



# Ty Unnos

## Standard Ty Unnos Structural Connections Review

For  
Coed Cymru  
'Improve the Supply Chain for Low value Welsh Timber'

Project Number: - 7224

Date: - 02/10/14

Rev: - P4



Cronfa Amaethyddol Ewrop ar gyfer Datblygu  
Gwledig: Ewrop yn Buddsoddi  
mewn Ardaloedd Gwledig  
The European Agricultural Fund for  
Rural Development: Europe Investing in  
Rural Areas



Llywodraeth Cymru  
Welsh Government

## Content/Quality Assurance

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- 1.0** Introduction
- 2.0** Box Beam Frame Connections
- 3.0** Box beam Secondary Connections
- 4.0** Foundation Connections
- 5.0** Ty Unnos Modular™ Ladder Beam Connections
- 6.0** Coed Cymru Ladder Beam Connections
- 7.0** Other connections

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### Document issue details:

<b>Version Number</b>	<b>Issue Date</b>	<b>Issue Status</b>	<b>Distribution</b>
P1	07/10/14	Preliminary for Comment	Client
P2	16/10/14	Preliminary for Comment	Client
P3	24/10/14	Final	Client
P4	26/11/14	Final	Client

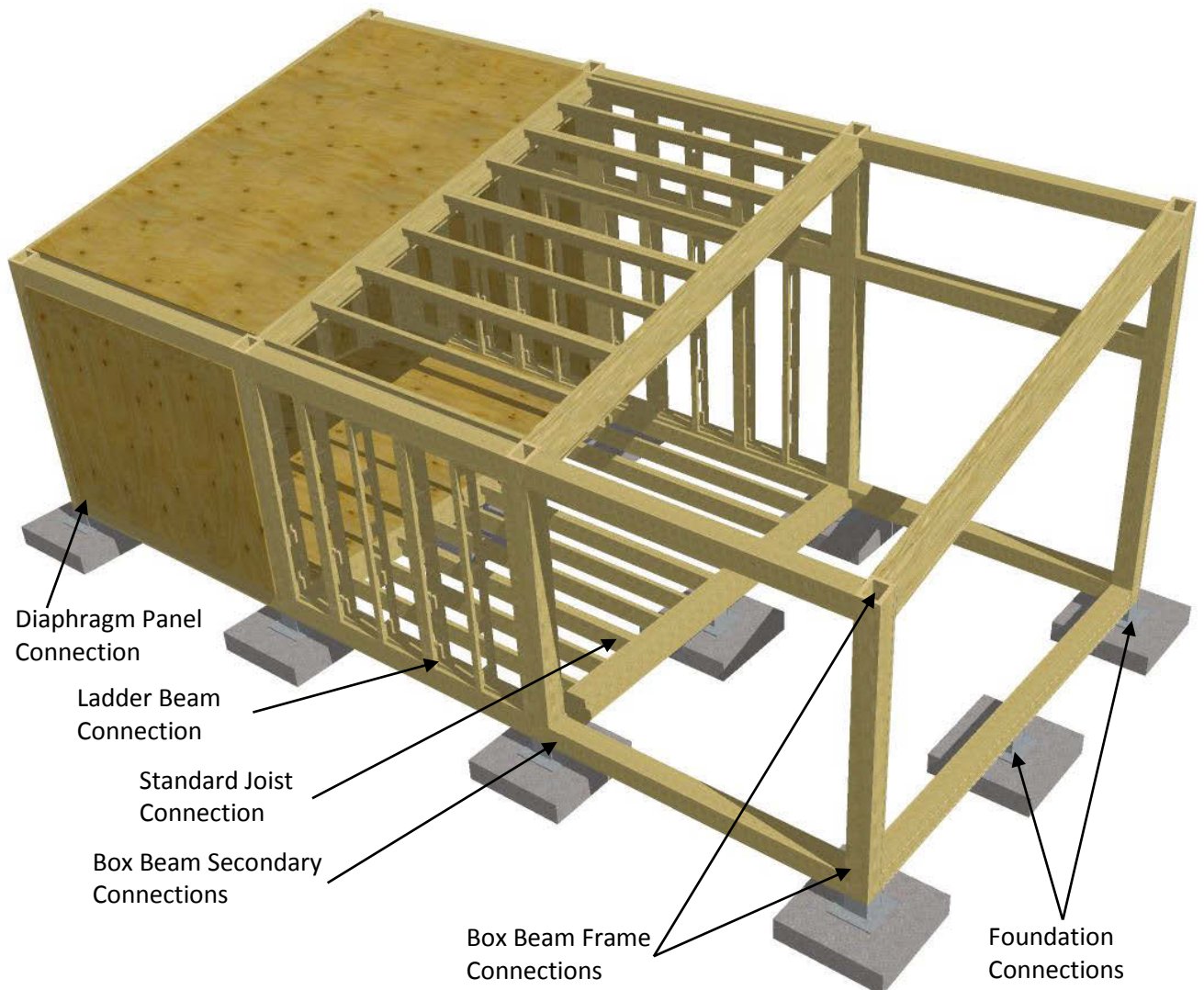
<b>Prepared</b>	<b>Checked</b>	<b>Approved</b>	<b>Date</b>
TM	TH	TH	07/10/14
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TM	TH	TH	26/11/14

