

# BMTRADA

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## European Technical Assessment

**ETA 07/0317**  
of 18/10/2014

### I General Part

<b>Trade Name</b>	Simpson Strong-Tie Miscellaneous Brackets Three Dimensional nailing Plates (Truss Connector)
<b>Product Family to which the Construction Product Belongs</b>	EC PAC 13
<b>Manufacturer</b>	Simpson Strong-Tie Winchester Road Cardinal Point Tamworth Staffordshire B78 3HG
<b>Manufacturing Plant</b>	Simpson Strong-Tie Winchester Road Cardinal Point Tamworth Staffordshire B78 3HG
<b>This European Technical Assessment Contains</b>	44 pages including 5 Annexes which form an integral part of this assessment.
<b>This European Technical Assessment is issued in accordance with Regulation (EU) No. 305/2011, on the basis of</b>	ETAG 015, Edition November 2012, used as European Assessment Document (EAD)

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## II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL ASSESSMENT

### 1 Technical Description of Product and Intended Use

#### 1.1 Technical Description of the Product

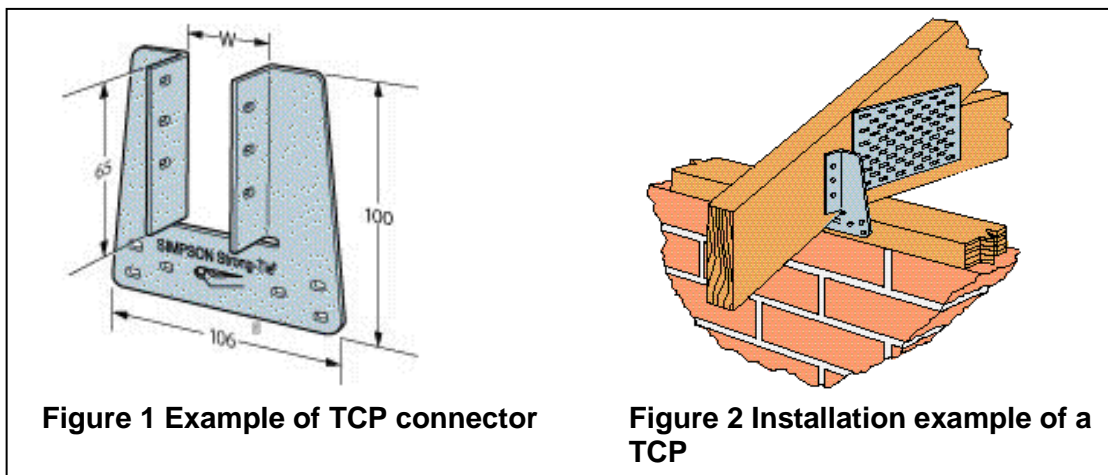
Simpson Strong-Tie connector types TCP, TBE, TC, PFP48/2760, PFP, PFA, PCAB46/2, 2748, 2750-2765, 7620-4, 13001-5, 13014-15, 23100/23120, MJC, GS and VTCR are one-piece, non-welded connectors. Connector types 23080 and 24080 are welded connectors.

The Miscellaneous Brackets product range is used to connect girders, trusses or rafters to wall plates or ridge boards. The Glide Shoe Connector is designed to support a raised tie truss, where the timber continues beyond the connector.

The VTCR (Valley Truss Clip) is a single sided connector that provides a positive connection between the valley truss and the common truss below. It eliminates the need to add a support wedge under the valley truss or to bevel the bottom chord to match the roof pitch.

ZYKLOP connectors are inclined screw connectors provided in a combination of steel plates and screws.

Typical connector and installation is shown below in Figure 1 and Figure 2.



The Miscellaneous Brackets and fasteners are made from zinc-coated steel or stainless steel and are available in various sizes. Annex 2 contains the Miscellaneous Brackets' full range description.

The connectors are fixed using a range of fasteners including smooth shank nails, square twist nails, annular ring shank nails, connector screws or bolts. A list of the fasteners' types to be used with SST's Miscellaneous Brackets connectors is given in Annex 2.

The wood members to be supported with Miscellaneous Brackets can be of solid timber, glued laminated timber and similar glued members, or wood-based engineered members with a characteristic density from 290 kg/m<sup>3</sup> to 420 kg/m<sup>3</sup>. This requirement can be fulfilled using the following materials:

Table 1 Range of Timber Materials used with the Miscellaneous Brackets

<b>Timber Grade/Type</b>	<b>Standard</b>
Solid timber classified to C14-C40	EN 338 / EN 14081
Glued members of timber classified to C14-C40	EN 338 / EN 14081 when structural adhesives are used
Glued Laminated Timber	EN 1194 / EN14080
Laminated Veneer Lumber, LVL	EN 14374
Oriented Strand Board	EN 300
Cross Laminated Timber, CLT	prEN 16351

The provisions made in this ETA are based on an assumed intended working life for the Miscellaneous Brackets of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be used as a means for selecting the appropriate product in relation to the expected economically reasonable working life of the works.

## **2 Specification of the Intended Use in Accordance with the Applicable EAD**

Simpson Strong-Tie Miscellaneous Brackets are primarily for use in timber structures subject to dry, internal conditions defined by service classes 1 and 2 of Eurocode 5. Connectors and fasteners manufactured from stainless steel can also be used in Service Class 3 as defined in Eurocode 5.

## **3 Performance of the Product and References to the Methods Used for its Assessment**

<b>BWR</b>	<b>ETAG Clause No.</b>	<b>Characteristic</b>	<b>Assessment of Characteristic</b>
<b>1</b>	<b>4.1</b>	<b>Mechanical Resistance and Stability</b>	<b>See ETA Section 4.1</b>
<b>2</b>	<b>4.2</b>	<b>Safety in Case of Fire</b>	<b>See ETA Section 4.2</b>
	4.2.1	Reaction to Fire	See ETA Section 4.2.1
	4.2.2	Resistance to Fire	See ETA Section 4.2.2
<b>3</b>	<b>4.3</b>	<b>Hygiene, Health &amp; the Environment</b>	<b>See ETA Section 4.3</b>
	4.3.3	Release of dangerous substances	See ETA Section 4.3.1
<b>4</b>	<b>4.4</b>	<b>Safety and Accessibility in Use</b>	<b>See ETA Section 4.4</b>
<b>5</b>	<b>4.5</b>	<b>Protection against Noise</b>	<b>See ETA Section 4.5</b>
<b>6</b>	<b>4.6</b>	<b>Energy Economy &amp; Heat Retention</b>	<b>See ETA Section 4.2</b>
	4.6.1	Thermal Resistance	See ETA Section 4.6.1
<b>7</b>	-	<b>Sustainable Use of Natural Resources</b>	Not Relevant
-	-	<b>General Aspects Related to the Performance of the Product</b>	<b>See ETA Section 4.7</b>

## **4 Methods of Verification**

### **4.1 Mechanical Resistance and Stability**

The characteristic load-carrying capacities of the products shall be calculated in accordance with the manufacturer's design code, extracts of which are given in Annex 3.

The design methods (see Annex 3) have been derived in accordance with ETAG 015 and Eurocode 5.

The characteristic capacities have been determined by test for the MJC, GS and VTCR connectors in accordance with EOTA TR016, and by calculation assisted by testing for the ZYKLOP as described in the ETAG 015.

The declared values should be used for designs in accordance with Eurocode 5 only. Wane under flaps of the connectors is allowed provided it does not occur under the nails.

The connectors shall be used with the fasteners specified in Annex 2.

No performance has been determined in relation to the joint's stiffness properties — to be used for the analysis of the serviceability limit state.

No performance has been determined in relation to ductility of a joint under cyclic testing. The contribution to the performance of structures in seismic zones, therefore, has not been assessed.

### **4.2 Safety in case of Fire**

#### **4.2.1 Reaction to Fire**

The Miscellaneous Brackets and associated fasteners are classified as non-combustible and meet the requirements of class A1 according to EN 13501-1-2002 and EC Decision 96/603/EC, amended by EC Decision 2000/605/EC.

#### **4.2.2 Resistance to Fire**

Performance in relation to fire resistance would be determined for the complete structural element with any associated finishes, therefore there is no performance determined to this Essential Requirement.

### **4.3 Hygiene, Health and the Environment**

#### **4.3.1 Release of Dangerous Substances**

Based on the declaration of the manufacturer, the Miscellaneous Brackets and associated Fasteners do not contain harmful or dangerous substances as defined in the EU database

**Note:**

In addition to the specific clauses relating to dangerous substances contained in this European Technical Approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

### **4.4 Safety and Accessibility in Use**

Not Relevant

## 4.5 Protection against Noise

Not Relevant

## 4.6 Energy Economy and Heat Retention

### 4.6.1 Thermal Resistance

No performance determined.

## 4.7 Sustainable Use of Natural Resources

### 4.7.1 General Aspects Related to the Performance of the Product

#### 4.7.1.1 Manufacturing

Simpson Strong-Tie Miscellaneous Brackets detailed in this ETA, section **Error! Reference source not found.** are manufactured in accordance with the provisions of this European Technical Approval using the manufacturing processes as identified in the inspection of the plant by BM TRADA Certification and laid down in the technical documentation.

#### 4.7.1.2 Installation – Joints

A miscellaneous bracket (three-dimensional nailing plate) is deemed fit for its intended use provided:

- The connector capacity is calculated using the design methods described in Annex 3.
- The joints are designed in accordance with Eurocode 5 and ETAG 015 (clauses 5.1.0 and 7.3 of ETAG 015).
- The nailing pattern used shall be either the maximum or the minimum pattern as defined in Annex 2.
- Wane under flaps of the connectors is allowed provided it does not occur under the nails. Wane can reduce the load-bearing capacity of the connection.
- The execution of the connection shall be in accordance with the approval holder's technical literature.

#### 4.7.1.3 Durability, Serviceability & Identification

- **Durability**

The hangers have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species (including timbers preserved with organic solvent, boron diffusion and related preservatives) described in Eurocode 5 and subject to the dry, internal conditions defined by service classes 1 and 2.

On the basis of the established history, the connectors' coating complies with Eurocode 5, Table 4.1. The galvanised connectors within the scope of this ETA are considered appropriate for service class 1 and 2 situations with an intended design life of 50 years.

On the basis of established history of stainless steel in service class 3 and its compliance with EN 1995-1-1, stainless steel is considered appropriate for service class 3 situations with an intended design life of 50 years.

Connectors within the scope of this application for use in service class 3 are manufactured from stainless steel and are therefore considered suitable for this application.

From the coating specifications submitted by the manufacturer, the miscellaneous brackets are suitable for use within a corrosivity category C1 or C2 as defined by Table 1 of EN ISO 12944-2.

- **Serviceability**

Not relevant.

- **Identification**

Each Miscellaneous Bracket (connector) bears the manufacturer's identification mark and the product type. The CE marking appears on the packaging.

#### 4.7.1.4 Packaging, Transport and Storage

The Miscellaneous Brackets are packed in boxes bearing the manufacturer's name, product type, dimensions, quantity, date of fabrication and batch reference details.

In relation to transportation and storage, the connectors should be treated as conventional metallic building products.

#### 4.7.1.5 Use, Maintenance and Repair

The assessment of the fitness for use is based on the assumption that maintenance is not required during the assumed intended working life.

Should repair prove necessary, it is normal for the connectors to be replaced.

## 5 Assessment & Verification of Constancy of Performance

### 5.1 AVCP System

According to Decision 1997/638/EC of the European Commission<sup>1</sup>, the System(s) of Assessment and Verification of Constancy of Performance (see Annex V of Regulation (EU) No. 305/2011) given in Table 3 applies.

**Table 3:** System of Assessment and Verification of Constancy of Performance

Product	Intended Use	AVCP System
Three-dimensional nailing plates (with fasteners specified)	In Structural Timber Products	2+

The System of Attestation and Verification of Constancy of Performance referred to above is defined as follows.

System 2+: Certification of the Conformity of Factory Production Control by a Notified Certification Body on the basis of:

a) **Tasks for the Manufacturer**

- (1) Initial Type Testing of the product
- (2) Factory Production Control
- (2) Further testing of samples taken from the factory in accordance with a prescribed test plan.

b) **Tasks for the Notified Body**

- (3) Initial inspection of Factory and of Factory Production Control
- (4) Continuous surveillance, assessment and approval of factory production control

**Note:** In addition to the above, the manufacturer shall make a Declaration of Performance (DoP) of the product.

<sup>1</sup> Official Journal of the European Communities

## **6 Technical Details necessary for the Implementation of the AVCP System, as foreseen in the applicable EAD**

### **6.1 Tasks for the Manufacturer**

#### **6.1.1 Initial Type Testing of the Product**

Initial type testing has been undertaken under the responsibility of the Manufacturer to verify that the production line in question is able to manufacture products in conformity with this ETA.

The characteristics values have been determined by calculation, by calculation supported by testing or purely by testing, as appropriate to the product type. The test programme included testing of Angle Brackets, Tee-joints and column bases.

Whenever a change occurs in materials or production process which would significantly change the product characteristics, the tests and/or assessments shall be repeated for the appropriate characteristics. In such cases the necessary type testing has to be agreed between BM TRADA and the Notified Body.

#### **6.1.2 Factory Production Control (FPC)**

The manufacturer has a Factory Production Control system (FPC) and exercises permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer are documented in a systematic manner in the form of policies, procedures and work instructions. This FPC system ensures that the product is in conformity with this European Technical Assessment.

The manufacturer shall only use raw materials or components that are supplied with the relevant inspection documents as laid down in the Test Plan<sup>2</sup>. All incoming raw materials shall be subject to inspection, verification, controls and tests (as applicable) by the manufacturer.

The results of FPC are recorded and evaluated. These records include but are not limited to:

- Product specification and designation, basic materials and components
- Type(s) of Control testing
- Date of manufacture of the product and date of testing of the product or basic material and components;
- Result of control and testing and, if appropriate, comparison with requirements;
- Signature of the person responsible for FPC

These records shall be presented to BM TRADA upon request.

#### **6.1.3 Further Testing of Samples**

The manufactured components are checked visually and for dimensions. The frequency of controls and tests conducted during production and on the finished connector is laid down in the prescribed Test Plan.

The Test Plan which is part of the technical documentation of this European Technical Assessment includes details of the extent, nature and frequency of testing and controls to be performed within the FPC system and has been agreed between the approval holder and BM TRADA. Any changes to the FPC or the product shall only be made following approval by BM TRADA.

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<sup>2</sup> The Test Plan has been deposited at BM TRADA and is only made available to the Approved Bodies involved in the AVCP procedure.



## **6.2 Tasks of Notified Bodies**

### **6.2.1 Initial Inspection of Factory and of Factory Production Control**

An assessment of each production unit shall be carried out by the Notified Body to demonstrate that the factory production control is in conformity with the ETA and any subsidiary information. This assessment shall be based on an initial inspection of the factory. Subsequently continuous surveillance of factory production control, including verification that tests are being carried out in accordance with the prescribed test plan, is necessary to ensure continuing conformity with the ETA.

