1.76	1.92	2.18	1.27	2.75
12mm	1.39	2.00	2.11	2.30	2.62	1.54	3.29
				α = 30°			
6mm	0.65	0.93	0.98	1.08	1.22	0.72	1.54
8mm	0.87	1.25	1.31	1.44	1.63	0.96	2.05
10mm	1.08	1.55	1.64	1.80	2.04	1.20	2.57
12mm	1.30	1.86	1.97	2.15	2.44	1.43	3.08

Notes: α = relative angle between screw axis to grain direction in timber member. Withdrawal values listed are in accordance with CCMC Report CCMC 13677-R and are only applicable to SWG ASSY® Engineered Structural Screws. The designer must verify that the factored withdrawal resistance does not exceed the factored tensile resistance. The designer must verify the actual thread embedment length of the screw. The effective thread embedment depth is the thread length—tip length (=d). For conditions other than K_D=1, K_{SF}=1 the designers must apply adjustment factors to values in the table above. Minimum effective thread penetration L_{ef} into main member required L_{ef}=4d (d=outside thread diameter).

Factored Withdrawal Resistances calculated by: $P_{rw} = P'_{rw} \cdot L_{ef} \cdot n_F \cdot K' \cdot J_E$



“This is equivalent to 1.74 kN per 1″ of thread penetration of factored withdrawal capacity”
“The total resistance will be this pull–out per inch value multipled by the minimum ”
“penetration depth:”

$$P_{rwa} := 1.74 \cdot \left(\frac{p}{25.4}\right) = 5.652 \quad kN \quad \text{“per screw at 45 degrees”}$$

“Now, we need to calculate the corresponding Vertical Uplift Force this screw”
“can withstand acting at 90 degrees relative to the grain orientation of the member:”

$$\alpha := 45 \cdot \frac{\pi}{180} = 0.785$$

$$Uplift := P_{rwa} \cdot (\sin(\alpha)) = 3.996 \quad \text{“per screw”}$$

“Using 2 screws as toe screws:”

$$n := 2$$

$$Uplift := Uplift \cdot 2 = 7.993 \quad kN \quad \text{“Factored Resistance to Uplift”}$$

[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