## 1.0 Introduction

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- 1.1. The following document is intended as a guide to explain the principal connections used to date as part of the Ty Unnos system. It provides a brief description of the connections including the principle of design but does not include any design data.
- 1.2. This document has been compiled for 'Improve the Supply Chain for Low value Welsh Timber' a Coed Cymru project that is funded through the Rural Development Plan for Wales 2007-2013 which is funded by the Welsh Government and the European Agricultural Fund for Rural Development
- 1.3. The Ty Unnos system is a highly adaptable, additive, modular system that can create a range of house types and other buildings. The system is based on a simplified, standardised kit of parts. The system uses locally sourced timber in standard, readily available lengths to create a simple building system which is also suitable for self or assisted build.
- 1.4. Typical Ty Unnos structures are formed from one or two storey frames spanning up to approximately 6m between columns. The frames are typically at centres up to approximately 5m, although the maximum span and centres cannot be used simultaneously. The roof level of the frames can include flat, mono-pitch or duo-pitch roof beams. Frames can be arranged in a variety of configurations to give different building sizes and shapes of any size.
- 1.5. The Ty Unnos system is formed from two principal components; box beams and ladder beams. In addition to these standard timber joists, plywood or OSB sheathing and connections are used.
- 1.6. The Ty Unnos box beam is a rectangular hollow section formed from four solid timber sections jointed with glued joints. The solid timber sections can be jointed in the length of the beam to create beams longer than standard timber sizes. The web pieces can also be jointed along the length of the beam to create deeper beams.
- 1.7. There are two current versions of the Ty Unnos ladder beam one developed by Coed Cymru and one developed by Ty Unnos Modular™.
- 1.8. The Ty Unnos Modular™ ladder beam is an engineered joist constructed from sections of timber in a ladder arrangement. The booms, top and bottom, are formed from 70x40 continuous sections with a groove joint. The rungs running between the booms, are formed from 140x40 sections with a tongue joint at each side to fit into the boom grooves. The rungs are connected to the flanges with glue and long screws into the rung side grain
- 1.9. The Coed Cymru ladder beam is an engineered joist constructed from small sections of timber in a ladder arrangement. The booms, top and bottom, are formed from two continuous sections. The rungs running between the booms, are formed from single sections and are positioned between the two boom sections. The gaps in the booms between rungs are filled with short timber sections. All of the timber sections are 20x60mm in cross section except the rungs which are 20x95mm and spaced at max 400mm centres. The depth of the joists can be varied to suit different applications within the range of 200 to 300mm.
- 1.10. Where timber is used in the connections it should generally be stress graded C16 timber. Where timber is specified as less than 40mm thick it should be visually graded in accordance with the ladder beam timber specification. The specification of plywood and OSB boarded products will vary depending on the level of stress in the connections, typically Finish Birch plywood has been used.
- 1.11. Where steel plates are used in the connections they should be a minimum of grade s275 J0 and generally should be hot dip galvanised (these should be confirmed by the designer for the specific application).
- 1.12. Ty Unnos components and connections are typically designed to the Eurocodes.