### **6.2.2 Continuous Surveillance**

The Notified Body shall visit the each Production Unit / Factory twice a year for regular inspection. It shall be verified that the system of factory production control and the specified manufacturing process is maintained in accordance with this European Technical Assessment and the Test Plan.

Continuous surveillance and assessment of factory production control shall be performed according to the Test Plan.

The results of product certification and continuous surveillance shall be made available on demand by the certification body or inspection body, respectively, to BM TRADA. In cases where the provisions of this European Technical Assessment and the prescribed test plan are no longer fulfilled, the conformity certificate shall be withdrawn.

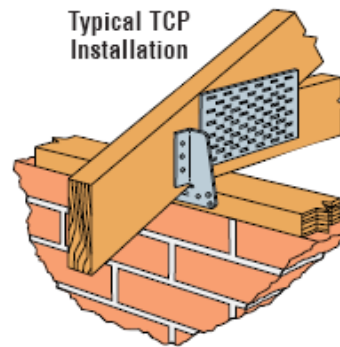
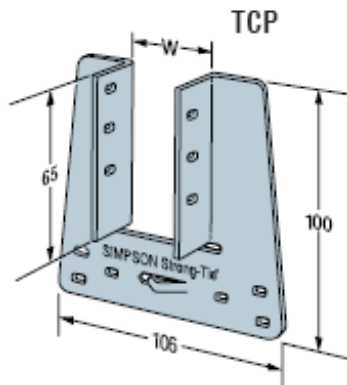
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Niresh D Somlie  
Senior Technical Officer

## 7 Annex 1: Product Details and Specification

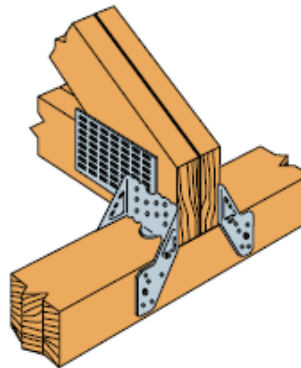
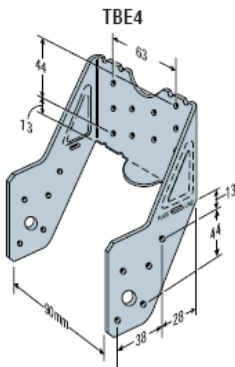
### A 1.1: TCP Truss Clip



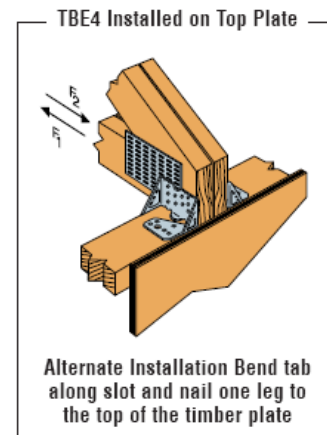
**Table 2: Specifications of TCP Truss Clip**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)
			W
TCP 38	0.9	Pre galvanised. DX51D+Z275 to EN 10327-2004	38
TCP 44			44
TCP 50			50

### A 1.2: TBE Truss Bearing Enhancer



Two TBEs Installed with two ply girder truss



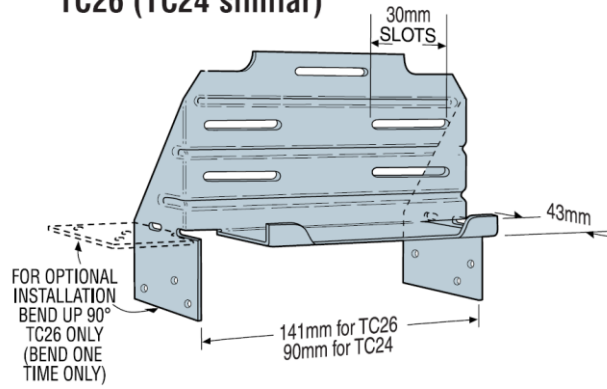
Alternate Installation Bend tab along slot and nail one leg to the top of the timber plate

**Table 3: Specifications of TBE Truss Bearing Enhancer**

Model No.	Truss Plys	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)
TBE 4	1 –35 mm	1.2	Pre galvanised. DX51D+Z275 to EN 10327-2004	See above pictures.
	2 –35 mm			
	1 –47 mm			
	3 –35 mm			
	2 –47 mm			

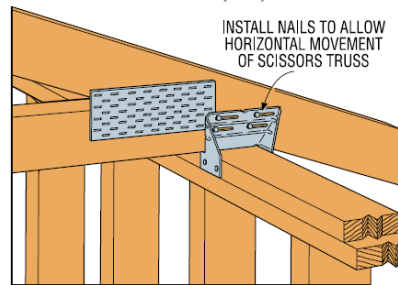
**A 1.3: TC Scissor Truss Clip**

**TC26 (TC24 similar)**



**Typical TC24 Installation**

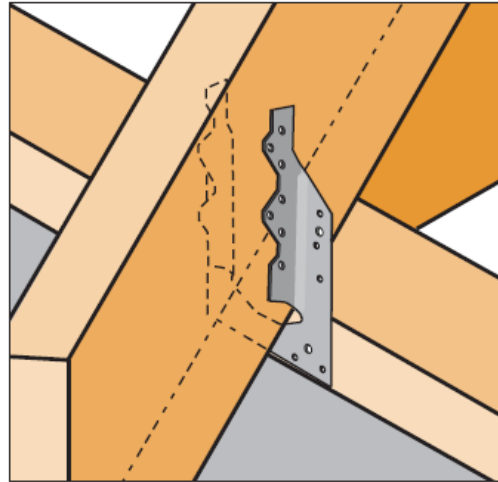
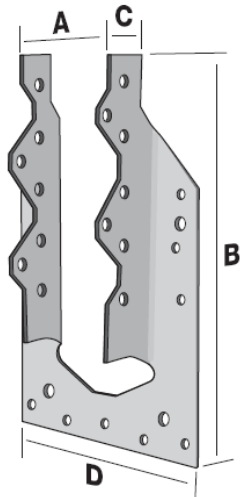
U.S. Patent 4,932,173



**Table 4: Specifications of TC Scissor Truss Clip**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)
TC 24	1.2	Pre galvanised. DX51D+Z275 to EN 10327-2004	See above pictures.
TC 26			

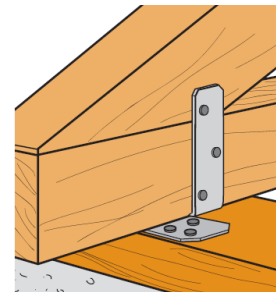
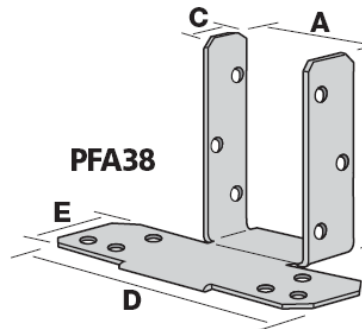
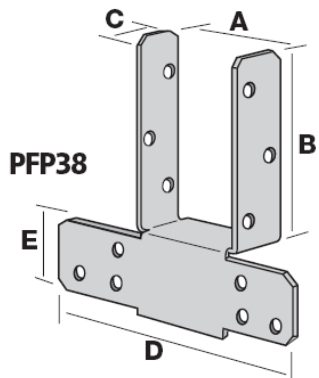
**A 1.4: PFP48 Truss Clip**



**Table 5: Specifications of PFP48 Truss Clip**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)			
			A	B	C	D
PFP48/2760	1.5	S250GD+Z275 to EN 10326: 2004.	48	170	37	100

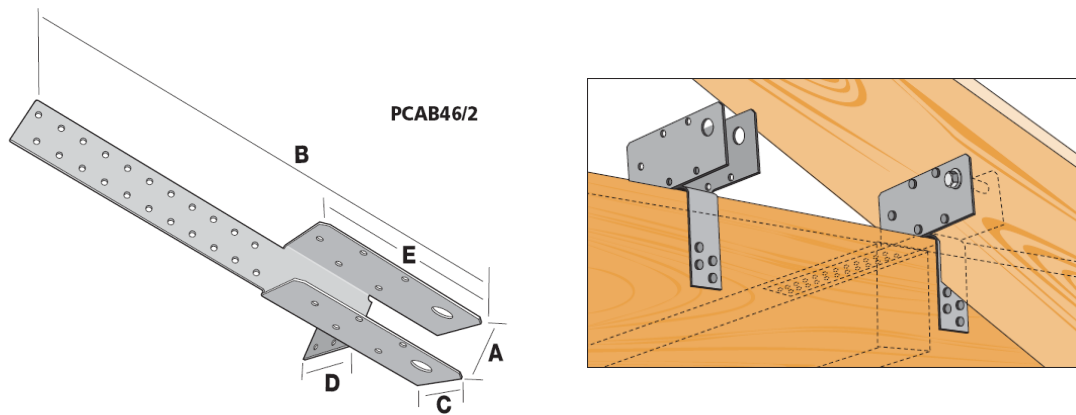
**A 1.5: PFP and PFA Truss Clips**



**Table 6: Specifications of PFP and PFA Truss Clips.**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)				
			A	B	C	D	E
PFP38	1.0	S250GD+Z275 to EN 10326: 2004	38	84	23	114	29
PFA38							

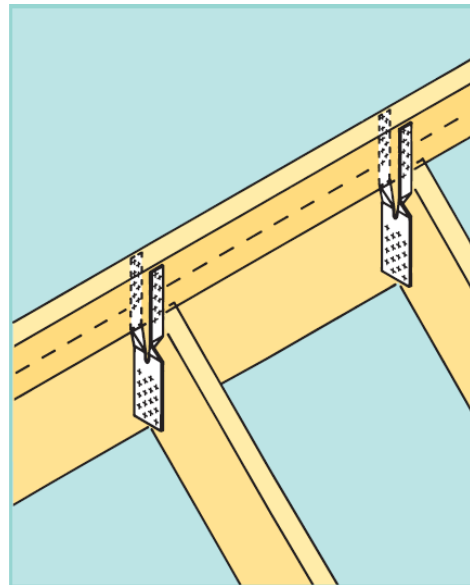
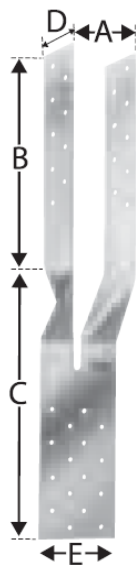
**A 1.6: PCAB Rafter Connector**



**Table 7: Specifications of PCAB Rafter Connector**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)				
			A	B	C	D	E
PCAB46/2	2.0	S250GD+Z275 to EN 10326: 2004	47	385	70	110	150

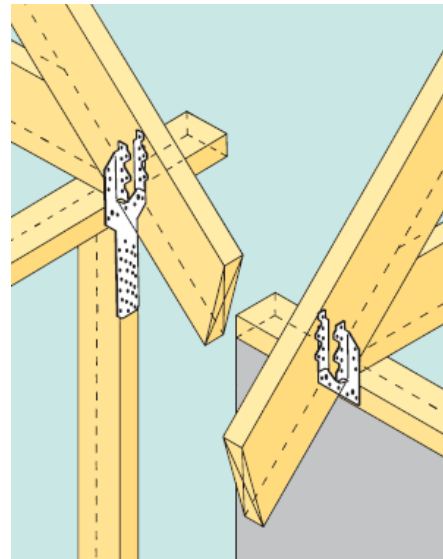
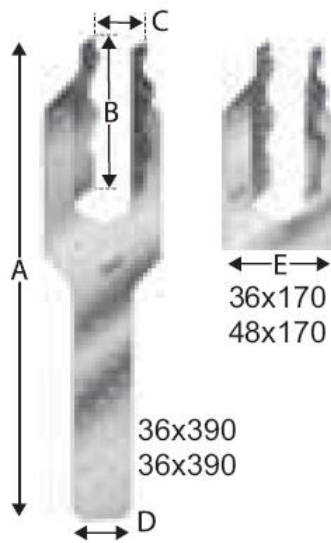
**A 1.7: 2748 Type Ridge Clip**



**Table 8: Specifications of 2748 Type Ridge Clip.**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)				
			A	B	C	D	E
2748	1.5	Pre galvanised. DX51D+Z275 to EN 10327-2004	50	138	178	26	60

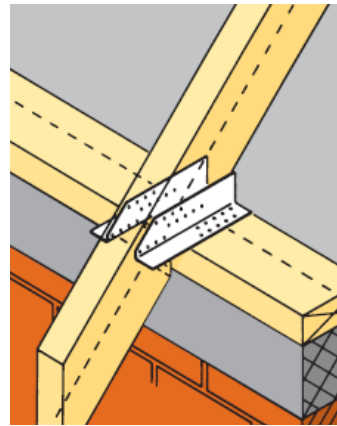
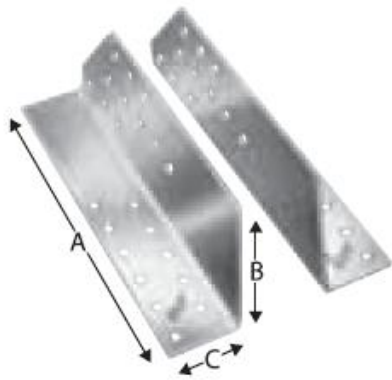
**A 1.8: 2750-65 Type Truss Clip**



**Table 9: Specifications of 2750-65 Type Truss Clip**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)				
			A	B	C	D	E
2750	1.5	S250GD+Z275 to EN 10326: 2004	170	122	36	-	100
2755			386	122	36	50	100
2760			170	122	48	-	100
2765			50	138	178	26	60

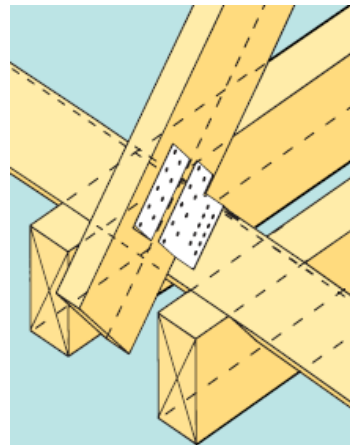
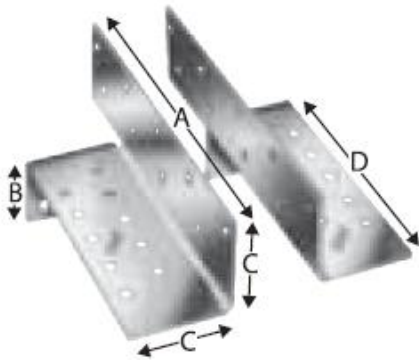
**A 1.9: 7620-24 Type Truss Clip**



**Table 10: Specifications of 7620-24 Type Truss Clip**

Model No	Steel thickness (mm)	Steel specification and grade	Dimensions (mm)		
			A	B	C
7620	2.0 / 2.5	S250GD+Z275 to EN 10326: 2004	200	62.0	42.0
7624			240	62.5	42.5