- 1.13. The connections outlined in this document represent the connections used to date which are applicable to general Ty Unnos structures. Other one off connections have been developed for specific circumstances and as such future designs do not need to be limited to the range of connections presented here. However the simplest and most cost effective way of building / designing in Ty Unnos is to use the standardised component wherever possible.
- 1.14. Each of the connections are described and shown pictorially, these are intended to be generic and indicative representations of the connections as they are typically used. The connections as shown should not be constructed without a detailed design by a suitably qualified engineer to confirm the connection arrangement. Typically this will relate to the size and number of fixings.

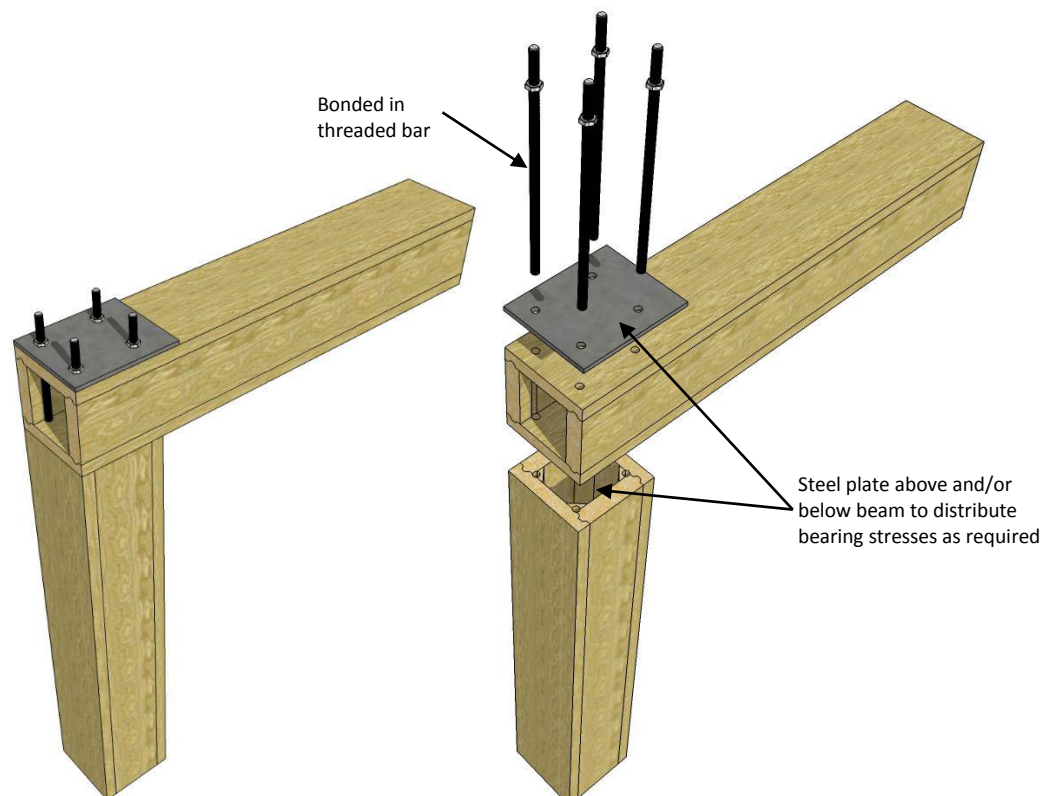


## 2.0 Box Beam Frame Connections

- 2.1. Typically these connections are between box beams forming floor/roof beams/rafters and columns within a frame.
- 2.2. They are generally required to transfer shear loads from the beams to the columns as well as axial loads from the upper column to the lower column.
- 2.3. Often they are also used to transfer moments from the beams to the columns to enable the frames to act as stability structures and to improve the performance of floor/roof beams.
- 2.4. Four different connection types have been used in Ty Unnos projects to date. These are all outlined below with a brief description.