**A 1.10: 13001-2 Type Truss Clip**

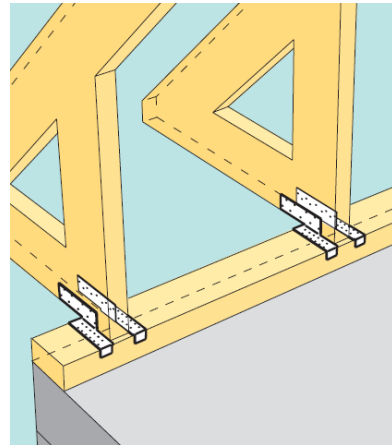
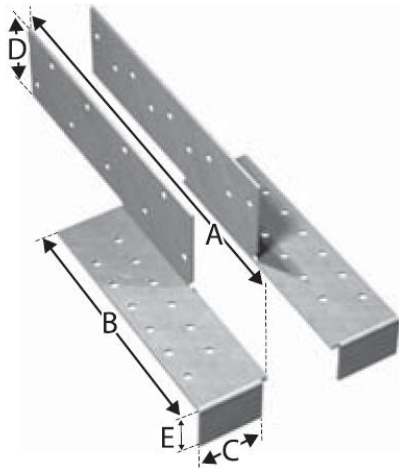


**Table 11: Specifications of 13001-2 Type Truss Clip**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)			
			A	B	C	D
13001	2.5	S250GD+Z275 to EN 10326: 2004	177	38.5	52.5	138.5
13002			260	91.0	72.5	169.0



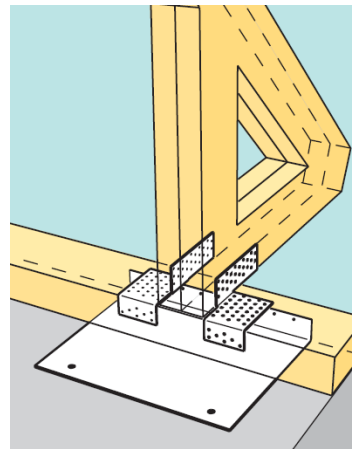
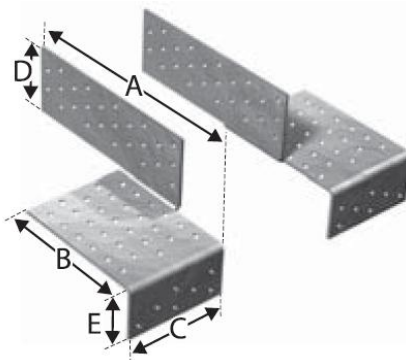
**A 1.11: 13003-4 Type Truss Clip**



**Table 12: Specifications of 13003-4 Type Truss Clip**

Model No	Steel thickness (mm)	Steel specification and grade	Dimensions (mm)				
			A	B	C	D	E
13003	2.0	S250GD+Z275 to EN 10326: 2004	270	159	45	60	27
13004			270	140	108	75	50

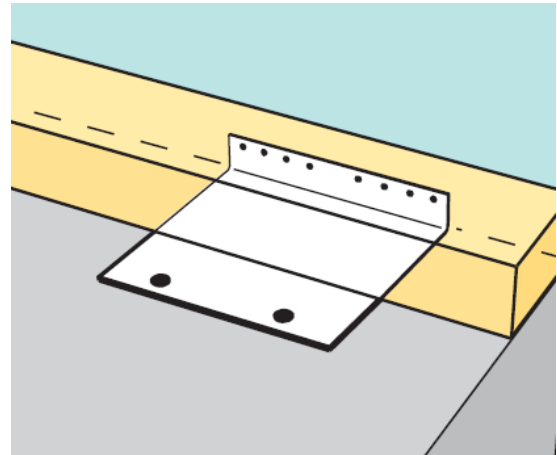
**A 1.12: 13005 Type Truss Clip**



**Table 13: Specifications of 13005 Type Truss Clip**

Model No.	Steel Thickness (mm)	Steel Specification and Grade	Dimensions (mm)				
			A	B	C	D	E
13005	3.0	Pre galvanized, DX51D+Z275 to EN 10327: 2004	260	140	108	75	50

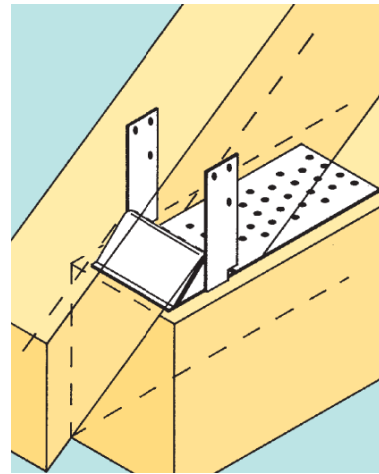
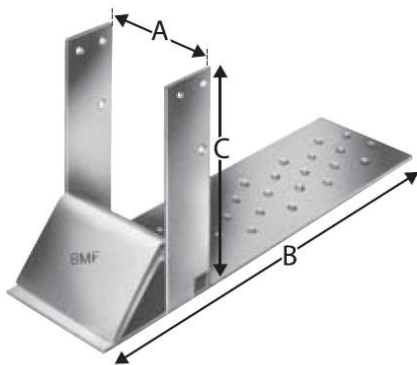
**A 1.13: 13014-15 Type Wall Plate Anchor**



**Table 14: Specifications of 13014-15 Type Wall Plate Anchor**

Model No	Steel thickness (mm)	Steel specification and grade	Dimensions (mm)		
			A	B	C
13014	3.0	S250GD+Z275 to EN 10326: 2004	360	280	53
13015			500	387	52

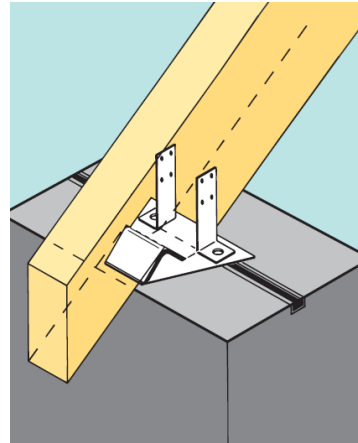
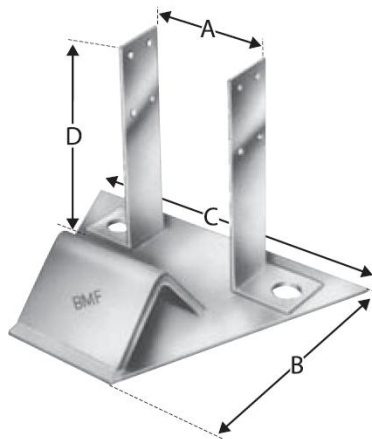
**A 1.14: 23080/100/120 Truss Shoes Type H**



**Table 15. Specifications of 23080/100/120 truss shoes type H.**

Model No	Steel thickness (mm)	Steel specification and grade	Dimensions (mm)		
			A	B	C
23080	2.0	S355MC TO EN 10149-2 *	84	300	140
	2.5	S235JR TO EN 10025 *			
23100	2.0	S355MC TO EN 10149-2 *	104	280	140
	2.5	S235JR TO EN 10025 *			
23120	2.0	S355MC TO EN 10149-2 *	124	260	140
	2.5	S235JR TO EN 10025 *			

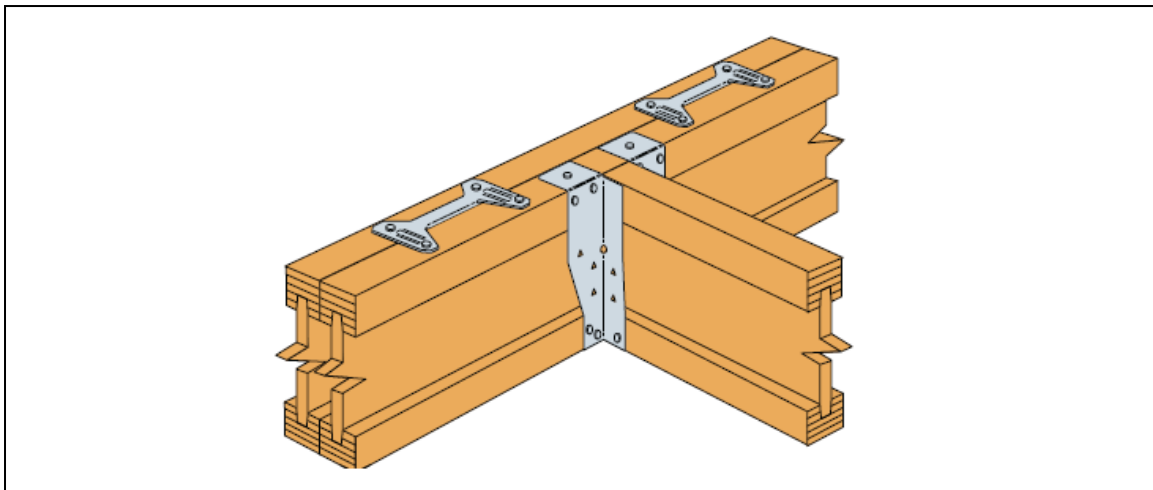
**A 1.15: 24080/100/120 Truss Shoes Type B**



**Table 16: Specifications of 24080/100/120 Truss Shoes Type H**

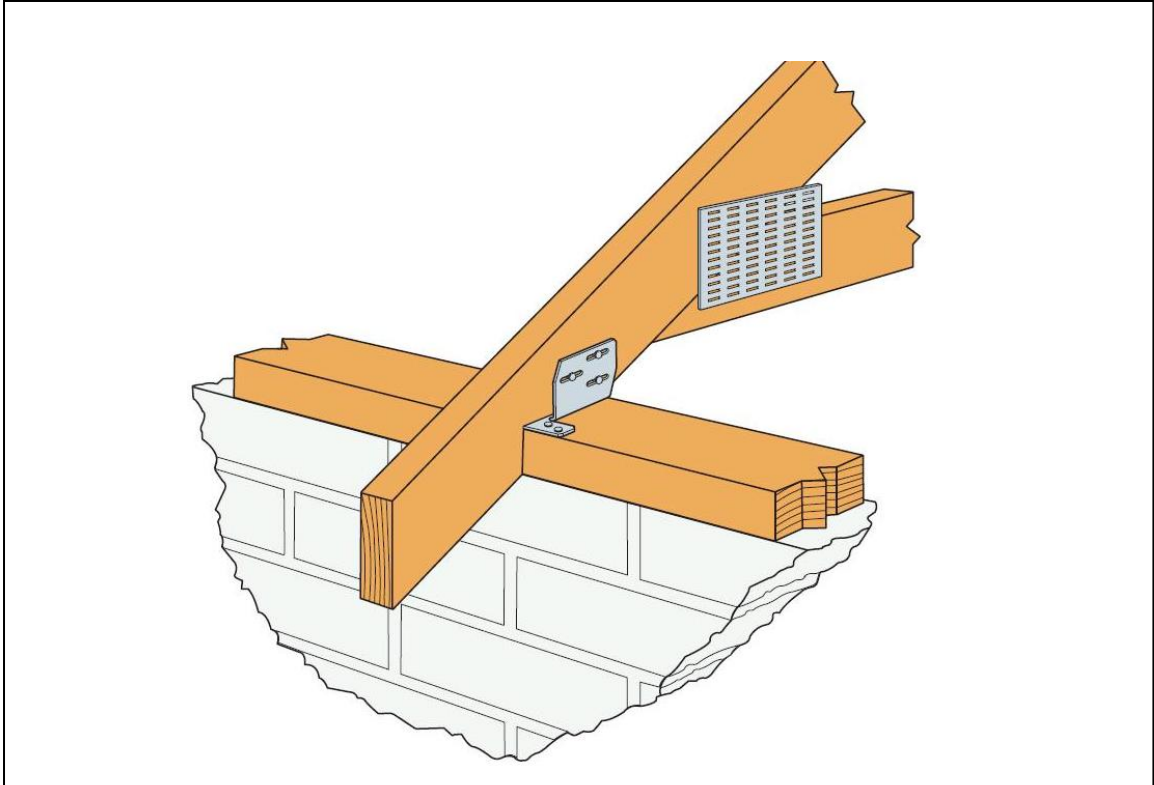
Model No	Steel thickness (mm)	Steel specification and grade	Dimensions (mm)		
			A	B	C
24080	2.0	S355MC TO EN 10149-2 *	84	170	220
	2.5	S235JR TO EN 10025 *			
24100	2.0	S355MC TO EN 10149-2 *	104	170	240
	2.5	S235JR TO EN 10025 *			
24120	2.0	S355MC TO EN 10149-2 *	124	170	260
	2.5	S235JR TO EN 10025 *			

**A 1.16: MJC –MultiPly Joist Connector**



1. Position MJC's onto 1<sup>st</sup> joist ensuring that they are centred about the incoming load at 400mm c/c (may be adjusted within 10mm each way). The MJC's can be installed in any orientation.
2. Connect MJC to the top and bottom flanges with the specified fasteners.
3. Position 2<sup>nd</sup> joist ensuring ends are flush and joists are parallel.
4. Connect the MJC to the top and bottom flanges with the specified fasteners

## A 2.17 - GS- Glide Shoe connector

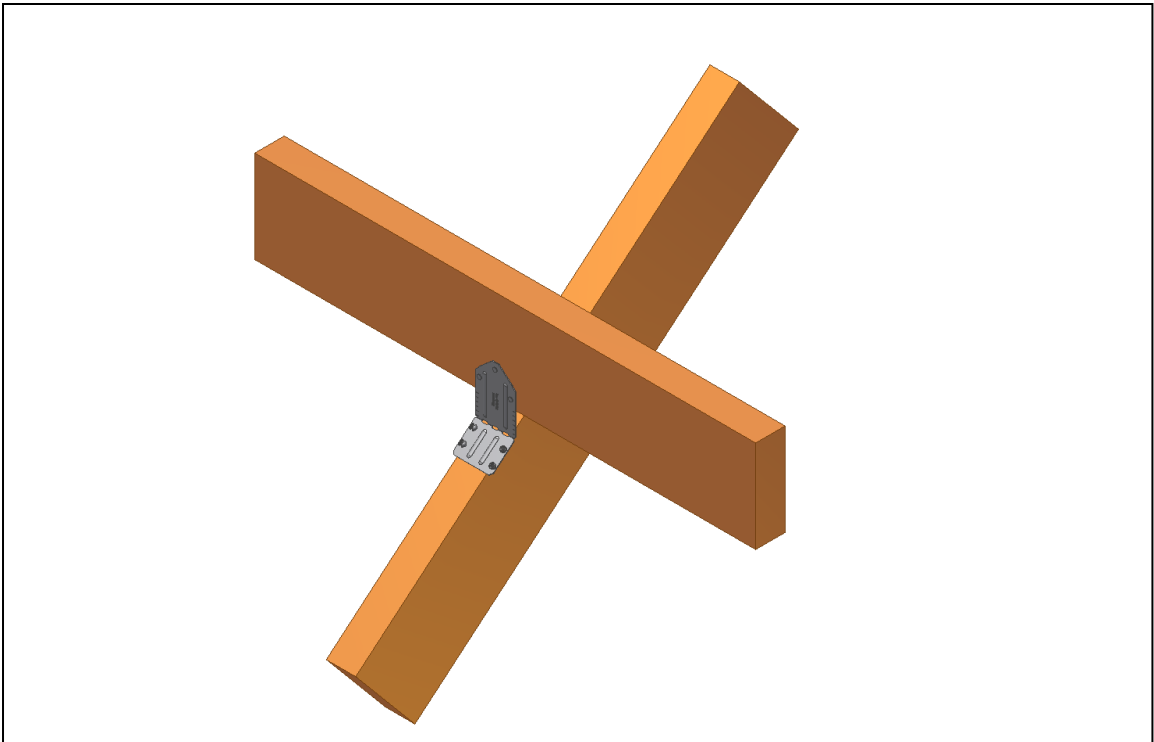


In all circumstances, the GS should be fixed by even hammering to a 100mm horizontal cut made in the rafter so as to allow proper bearing over the wall plate. The location and cutting of the notch in the rafter should be approached in the normal manner i.e. as if no GS was being installed so as to provide a level bearing surface for attaching the upper bearing plate.

The truss positions (and hence glide shoe positions) should be marked out along the wall plate according to the roof designers layout drawings. The GS should be fixed to the inner edge of the wall plate using the specified fasteners.

The truss, with the GS plate should be located centrally across the span with the bearing points located inside the shoe. When the truss is in the correct position, fully nail the GS to the rafter using the specified fasteners. Make sure when nailing into the slots, nails are located towards the inner most position allowing for any lateral spread to occur during the completion of the roof structure.

### A 1.18: VTCR- Valley Truss Clip



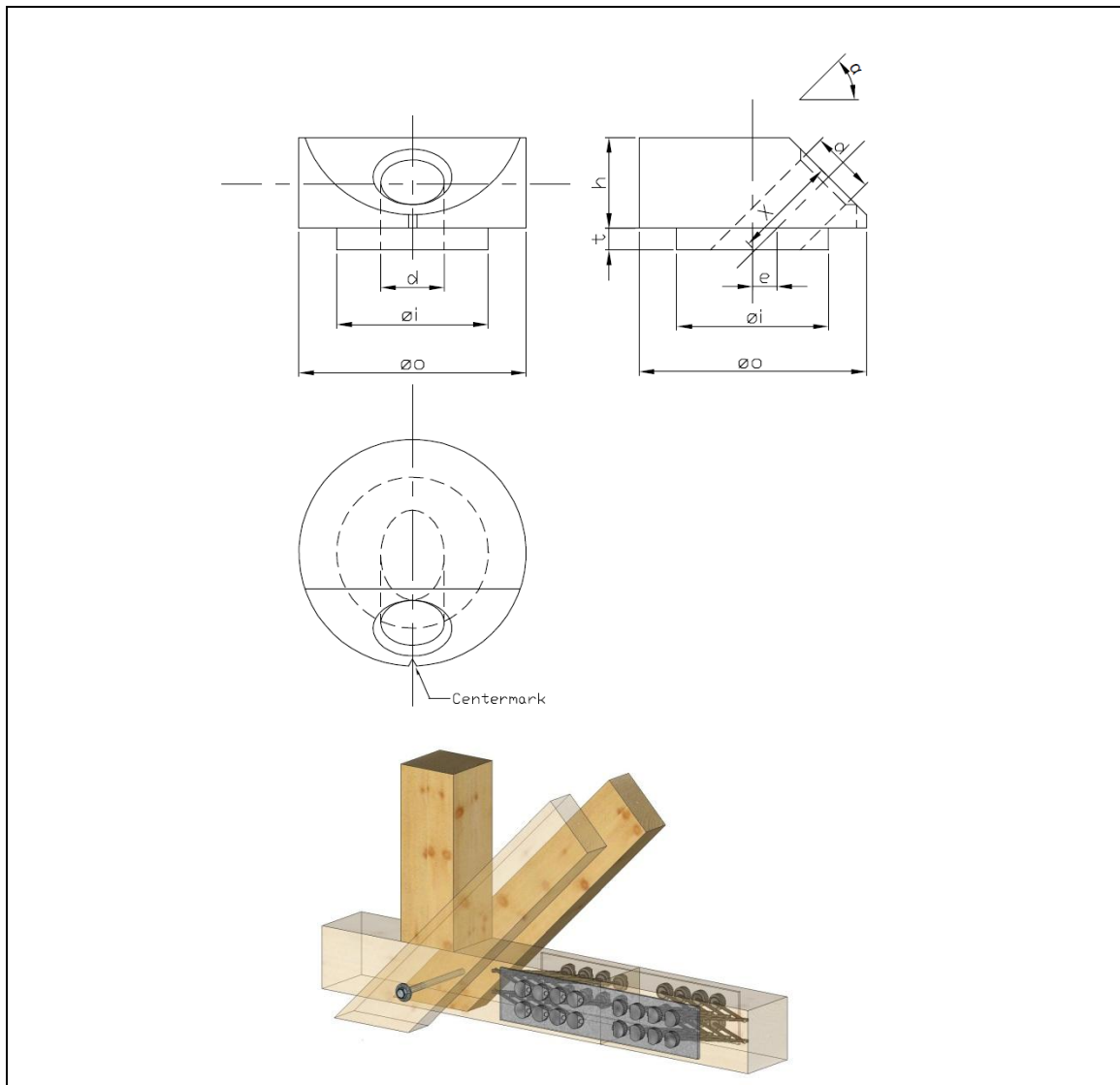
Position VTCR onto the common truss ensuring the timber is of adequate width to accommodate the specified fasteners and ensuring the connector is positioned in the centre of the truss width.

Connect the VTCR onto the common truss with the specified fasteners using the dome nail feature to guide the fastener into the timber at 45°.

Bend the VTCR once only to the specified pitch angle ensuring the vertical leg is positioned flush to the valley truss.

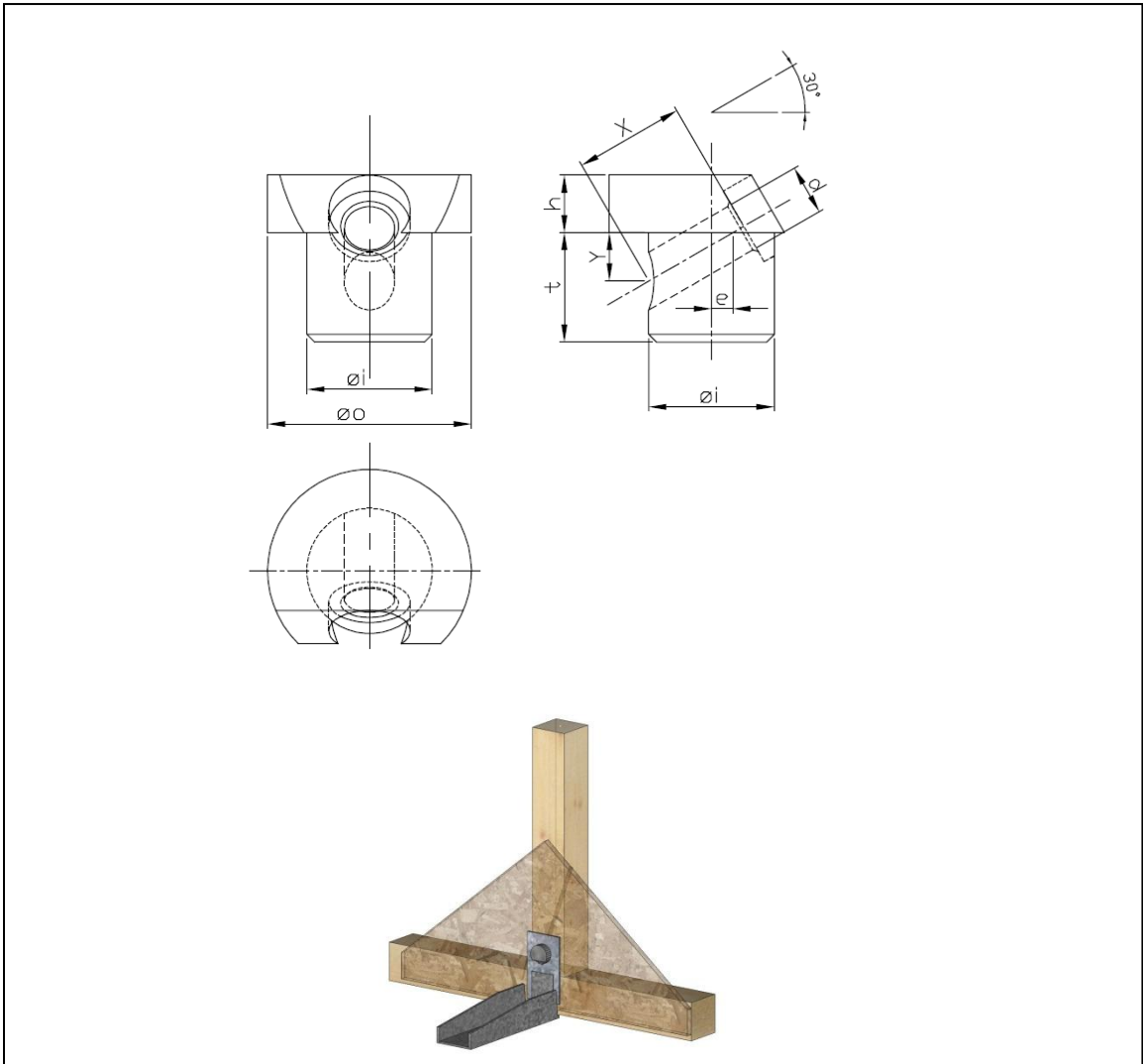
Connect the VTCR onto the valley truss using the specified fasteners.

## A 1.19: ZYKLOP –ZYK



1. The Steel Plate to which the ZYKLOP will be attached shall be firmly fixed to the timber. The ZYKLOP is placed in a hole in the sheet steel in a predetermined position.
2. The steel plate into which the ZYKLOP is to be fixed to shall be drilled with a diameter of maximum 1mm greater than  $\varnothing i$  as shown in the figure above.
3. The supplied corresponding screw is threaded through the hole in the ZYKLOP into the timber. The timber should be pre-drilled to at least 10mm depth and with a maximum diameter equal to the core diameter of the screw so that an accurate installation is guaranteed. The installation should be completed at low speed to avoid overstressing.
4. If more than one ZYKLOP is installed on the same sheet, the tight fit of each connector shall be checked.

## A 1.20: ZYKLOP- ZYKT



1. The Steel Plate to which the ZYKLOP will be attached shall be firmly fixed to the timber. The ZYKLOP is placed in a hole in the sheet steel and the timber in a predetermined position.
2. The steel plate and timber into which the ZYKLOP is to be fixed to shall be drilled with a diameter of maximum 1mm greater than  $\varnothing i$  as shown in the figure above. An additional notch is necessary in the steel plate to provide clearance for the fixing screw
3. The supplied corresponding screw is threaded through the hole in the ZYKLOP into the timber. The timber should be pre-drilled to at least 10mm depth and with a maximum diameter equal to the core diameter of the screw so that an accurate installation is guaranteed. The installation should be completed at low speed to avoid overstressing.
4. If more than one ZYKLOP is installed on the same sheet, the tight fit of each connector shall be checked.

## Annex 2: Range of Fasteners Used with SST Miscellaneous Brackets

**Table A2.1: Fastener Types according to ETA 04/0013, Annex A, for Use with Truss Connectors' Range**

Nail Type	Nail Size		Finish
	Diameter (mm)	Length (mm)	
Connector Nail (ARS)	3.1	22	Electroplated zinc
Connector Nail (ARS)	4.2	35	Electroplated zinc
Connector Nail (ARS)	4.2	50	Electroplated zinc
Connector Nail (CN)	3.1	40	Electroplated zinc
Connector Nail (CN)	4.0	40	Electroplated zinc
Connector Nail (CN)	4.0	50	Electroplated zinc
Connector Screw (CS)	5.0	35	Electroplated zinc
Connector Screw (CS)	5.0	40	Electroplated zinc

(ARS = Annular Ring Shank nail)

**Table A2.2: Fastener Types (Capacities to be Determined using Eurocode 5 Principles)**

Nail Type	Nail Size		Finish
	Diameter (mm)	Length (mm)	
Square Twist nail (ST)	3.75	30	Electroplated zinc
Round Wire (SR)	3.75	75	Electroplated zinc
Bolt	16	80	Hot-dip galvanized or electroplated zinc

**Table A2.3: Fastener Types used with MJC, GS, VTCR & ZYKLOP**

Nail Type	Connector Type	Nail Size		Finish
		Diameter (mm)	Length (mm)	
Smooth Shank Nail (SS)	MJC, GS, VTCR	3.35	65	Hot-dip Galvanised
Square Twist Nail (ST)	MJC, GS, VTCR	3.75	30	Hot-dip Galvanised
Square Twist Nail (ST)	MJC, GS, VTCR	3.75	30	Sherardized
Timber Construction Screws (ETA 12/0373)	ZYKLOP	6, 8, 10	200 - 400	12µm Electro-Galvanised

**Table A2.4: Fastener Types for Connection of Wood to Concrete (Capacities to be Determined using Eurocode 5 Principles)**

Bolt Diameter (mm)	Corresponding Hole Diameter (mm)	Bolt Type
16	17.5	See Manufacturers Specification
16	18	



## Annex 3: Basis of Design

### A 3.1: Design by Calculation

Riberholt, H. *Simpson Strong-Tie UK: Truss Connectors, Calculation methods and documentation*. Version 8a, 2007-08-03, updated to include TCP47.

#### 1. Scope and background

This document sets out the equations for calculation of the load-carrying capacities of the Simpson Strong-Tie Truss Connectors listed in section 2.1.

The background is given in "Simpson Strong-Tie UK: Truss Connectors, Calculation methods and Documentation, 2007-08-03.

#### 2. Materials and Components

##### 2.1. Connectors

The products listed below are covered by the document.

Product	Description
<b>TCP</b> Truss Clip	0.9 mm thick pre-galvanised steel; Grade DX51D+Z275 to BS EN 10327: 2004
<b>TBE</b> Truss Bearing Enhancer	1.2 mm thick pre-galvanised steel; Grade DX51D+Z275 to BS EN 10327: 2004
<b>TC</b> Scissor Truss Clip	1.5 mm thick pre-galvanised steel; Grade DX51D+Z275 to BS EN 10327: 2004
<b>PFP48/2760</b> Truss Clip	1.5 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>PFP</b> Truss Clip	1.0 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>PFA</b> Truss Clip	1.0 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>PCAB46/2</b> Rafter Connector	2.0 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>2748</b> Ridge Clip	1.5 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>2750-65</b> Truss Clip	1.5 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>7620-24</b> Truss Angle	2.0 / 2.5 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>13001-2</b> Truss Clip	2.5 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>13003-4</b> Truss Clip	2.0 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>13005</b> Truss Clip	3.0 mm thick pre-galvanised steel; Grade S250GD+Z275 to BS EN 10326: 2004
<b>130014-15</b> Wall Plate Anchor	3.0 mm thick pre-galvanised steel; Grade S250GD+Z275 to EN 10326: 2004
<b>23080/100/120</b> Truss Shoe type H	5.0 mm thick angle part hot-dip galvanized; Grade S355MC according to EN 10149-2.
<b>24080/100/120</b> Truss Shoe type B	2.0 and 2.5 mm thick steel sheet hot-dip galvanized; Grade S235JR according to EN 10025. The zinc coating thickness is about 55µm according to EN 1461

## 2.2 Timber Members

The wood members can be of solid timber, glued laminated timber and similar glued members, or wood-based structural members with a characteristic density from 290 kg/m<sup>3</sup> to 420 kg/m<sup>3</sup>.

Using the following materials will fulfill the requirements to the material of the wood members:

- Solid timber classified to C14-C40 according to EN 338 / EN 14081
- Glued members of timber classified to C14-C40 according to EN 338 / EN 14081 when structural adhesives are used
- Glued laminated timber classified to GL24c or better according to EN 1194 / EN 14080
- Laminated Veneer Lumber LVL according to EN 14374
- Laminated Strand Lumber, LSL e.g. Timber Strand
- Parallel Strand Lumber, PSL e.g. Parallam

For Engineered Wood Products, all requirements in the manufacturer's certification literature relating to connections shall be observed.

## 2.3 Fasteners

The fasteners to be used are zinc electroplated

- Connector nails (CN) 3,1 mm length 40 mm
- Connector nails (CN) 4,0 mm length 35 to 50 mm
- Connector screws (CS) 5,0 mm length 35 and 40 mm

The above shall be in according to ETA 04/0013.

### **Note:**

4.2 mm connector nails can be used instead of 4.0 mm nails. Since they have a slightly greater capacity the stated capacity of the connection will be on the safe side.

- Ring shank nails (ARS) 3,1 mm length 22 mm
- Ring shank nails (ARS) 3,1 mm length 35 mm
- Ring shank nails (ARS) 4,0 or 4,2 mm length 35 and 50 mm

The above shall be according to EN 14592 . The lateral capacity is calculated according to Eurocode 5, EN 1995-1-1.

- Square Twist (SqT) nails 3,75 mm length 30 mm
- Round wire (SR) nails 3,75 mm length 75 mm
- hot-dip galvanized or zinc electroplated 16x80 mm bolts in 17,5-18 mm holes.

The above shall be according to EN 14592. The lateral capacity is calculated according to Eurocode 5, EN 1995-1-1.

### 3 Notation and Forces

$F_{R1}$	Load-carrying capacity for downwards load
$F_{R2}$	Load-carrying capacity for upwards load
$F_{R3}$	Load-carrying capacity for lateral load
$F_{R4}$	Load-carrying capacity for axial load
$R_+$	Load-carrying capacity of a plane nail group for a unit nail capacity calculated by the program PLANFORB
$R_{lat,k}$	Characteristic lateral load carrying capacity of a nail
$R_{ax,k}$	Characteristic axial load carrying capacity of a nail
$b$	width of joist
$f_{c,90}$	characteristic compressive strength perpendicular to grain
$f_v$	characteristic shear strength
$f_y$	characteristic yield strength
$f_u$	characteristic ultimate strength
$n$	number of nails
$t$	plate thickness
$v$	angle
$w$	width

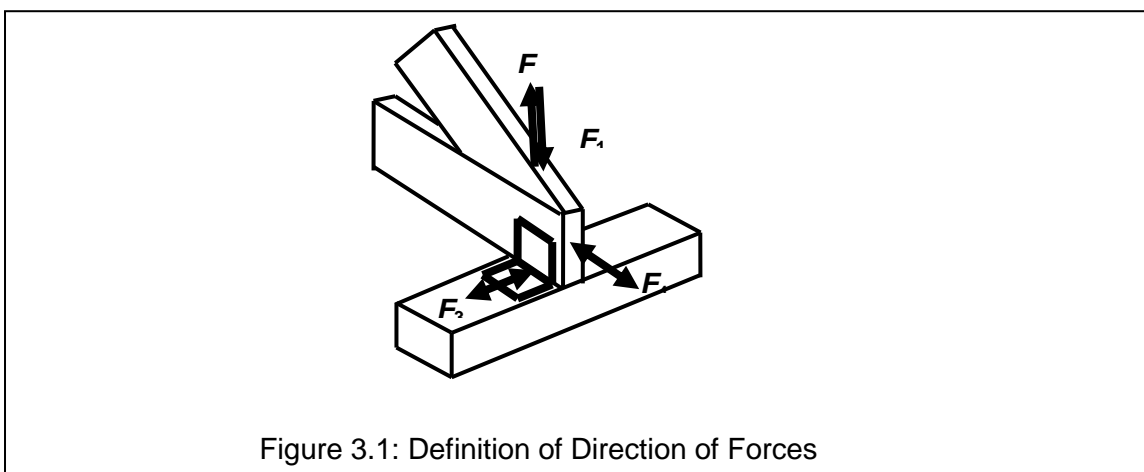


Figure 3.1: Definition of Direction of Forces

### 4 Design Equations

#### 4.0 General Assumptions and Conditions for the Formulas for the Load-carrying Capacities

The characteristic capacities have been determined under the following assumptions

- The characteristic capacities are given for one connector unless otherwise is stated.
- The characteristic capacities are given only for the declared force directions. It is up to an engineer to determine the capacity in any another direction.
- Timber strength class C14 to C24. For a higher strength class up to C40 the capacity for C24 should be used.
- Concrete class C15
- Steel quality and dimensions as defined in clause 2.1. For the grade DX51D+Z275 to BS EN 10327: 2004 a minimum ultimate tensile strength of 270 MPa has been assumed.
- Fasteners as defined in clause 2.3
- Number of fasteners and fastener pattern. If no specific information is given the capacity is for fasteners in all holes.

- No wane occurs where force is carried by contact compression
- Maximum gap allowed between connector and timber is 1.5mm

The rules of Eurocode 5, EN 1995-1-1 for minimum spacing between the fasteners and the minimum distances to edges of the wood shall be fulfilled. In some cases this has lead to that some nails have been disregarded in the determination of the characteristic load-carrying capacities.

The connectors are typically used between to timber members, which continue on both sides of the connections. The timber members shall have full contact, no gaps shall occur.

The connectors Ridge Clip and Truss Clip may be used close to an end of a timber member, e.g. at a ridge connection. In this case the minimum nail distances to end grain shall be considered when the effective number of nails is determined.

If the load-carrying capacity of connections are required for a lower characteristic density this can be done by proportioning with the density. The capacity for a larger density should be taken as that of this document.

## 4.1 TCP Truss Clip

### 4.1.1 Uplift $F_2$

The characteristic load-carrying capacities should not be taken higher than the values given in Table 4.1. Only nails with a diameter of up to 3.75mm are to be used.

Table 4: Characteristic load-carrying Capacities  $R_{2,t}$  for one TCP

Type	TCP 38	TCP 44	TCP47	TCP 50
$R_2$	$4,33 \cdot R_{lat,k}$	$3,81 \cdot R_{lat,k}$	$3,49 \cdot R_{lat,k}$	$3,08 \cdot R_{lat,k}$

However,  $R_{F2}$  maximum  $8,9^{*u}$  kN

## 4.2 TBE 4 Truss Bearing Enhancer

The characteristic load-carrying capacities should not be taken higher than the values given in Table 4.2.

For downward load the  $F_1$  is additional to the normal load-carrying capacity corresponding to the contact pressure. For upward load  $R_2$  is the total load-carrying capacity.

Table 4.2: Characteristic load-carrying Capacities for a pair of TBE 4 or TBE 6

Installation	$R_{1,k}$	$R_{2,k}$	$R_{3,k}$	$R_{4,k}$
	Downward	Uplift	In the beam direction	In the truss direction
Normal	$10,2 R_{lat,k}$	$10,2 R_{lat,k}$	$3,9 R_{lat,k} + 0,4^{*u}$ kN However not more than $4,5^{*u}$ kN	$1,6^{*u}$ kN
Alternative (1 bent flap in each)	$2,4 R_{lat,k} + 2,3^{*u}$ kN	0	$1,9 R_{lat,k} + 2,4^{*u}$ kN However not more than $4,5^{*u}$ kN	$2,7 R_{lat,k} + 0,1^{*u}$ kN

### 4.3 TC Scissor Truss Clip

For typical installation the characteristic uplift load-carrying capacity,  $R_2$ , should for one connector not be taken higher than:

Type TC 24:  $R_{2,k} = 2,22 R_{lat,k}$

Type TC 26:  $R_{2,k} = 4,16 R_{lat,k}$

However maximum  $6,1^*^u$  kN for TC24

$6,9^*^u$  kN for TC26

For alternative installations with 1 bend flap the characteristic uplift load-carrying capacity,  $R_2$ , should not be taken higher than:

$$R_{2,k} = 0,14^*^u \text{ kN} + k_{2,alt} \cdot R_{lat,k}$$

Where,

$$k_{2,alt} = 1,01 \text{ for TC24}$$

$$k_{2,alt} = 1,95 \text{ for TC26}$$

However maximum  $3,2^*^u$  kN for TC24

$3,6^*^u$  kN for TC26

### 4.4 PFP48/2760 Truss Clip

This clip is identical to Truss clip 2760 and reference is made to clause 4.10.

### 4.5 PFP Truss Clip

The characteristic uplift load-carrying capacity per PFP,  $R_{2,k}$ , should not be taken higher than

$$R_{2,k} = 2 R_{lat,k}$$

However maximum  $3,8^{*u}$  kN per Truss Clip.

### 4.6 PFA Truss Clip

It is required that the distance from the edge of the sill to the connector is in accordance with Eurocode 5 as a minimum of  $5d$  which for 4.0 mm nails is 20 mm.

#### 4.6.1 Uplift $F_{R2}$

The characteristic uplift load-carrying capacity per PFA  $R_{2,k}$  should not be taken higher than:

$$R_{2,k} = \text{Min} \{ 6 R_{ax,k} ; 5 R_{lat,k} \}$$

and not higher than:

$$R_{2,k} = 0,14^{*u} \text{ kN}$$

#### 4.6.2 Lateral Load $F_{R3}$

The characteristic load-carrying capacity  $R_{3,k}$  should not be taken higher than:

$$R_{3,k} = 4 R_{lat,k}$$

and not higher than:

$$R_{2,k} = 3,8^{*u} \text{ Kn}$$

#### 4.7 Rafter Connector PCAB46/2

Provided the downward vertical reaction  $F_{\text{contact}} > 2/3 F_{\text{hor}}$  ( $F_{\text{hor}} = F_4$ ) the characteristic horizontal load-carrying capacity  $R_{4,k}$  (in the truss direction) should not be taken higher than:

$$R_{4,k} = 17,7^{*y} \text{ kN}$$

And not higher than:

$$R_{4,k} = n R_{\text{lat},k}$$

where  $n$  is the number of nails in the strap. Since the connector PCAB typically is installed over a timber beam with coinciding length direction the minimum spacing between the nails is in accordance to Eurocode 5 10d leading to  $n_{\text{max}} = 12$ .

#### 4.8 Ridge Clip 2748

It is assumed that there are  $n$  nails in each of the flaps in the upper part and  $2n$  in the lower part.

The characteristic uplift load-carrying capacity  $R_2$  should not be taken higher than:

$$R_{2,k} = \min\{n_{\text{total,up}}; n_{\text{total,low}}\} R_{\text{lat},k}$$

Where

$n_{\text{total,up}}$  Total number of effective nails in the two upper flaps. For  $60^\circ$  roof inclination maximum 18 nails, for  $60^\circ$  to  $70^\circ$  maximum 10 nails

$n_{\text{total,low}}$  Total number of effective nails in the lower flap. Nails are allowed in all holes.

However, the characteristic uplift force shall be less than the characteristic tensile strength of the steel

$$R_{\text{steel},k} = 19,5^{*y} \text{ kN.}$$

If the Ridge Clip is installed at the ridge the nails in the lower flap with a distance to end grain less than  $10d$  shall be disregarded when the load-carrying capacity is determined.

#### 4.9 Truss Clip 2750, 2755, 2760 and 2765

It is assumed that there are  $n$  nails in each of the flaps in the upper part and  $2n$  in the lower part. The holes with a diameter of 5,0 mm shall not be used. The uplift load-carrying capacity should not be taken higher than:

$$R_{2,k} = \min\{n_{\text{total,up}}; n_{\text{total,low}}\} R_{\text{lat},k}$$

Where

$n_{\text{total,up}}$  Total number of effective nails in the two upper flaps  
For 2750 and 2755 this is max. 9 for roof angle  $< 70^\circ$  4 for roof angle  $> 70^\circ$   
For 2760 and 2765 this is max. 12

$n_{\text{total,low}}$  Total number of effective nails in the lower flap. For the short connectors 2750 and 2760 this number is 5.

However, the characteristic uplift force shall be less than the characteristic tensile strength of the steel

$$R_{\text{steel},k} = 17,7^{*y} \text{ kN.}$$

If the Truss Clip is installed near end grain the nails with a distance to end grain less than  $10d$  shall be disregarded when the load-carrying capacity is determined.

#### 4.10 Truss angle

The characteristic axial load-carrying capacity (in the direction of the truss) should not be taken higher than the values given in Table 4.10 for the nail patterns in figure 4.10.

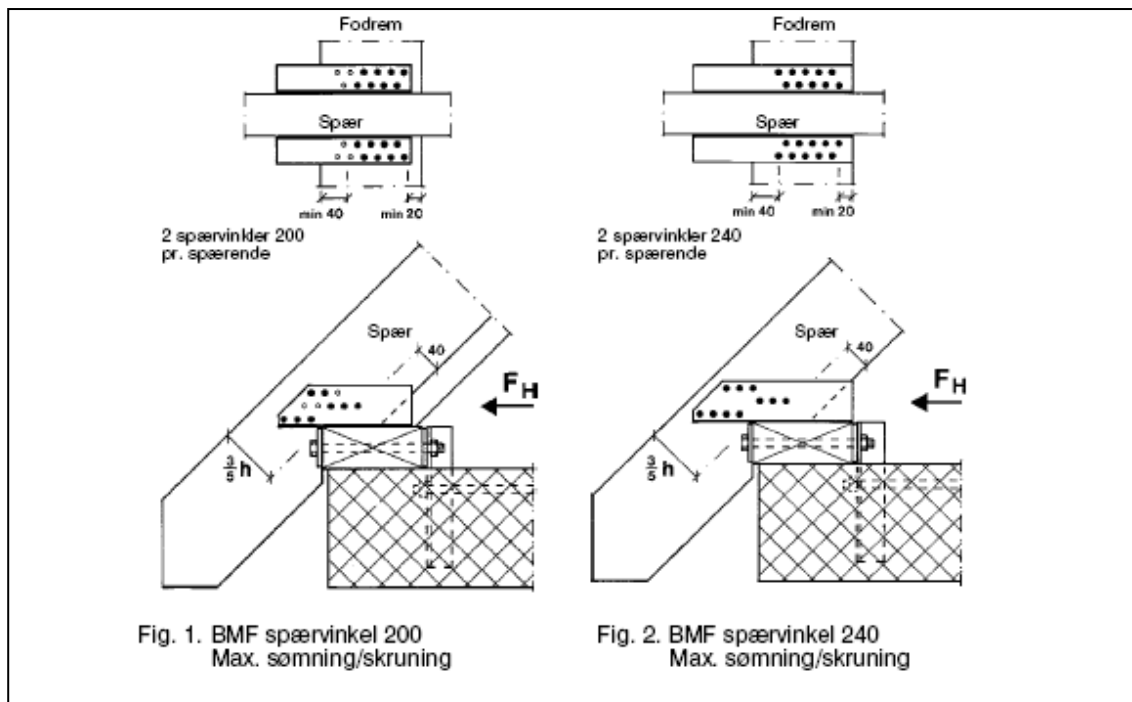


Figure 4.10: Nail patterns for the maximum nail numbers. For patterns with fewer nails the middle nails in the outermost row are omitted.

Table 4.10: Horizontal characteristic load-carrying capacity  $R_{4,k}$  for a pair of Truss angle connectors.

	Type			
	200		240	
Number of nails in truss and sill	6+6	8+8	9+9	10+10
	10,0 $R_{lat,k}$	11,7 $R_{lat,k}$	13,8 $R_{lat,k}$	14,1 $R_{lat,k}$

#### 4.11 Truss clip 13001 to 13005

The characteristic load-carrying capacity for a force parallel to the truss for a pair of connectors is given by the minimum of the following formulas:

$$R_{truss,k} = 2R_t^+ R_{lat,k}$$

$$R_{bend,k} = 2\{R_b^+ R_{lat,k} + k_q \sqrt{f_{c,k}} b_{bendflap} [kN]\}$$

Where: the  $R^+$  values,  $k_q$  and  $b_{bendflap}$  are given in Table 4.11. The characteristic compression strength shall be in MPa.

Table 4.11: Factors for the determination of characteristic load-carrying capacities for nails or screws and the fastener numbers stated as the number in top+ beam+truss i.e. nails in all holes.

	Type				
	13001	13002	13003	13004	13005
n nail	1+10+9	2+21+20	10+9	18+18	7+30+25
R <sub>t</sub>	7,51	17,54	7,55	15,21	21,78
R <sub>b</sub>	6,55	14,54	7,33	12,43	19,55
k <sub>q</sub>	0,048 <sup>*y</sup>	0,048 <sup>*y</sup>	0,038 <sup>*y</sup>	0,038 <sup>*y</sup>	0,058 <sup>*y</sup>
b <sub>bendfla</sub> p	47,5	67,5	30	50	101

For fewer nails, provided that the nails are evenly distributed over the length, the load-carrying capacity is proportional to the number of nails in either the truss or the beam.

#### 4.12 Wall Plate Anchor 13014 to 13015

The Wall Plate Anchor is fastened to the wall plate with 2 bolts. The characteristic lateral load-carrying capacity should not be taken higher than the values given in Table 4.12.

Table 4.12: Characteristic load-carrying capacities in kN

Type	
LM	LS
$13,1^{*y} \sqrt{f_{c,90,k}}$ kN	$18,2^{*y} \sqrt{f_{c,90,k}}$ kN

The compression strength  $f_{c,90,k}$  shall be in MPa.

Further, the lateral capacity of the fasteners into the wall plate shall be considered.

#### 4.13 Truss shoes Type H, 23080, 23100 and 23120

The characteristic load-carrying capacity for a compression force  $F_{H,k}$  parallel to the chord of the truss  $F_1$  should be taken as the minimum value of:

- the values given in Table 4.13
- formula (4.13.1) below the table

The capacities in Table 4.13 are determined from the contact between the truss and the connector, the contact against the timber below and the tensile strength of the horizontal flap.



Table 4.13: Characteristic load-carrying capacities for a contact force parallel to the truss in kN for type H.

Type	Roof Slope						
	30°	35°	40°	45°	50°	55°	60°
<b>Timber of Strength Class C14</b>							
<b>H80</b>	29,2 <sup>*y</sup>	28,7 <sup>*y</sup>	28,3 <sup>*y</sup>	28,2 <sup>*y</sup>	28,3 <sup>*y</sup>	28,7 <sup>*y</sup>	29,2 <sup>*y</sup>
<b>H100</b>	36,5 <sup>*y</sup>	35,8 <sup>*y</sup>	35,4 <sup>*y</sup>	35,3 <sup>*y</sup>	35,4 <sup>*y</sup>	35,8 <sup>*y</sup>	36,5 <sup>*y</sup>
<b>H120</b>	43,8 <sup>*y</sup>	43,0 <sup>*y</sup>	42,5 <sup>*y</sup>	42,3 <sup>*y</sup>	42,5 <sup>*y</sup>	43,0 <sup>*y</sup>	43,8 <sup>*y</sup>
<b>Timber of Strength Class C24</b>							
<b>H80</b>	33,4 <sup>*y</sup>	32,7 <sup>*y</sup>	32,3 <sup>*y</sup>	32,2 <sup>*y</sup>	32,3 <sup>*y</sup>	32,7 <sup>*y</sup>	33,4 <sup>*y</sup>
<b>H100</b>	41,7 <sup>*y</sup>	40,9 <sup>*y</sup>	40,4 <sup>*y</sup>	40,3 <sup>*y</sup>	40,4 <sup>*y</sup>	40,9 <sup>*y</sup>	41,7 <sup>*y</sup>
<b>H120</b>	50,0 <sup>*y</sup>	49,1 <sup>*y</sup>	48,5 <sup>*y</sup>	48,3 <sup>*y</sup>	48,5 <sup>*y</sup>	49,1 <sup>*y</sup>	50,0 <sup>*y</sup>

For intermediate strength classes, linear interpolation may be used.

Further the compression force shall be less than the capacity determined from the horizontal equilibrium and of the strength of the nails in the horizontal flap

$$R_{H,k} = n_{\text{nail}} R_{\text{lat},k} / \cos(\nu) \quad (4.13.1)$$

Where:

$n_{\text{nail}}$  is the number of nails in the horizontal steel plate

$\nu$  is the roof angle

The characteristic capacity for a lifting vertical force  $F_2$  is

$$R_{2,k} = n_{\text{ef, lift}} R_{\text{ax},k} = n_{\text{ef, lift}} R_{\text{ax},k}$$

Where:  $n_{\text{ef, lift}}$  is 5, 7 and 9 for type H80, H100 respectively H120

#### 4.14 Truss Shoes Type B, 24080, 24100 and 24120

The characteristic load-carrying capacity for a compression force  $F_{H,k}$  parallel to the chord of the truss should be taken as the minimum of:

- the values given in Table 4.14.
- formula (4.14.1) below the table.

Table 4.14: Characteristic load-carrying capacities in kN for a contact force parallel to the truss in kN for type B on concrete C15

Type	Roof Slope						
	30°	35°	40°	45°	50°	55°	60°
<b>Timber of Strength Class C14</b>							
<b>B80</b>	60,4 <sup>*y</sup>	59,3 <sup>*y</sup>	58,6 <sup>*y</sup>	58,4 <sup>*y</sup>	58,6 <sup>*y</sup>	59,3 <sup>*y</sup>	60,4 <sup>*y</sup>
<b>B100</b>	75,5 <sup>*y</sup>	74,1 <sup>*y</sup>	73,2 <sup>*y</sup>	73,0 <sup>*y</sup>	73,2 <sup>*y</sup>	74,1 <sup>*y</sup>	75,5 <sup>*y</sup>
<b>B120</b>	90,6 <sup>*y</sup>	88,9 <sup>*y</sup>	87,9 <sup>*y</sup>	87,5 <sup>*y</sup>	87,9 <sup>*y</sup>	88,9 <sup>*y</sup>	90,6 <sup>*y</sup>
<b>Timber of Strength Class C24</b>							
<b>B80</b>	60,4 <sup>*y</sup>	59,3 <sup>*y</sup>	58,6 <sup>*y</sup>	58,4 <sup>*y</sup>	58,6 <sup>*y</sup>	59,3 <sup>*y</sup>	60,4 <sup>*y</sup>
<b>B100</b>	75,5 <sup>*y</sup>	74,1 <sup>*y</sup>	73,2 <sup>*y</sup>	73,0 <sup>*y</sup>	73,2 <sup>*y</sup>	74,1 <sup>*y</sup>	75,5 <sup>*y</sup>
<b>B120</b>	90,6 <sup>*y</sup>	88,9 <sup>*y</sup>	87,9 <sup>*y</sup>	87,5 <sup>*y</sup>	87,9 <sup>*y</sup>	88,9 <sup>*y</sup>	90,6 <sup>*y</sup>

Further the compression force shall be less than the capacity determined from the horizontal equilibrium and of the lateral capacity of the bolts or inserts.

$$R_{H,k} = 2 R_{lat,bolt,k} / \cos(\nu) \quad (4.14.1)$$

Where,

$R_{lat,bolt,k}$  is the characteristic lateral capacity of one of the Ø16 bolts or inserts assumed to be used in the concrete.

$\nu$  is the roof angle

The characteristic capacity for a lifting vertical force  $F_2$  is

$$R_{2,k} = 8 R_{lat,k}$$

## A 4.2 - ZYKLOP Determination of capacities

The characteristic load-carrying capacities and the spacings of the Simpson Strong-Tie ZYKLOP connectors ZYK and ZYKT are dependent on compression strength of the timber, the bending capacity of steel plate and the screw capacity. The characteristic of this connector type is that the acting forces will affect only tensile loads on the screw as shown in "Figure 1 of this Section". The designer shall ensure that this connector is not subjected to forces in directions other than stated.

The calculation method evaluates the load capacities and spacings of the connectors in combination with the corresponding screws affected by a force  $F_k$  acting on the steel plate in the following two possible directions:

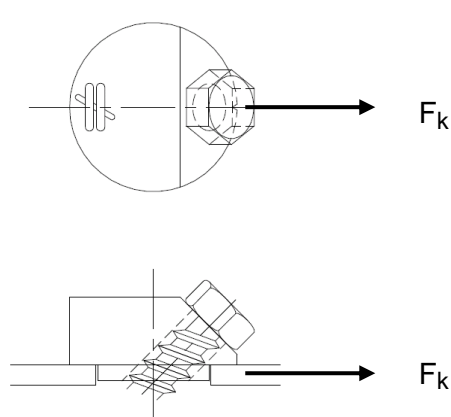


Figure 1: Planar Force

- 1) Planar to the steel plate surface on which the connector is mounted to, in direction of the screw from a perpendicular view on the surface:

The load  $F_k$  is transmitted from the steel plate into the ZYKLOP connector by bearing of the hole. The contact area between ZYKLOP and screw head is inclined and there is no collar under the screw head. This causes the screw only to take axial forces with a consequential compression force in direction towards the timber.

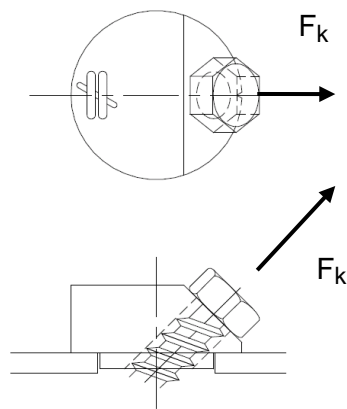


Figure 2: Inclined Force

- 2) In direction of the screw axis:

The load  $F_k$  is transmitted from the steel plate to the screw by bearing of the hole and contact compression via the ZYKLOP connector into the screw. This load evokes no compression between the steel plate and the timber.

The design load-carrying capacity of a ZYKLOP connection subjected to a planar force as shown in Figure 1 of this section is given as:

$$R_d = \min \begin{cases} R_{k,ZYK} \times n \times k_{\text{mod}} / \gamma_m \\ R_{ax,d,screw} \times \cos \alpha \times n_{ef} \end{cases} \quad \text{Eq. [ 1 ]}$$

where:

$R_{ax,d,screw}$  = The design tensile screw capacity in the formula above and for a ZYKLOP connection subjected to an inclined force as shown in Figure 2 of this section is given as:

$$\min \begin{cases} r_{ax,k,\alpha} \times l_{ef} \times k_{mod} / \gamma_m \\ R_{t,u,k} / \gamma_m \end{cases}$$

$n$  = number of ZYK/ZYKT fasteners on the same steel plate connected to one construction part

$n_{ef}$  = effective number:

$$n > 1 \rightarrow n_{ef} = n^{0.9}$$

$$n = 1 \text{ and } l_{ef} \geq 20d \rightarrow n_{ef} = 0.5$$

$$n = 1 \text{ and } l_{ef} < 20d \rightarrow n_{ef} = 0$$

$\alpha$  = screw angle, predetermined by the connector (Table 1 and Table 2 of this section)

$R_{t,u,k}$  = Ultimate tensile capacity of the screw (Table 8 of this section)

$l_{ef}$  = Effective embedment length of the screw thread into the load bearing member.  $l_{ef} \geq 4d$

$d$  = Nominal screw diameter (Table 8 of this section)

$R_{k,ZYK}$  = Steel plate and timber dependent characteristic value (Table 6 and Table 7 of this section)

$r_{ax,k,\alpha}$  = Screw withdrawal parameter characteristic value (Table 9 and Table 10 of this section)

## **Materials and Components**

### **Screws**

The three different screws being used are defined by the codes 060x200/192 J1J 0A0 C1D, 080x300/290 J1J 0A0 C1D and 100x400/388 J1J 0A0 C1D according to ETA-12/0373 and are 12µm zinc electroplated. Alternative screws SSTA6x200, SSTA8x300 and SSTA10x400 according to ETA-13/0796 are possible. Their dimensions and performances are exactly the same as the ones above.

### **Intermediate Connector “ZYKLOP”**

The connectors are made from S355 J2 G3 and are 12µm zinc electroplated.

### **Steel Plates**

The grade S235 is taken as a basis, any higher grade is possible. The shape of the steel plate shall be designed by an engineer and is not part of this calculation. The required thicknesses are listed in Table 5 of this section.

### **Intermediate Layer**

A non-load bearing intermediate layer between the steel plate and the timber is allowed, provided that it has a minimum compressive strength  $f_{c,k,90}$  of 7.5 N/mm<sup>2</sup>. For calculation purposes, the point side length of the fastening screw is the length that is embedded in the timber.

## Timber Types

The wood members can be of solid timber, glued laminated timber and similar glued members, or wood-based structural members with a characteristic density from  $350 \text{ kg/m}^3$  to  $460 \text{ kg/m}^3$ .

Using the following materials will fulfill the requirements to the material of the wood members:

Solid timber classified to C24-C40 according to EN 338 / EN 14081

Glued members of timber classified to C24-C40 according to EN 338 / EN 14081 when structural adhesives are used

Glued laminated timber classified to GL24c or better according to EN 1194 / EN 14080

For Engineered Wood Products, reference is made to the manufacturers' specifications.

All calculations are based on the values of solid timber C24. Higher static performances can not be derived from the use of higher grade timber material.

## Safety Principles and Partial Factors

The characteristic load-carrying capacities have been calculated considering different ratios between the partial factors for timber connections and steel cross sections.

As the static utilisation of the steel parts is almost always balanced with timber related failure, all design resistances can be calculated on the basis of EC5 without regarding differing material factors.

## ZYKLOP Components

### ZYK

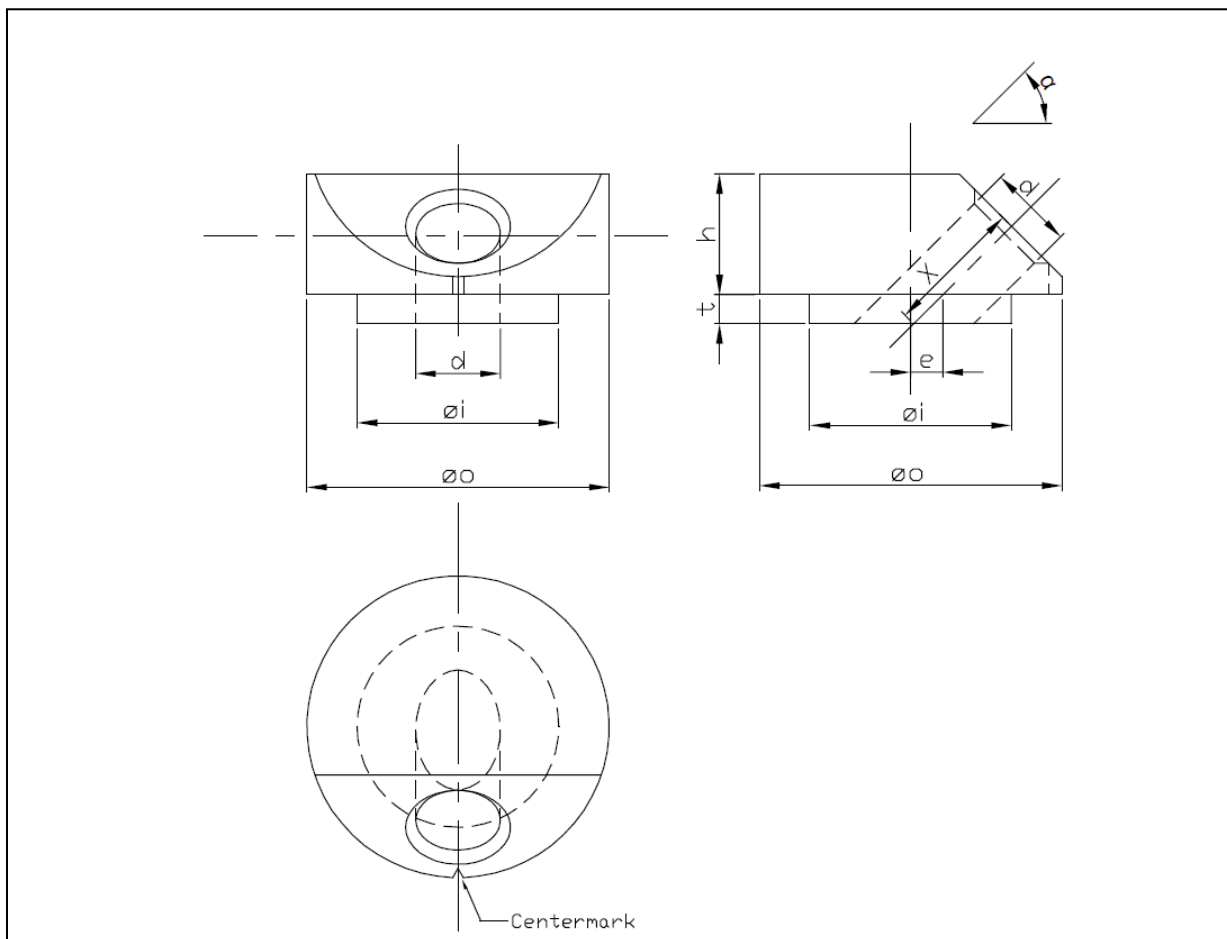


Figure 3: ZYK

Table 1: Dimensions ZYK

Connector	d [mm]	$\alpha$ [°]	$\varnothing_o$ [mm]	$\varnothing_i$ [mm]	h [mm]	t [mm]	e [mm]	X [mm]
ZYK6/20/30	6,4	30	32	20	11,5	1,9	2,8	16
ZYK6/16/45	6,4	45	25	16	10	1,9	2,7	11
ZYK6/12/60	6,4	60	20	12	7,5	1,9	1,5	7,9
ZYK8/27/30	8,4	30	45	27	14	2,9	4,5	22,5
ZYK8/20/45	8,4	45	30	20	12	2,9	3,2	13,7
ZYK8/16/60	8,4	60	25	16	9,5	2,5	2,3	9,5
ZYK10/30/30	10,4	30	50	30	16,5	3,5	3,7	26,2
ZYK10/24/45	10,4	45	35	24	15	3,5	3,8	15,9
ZYK10/20/60	10,4	60	30	20	11	2,9	3,1	10,9

**ZYKT**

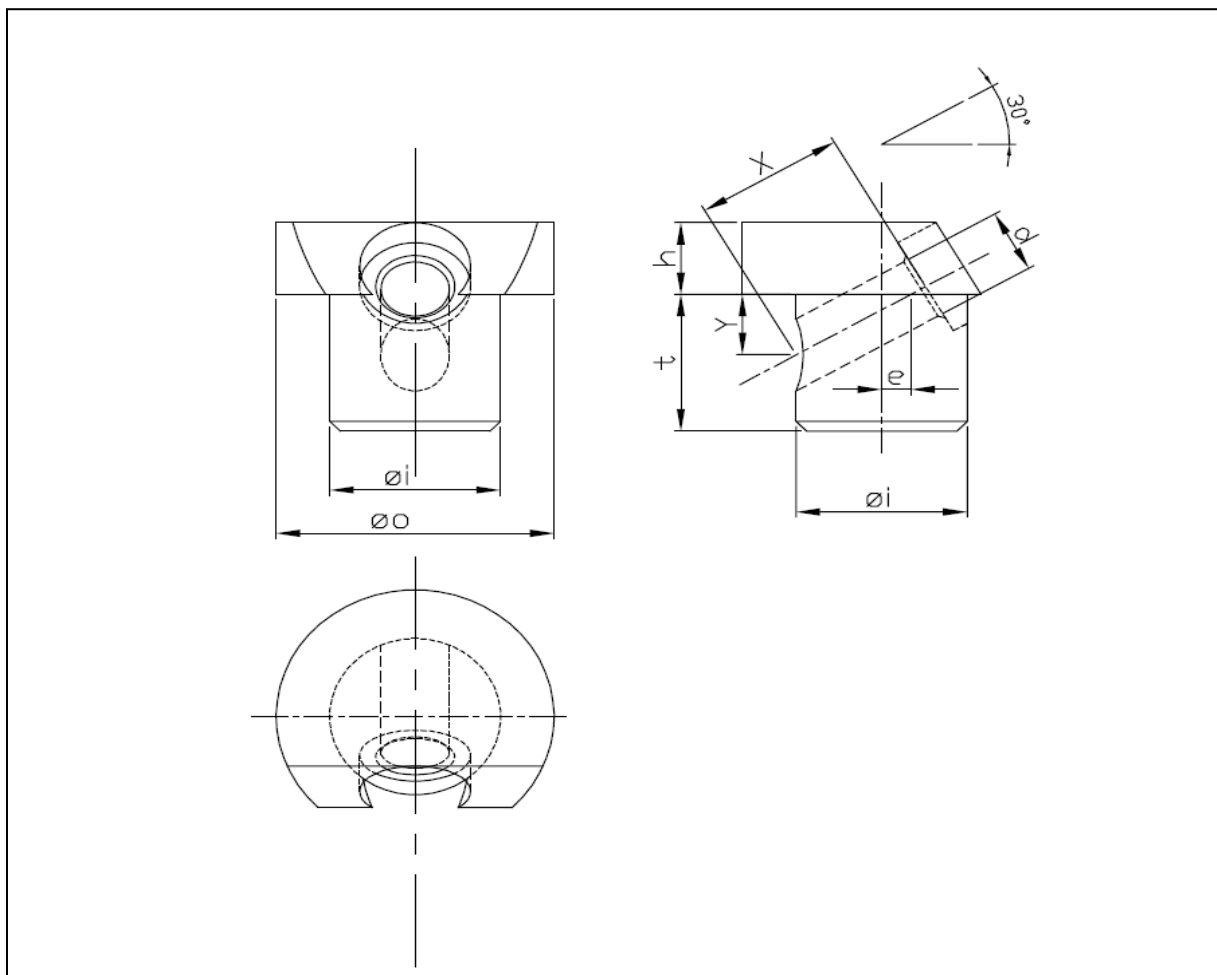


Figure 4: ZYKT

Table 2: Dimensions ZYKT

Connector	d [mm]	$\alpha$ [°]	$\varnothing_o$ [mm]	$\varnothing_i$ [mm]	X [mm]	t [mm]	e [mm]	Y [mm]	h [mm]
ZYKT6/16/30	6,4	30	25	16	14	14	2,4	6,2	7,4
ZYKT8/20/30	8,4	30	30	20	16,7	14	5,4	8,9	7,5
ZYKT10/20/30	10,4	30	35	20	16,2	19	9,4	11,2	7,5

### Screws

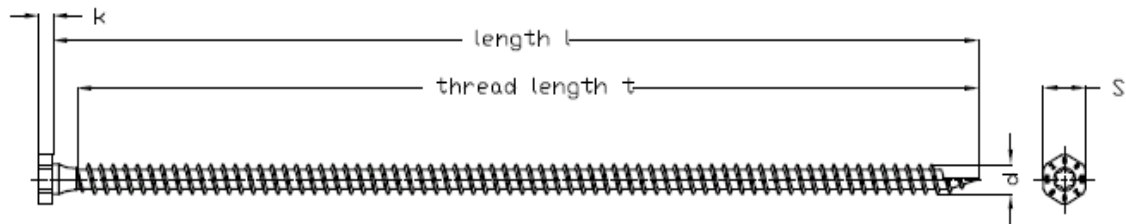


Figure 5: Screws

Table 3: Dimensions Screws

Screw code according to ETA-12/0373	d [mm]	l [mm]	t [mm]	k [mm]	s [mm]	abbreviation
060x200/192 J0J 0A0 C2D	6	200	192	3	9	6x200
080x300/290 J0J 0A0 C2D	8	300	290	4,5	12	8x300
100x400/388 J0J 0A0 C2D	10	400	388	5	15	10x400

## Product Codes

Table 4: Product Codes

Connector	Screw	Product Code
ZYK6/20/30	6x200	<b>ZYK10</b>
ZYK6/16/45	6X200	<b>ZYK11</b>
ZYK6/12/60	6x200	<b>ZYK12</b>
ZYKT6/16/30	6x200	<b>ZYKT39</b>
ZYK8/27/30	8x300	<b>ZYK40</b>
ZYK8/20/45	8x300	<b>ZYK41</b>
ZYK8/16/60	8x300	<b>ZYK42</b>
ZYKT8/20/30	8x300	<b>ZYKT69</b>
ZYK10/30/30	10x400	<b>ZYK70</b>
ZYK10/24/45	10x400	<b>ZYK71</b>
ZYK10/20/60	10x400	<b>ZYK72</b>
ZYKT10/20/30	10x400	<b>ZYKT99</b>

### Static Values

The connector capacities are, besides the predetermined geometry and material, dependent on the screw capacity and the steel plate thickness. The minimum value of all is decisive.

### Values from Geometrical and Material Specifications

There are boundaries regarding the steel plate thickness. Thicker steel plate than the ones shown below are possible but require additional work to avoid collision with the screw flanks.

Table 5: Steel Plate Thicknesses

Connector	Steel Plate Thickness (mm)	
	Minimum	Maximum
ZYK10	2,0	3,0
ZYK11	2,0	6,0
ZYK12	2,0	6,5
ZYKT39	1,5	2,5
ZYK40	3,0	5,0
ZYK41	3,0	8,0
ZYK42	2,5	9,0
ZYKT69	2,0	4,0
ZYK70	3,5	5,0
ZYK71	3,5	8,0
ZYK72	3,0	12,0
ZYKT99	2,0	5,0



The use of different thicknesses of steel plates results in different load distribution capabilities. These load distributions have an effect on timber compression and steel bending. The results of this behavior are documented in the following two tables.

Table 6: Steel Plate Thicknesses to reach maximum load capacity and capacities at minimum steel plate thickness for ZYK

Connector	Placed On The Side Of The Timber				Placed On The End Grain			
	Required steel plate thickness w at maximum load		Resulting load at minimum steel plate thickness w		Required steel plate thickness w at maximum load		Resulting load at minimum steel plate thickness w	
	max.R <sub>k</sub> [kN]*	req.w [mm]	res.R <sub>k</sub> [kN]	min w [mm]	max.R <sub>k</sub> [kN]*	req.w [mm]	res.R <sub>k</sub> [kN]	min w [mm]
ZYK10	10,8	2,0	10,8	2,0	10,8	2,0	10,8	2,0
ZYK11	8,8	4,0	4,6	2,0	8,8	2,0	8,8	2,0
ZYK12	6,3	4,5	2,6	2,0	6,3	2,0	6,3	2,0
ZYK40	20,4	3,0	20,4	3,0	20,4	3,0	20,4	3,0
ZYK41	16,6	5,5	7,8	3,0	16,6	3,0	16,6	3,0
ZYK42	11,8	6,5	3,8	2,5	11,8	3,5	9,0	2,5
ZYK70	28,6	3,5	28,6	3,5	28,6	3,5	28,6	3,5
ZYK71	23,3	7,0	10,5	3,5	23,3	3,5	23,3	3,5
ZYK72	16,5	7,5	5,3	3,0	16,5	4,0	12,7	3,0

\* These are maximum values and cannot be exceeded by using thicker plates

Table 7: Steel Plate Thicknesses to reach maximum load capacity and capacities at minimum steel plate thickness for ZYKT

Connector	Placed On The Side Of The Timber				Placed On The End Grain			
	Required steel plate thickness w at maximum load		Resulting load at minimum steel plate thickness w		Required steel plate thickness w at maximum load		Resulting load at minimum steel plate thickness w	
	max.R <sub>k</sub> [kN]*	req.w [mm]	res.R <sub>k</sub> [kN]	min w [mm]	max.R <sub>k</sub> [kN]*	req.w [mm]	res.R <sub>k</sub> [kN]	min w [mm]
ZYKT39	10.8	2.5	7.7	1.5	10.8	1.5	10.8	1.5
ZYKT69	20.4	4.0	10.8	2.0	20.4	2.0	20.4	2.0
ZYKT99	28.6	5.0	13.4	2.0	28.6	2.0	28.6	2.0

\* These are maximum values and cannot be exceeded by using thicker plates

For steel plate thicknesses between the ones given in Tables 6 and 7, the R<sub>k</sub> values may be linearly interpolated. Only the maximum required steel plate thicknesses in Tables 6 and 7 shall be used for interpolation, even if the actual thickness exceeds those values.

### Values from Screw Capacity

The geometry of the screws is shown in Table 3 of this section. The tensile capacity of the screw is either governed by the ultimate tensile capacity R<sub>t,u,k</sub> or the thread embedment into the load taking timber part. The values X and Y from Table 1 and Table 2 are needed to evaluate the embedment length l<sub>ef</sub>. The load carrying capacity of the connectors on a steel plate shall be evaluated by multiplying the screw-related value by the effective number n<sub>ef</sub> of connectors (see Eq. [ 1 ] above).

Table 8: Characteristic Ultimate Tensile Capacity of the Screws

Screw Diameter (mm)	R <sub>t,u,k</sub>
6	12,5
8	23,5
10	33

Table 9:  $r_{ax,k,\alpha}$  [N/mm] Characteristic Value of Withdrawal Parameter of a Screw for a ZYKLOP connector placed on the side grain. Values are Withdrawal per mm Embedded Length

Connector on Side Grain		30°	45°	60°
Screw Diameter (mm)	6	62,1	81,0	81,0
	8	66,9	87,2	87,2
	10	88,2	115,0	115,0

Table 10:  $r_{ax,k,\alpha}$  [N/mm] Characteristic Value of Withdrawal Parameter of a Screw for a ZYKLOP connector placed on the end grain

Connector on End Grain		30°	45°	60°
Screw Diameter (mm)	6	81,0	81,0	62,1
	8	87,2	87,2	66,9
	10	115,0	115,0	88,2

The screw capacity is evaluated according to Eq. [ 1 ] of this section:

If an applied force  $F_\beta$  acts under an angle  $\beta$  in a direction between those shown in Figure 1 and Figure 2 of this section,  $F_\beta$  shall be split into a component  $F_{par}$  parallel to the steel plate surface and another component  $F_{ax,screw}$  parallel to the screw. Each single component shall separately fulfil the required proofs stated above.

Additionally it shall be checked that the screw has capacity to carry the resulting axial force

$$F_{ax,screw} + F_{par}/\cos\alpha.$$

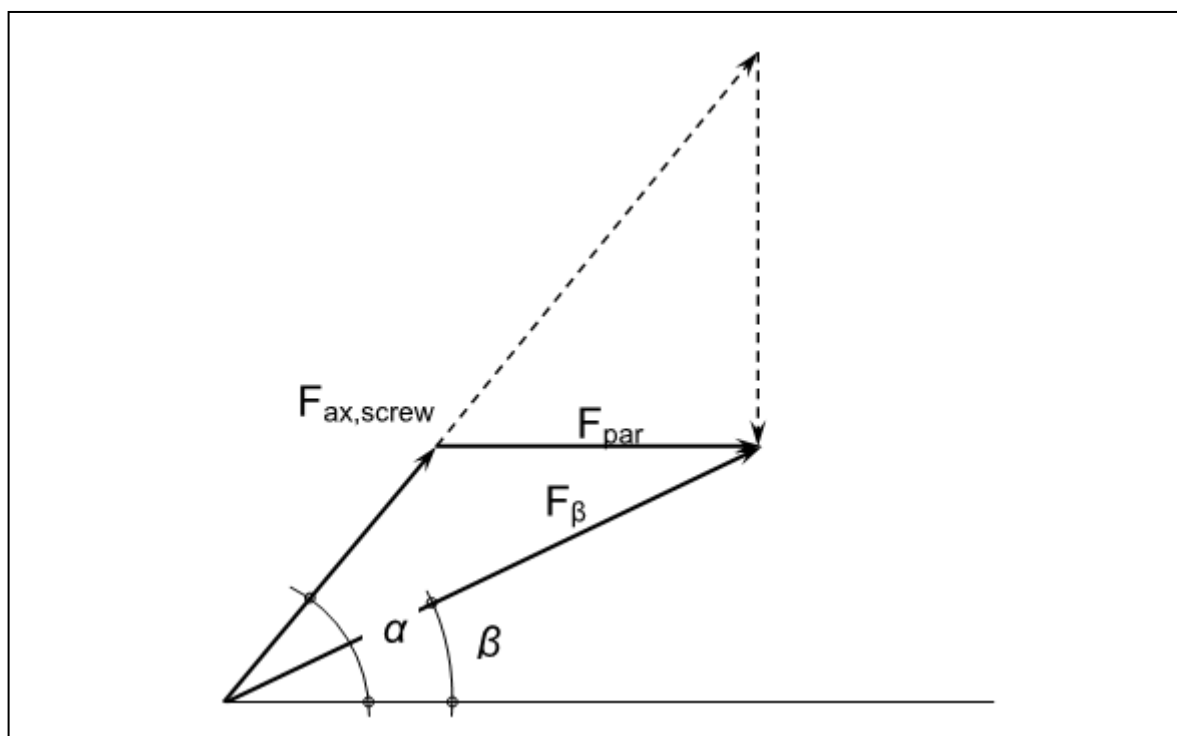
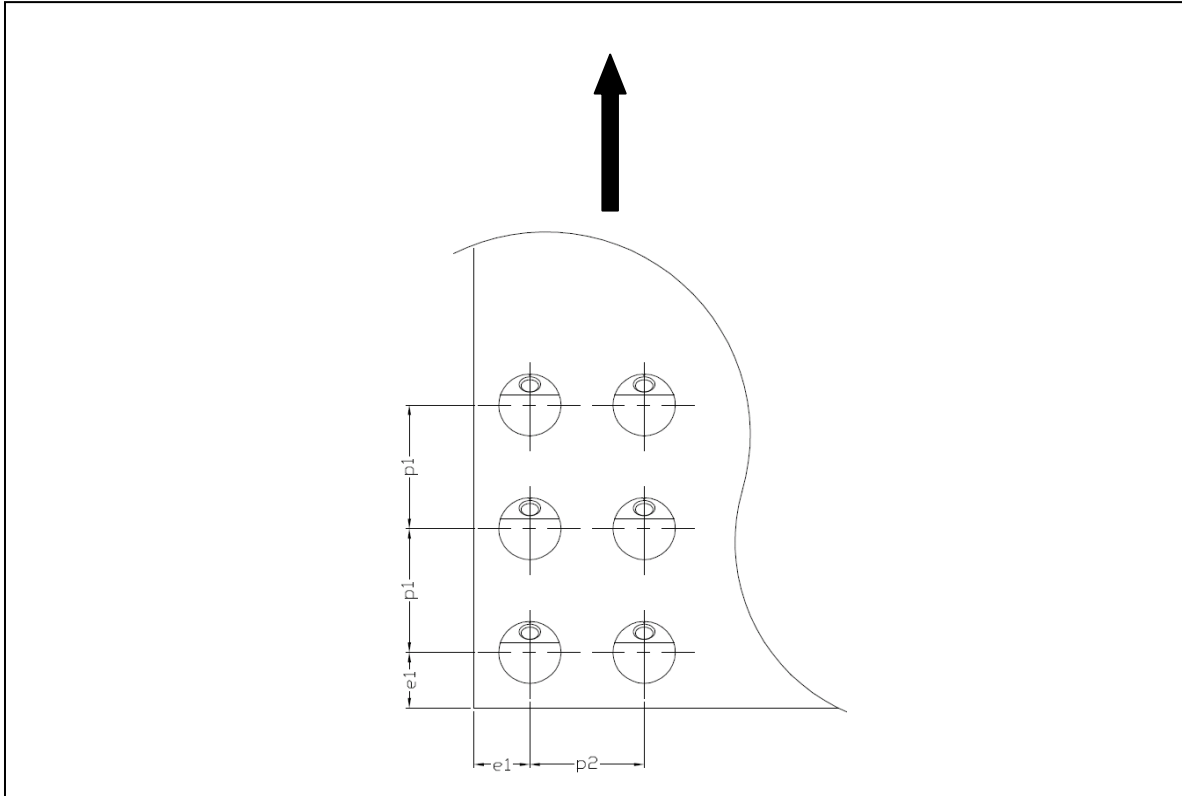


Figure 6: Load plan for an Applied Force  $F_\beta$  under an Angle  $\beta$

***Distances and Spacings***



*Figure 7: Definition of Distances and Spacings in a Rectangular Alignment*

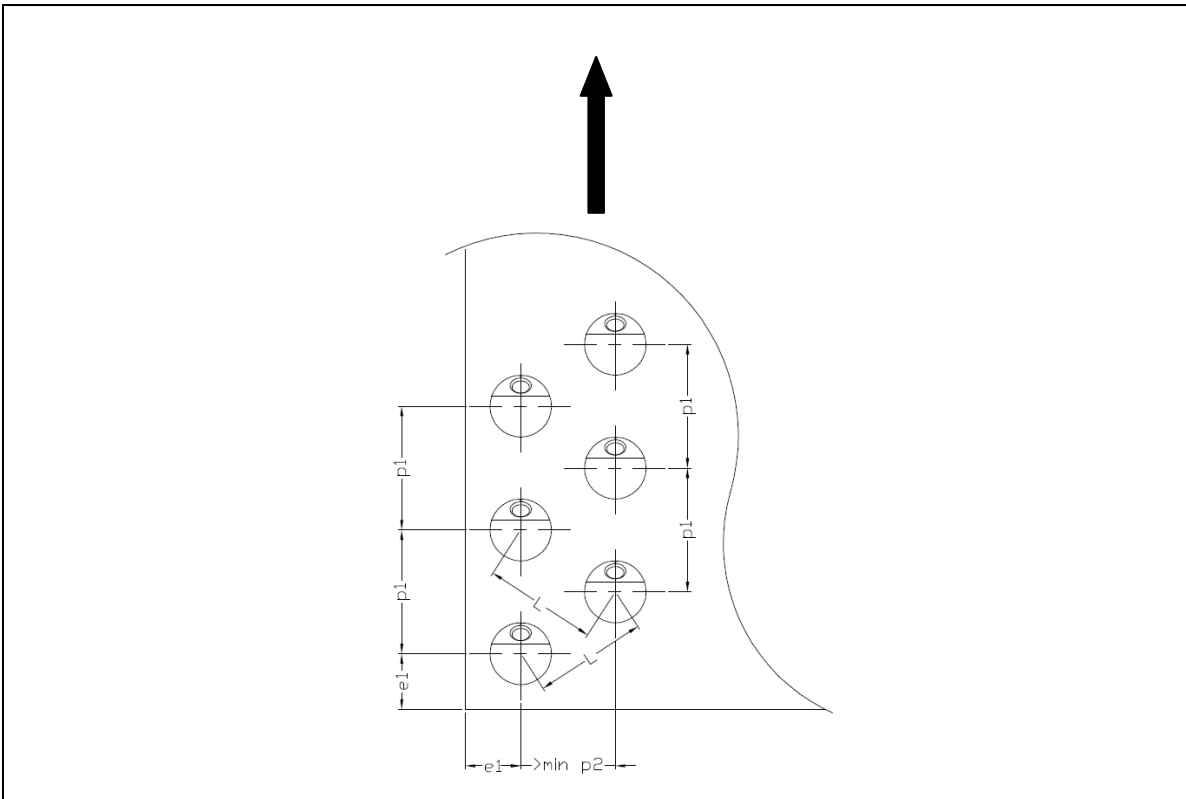


Figure 8: Definition of Distances and Spacings in a Staggered Alignment

Table 11: Spacings and Distances at Maximum Connector Load

Connector	$p_1$ (mm)	$p_2$ (mm)	$e_1$ (mm)	min $p_2$ (mm)*	L (mm)
ZYK10	60	55	30	25	55
ZYK11	59	59	30	20	59
ZYK12	55	55	30	16	55
ZYK40	80	78	40	34	78
ZYK41	75	75	40	25	75
ZYK42	75	75	40	20	75
ZYK70	100	88	50	37	88
ZYK71	91	91	50	30	91
ZYK72	88	88	50	25	88
ZYKT39	60	49	30	20	49
ZYKT69	80	65	40	25	65
ZYKT99	100	78	50	25	78

\*) :  $p_2$  can be reduced down to min  $p_2$  in a staggered alignment provided the L-values are not underrun.

Note: These spacings and distances assume a minimum plate thickness of 'req w' as given in Tables 6 and 7 of this section.

Table 12: Spacings and Distances at Minimum Steel Plate Thickness

Connector	$p_1$ (mm)	$p_2$ (mm)	$e_1$ (mm)	min $p_2$ (mm)*	L (mm)
ZYK10	60	55	30	25	55
ZYK11	46	46	30	20	46
ZYK12	39	39	30	16	39
ZYK40	80	78	40	34	78
ZYK41	59	59	40	25	59
ZYK42	49	49	40	20	49
ZYK70	100	88	50	37	88
ZYK71	71	68	50	30	68
ZYK72	59	59	50	25	59
ZYKT39	60	42	30	20	42
ZYKT69	80	52	40	25	52
ZYKT99	100	59	50	25	59

\*) :  $p_2$  can be reduced down to min  $p_2$  in a staggered alignment provided the L-values are not underrun.

Note: These spacings and distances assume a minimum plate thickness of 'min w' as given in Tables 6 and 7 of this section.

Spacings and distances between the values given in Table 12 and Table 11 for plate thicknesses between 'min w' and 'req w' may be determined by linear interpolation.

The steel plates shall not overlap the timber edges.

All capacities are evaluated for C24 timber. Timber of a lower strength class shall not be used. The higher strength properties of timber of a higher strength class shall not be taken into account.

## Annex 5 – Connectors’ Capacities – Determined from Tests

### A 5.1 –MJC capacities

Maximum Incoming Concentrated Load <sup>1</sup> (kN)			
Number of MJC's <sup>2</sup>	Characteristic Load		
	LVL Flanges	45mm Solid Sawn Flanges	Metal Web
4	16.46	9.10	9.12
8	24.69	13.65	13.68

Maximum Incoming Concentrated Load <sup>1</sup> (kN)			
Number of MJC's <sup>2</sup>	Characteristic Load		
	LVL Flanges	45mm Solid Sawn Flanges	Metal Web
2	8.23	4.55	4.56
4	12.35	6.86	6.84

1. “Maximum Incoming Concentrated Load” refers to the maximum concentrated load that can be applied when the MJC’s are installed either side of the incoming load.
2. Number of MJC’s equally spaced about the incoming load.
3. “Maximum Incoming Regular Load” refers to the maximum load that can be applied at regular intervals along the supporting timber  
Number of MJC’s between each incoming load

### A 5.2 – Glide Shoe capacities

Model No.	Dimensions (mm)	Fasteners (3.75x30)		Characteristic Capacity (kN)	
	Width	Support C24	Carried member LSL	Lateral	Uplift
GS38	38	10	6	6.6	2.8
GS50	50				
GS75	75				
GS100	100				
GS150	150				
GS200	200				

### A 5.3 – VTCR capacities

The connector can be used with various truss pitches from 10° - 40°.

Model No.	Number of Fasteners		Characteristic Capacities (kN)	
	Common truss (3.35mmx65mm)	Valley truss (3.75mmx30mm)	Uplift	Download
VTCR	4	3	0.97	8.00