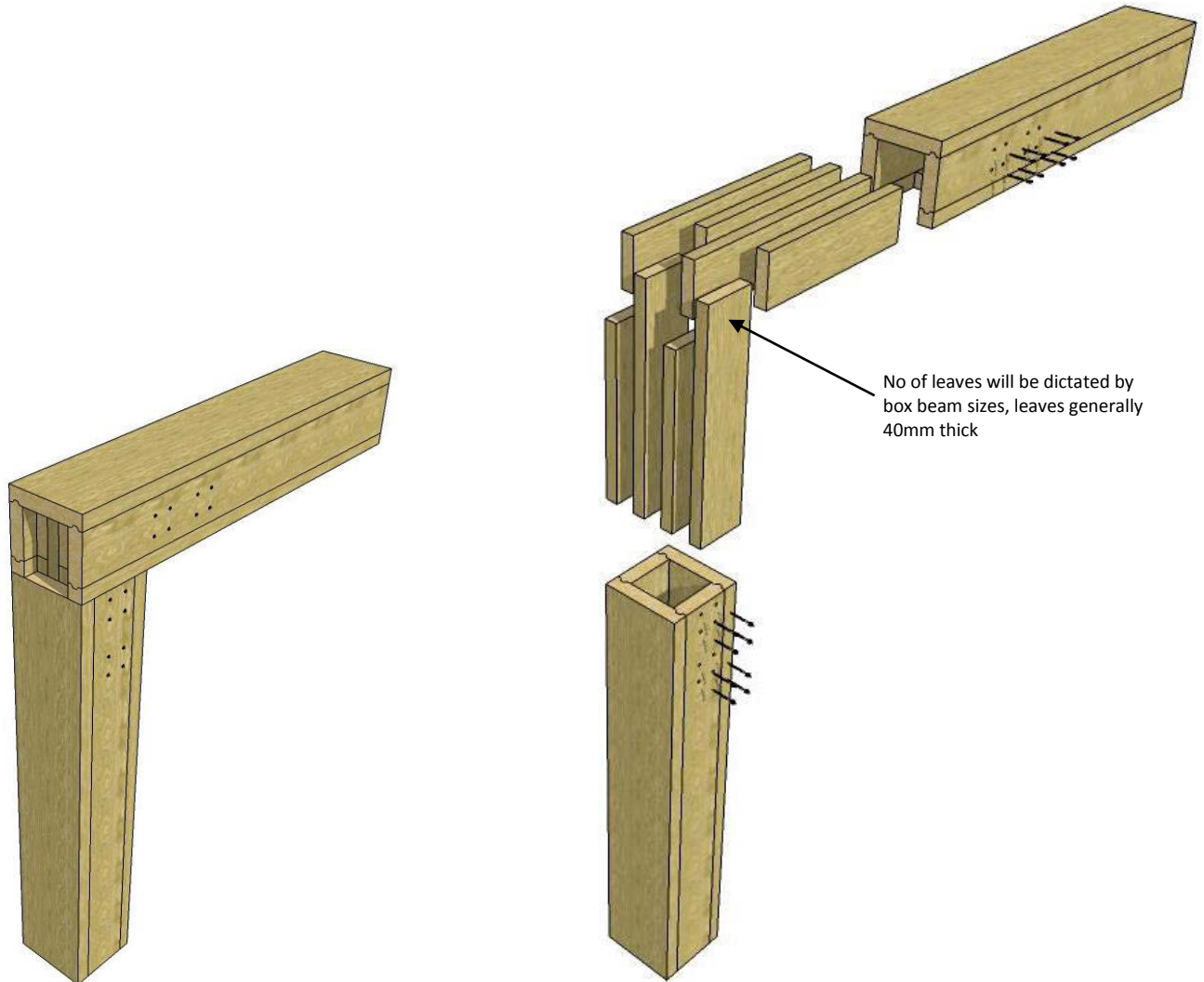
### 2.5. Threaded Bar Connection

- 2.5.1. This connection is formed by bonding threaded bars into a length of the beam or column these are then passed through holes in the second member and secured with nuts and washers.
- 2.5.2. A single threaded bar is installed in each corner of the box beam. This is achieved by gluing a chamfered piece of timber on the inside of each corner. The end of the section is then drilled to the required depth, partially in the web and flange and partly in the chamfered section. Threaded bar is then resin fixed into this hole.
- 2.5.3. This connection requires specialist machinery to construct, particularly a column drill able to accurately drill the end of the section. However it is simple to erect on site and could be used to connect Ty Unnos components to other building materials.
- 2.5.4. The strength of the joint is assessed on the basis that the bond between the timber and bolt is as good as the timber shear strength. Then standard calculations can be undertaken with compression zones between the timber members and shear/tension in the bolts.



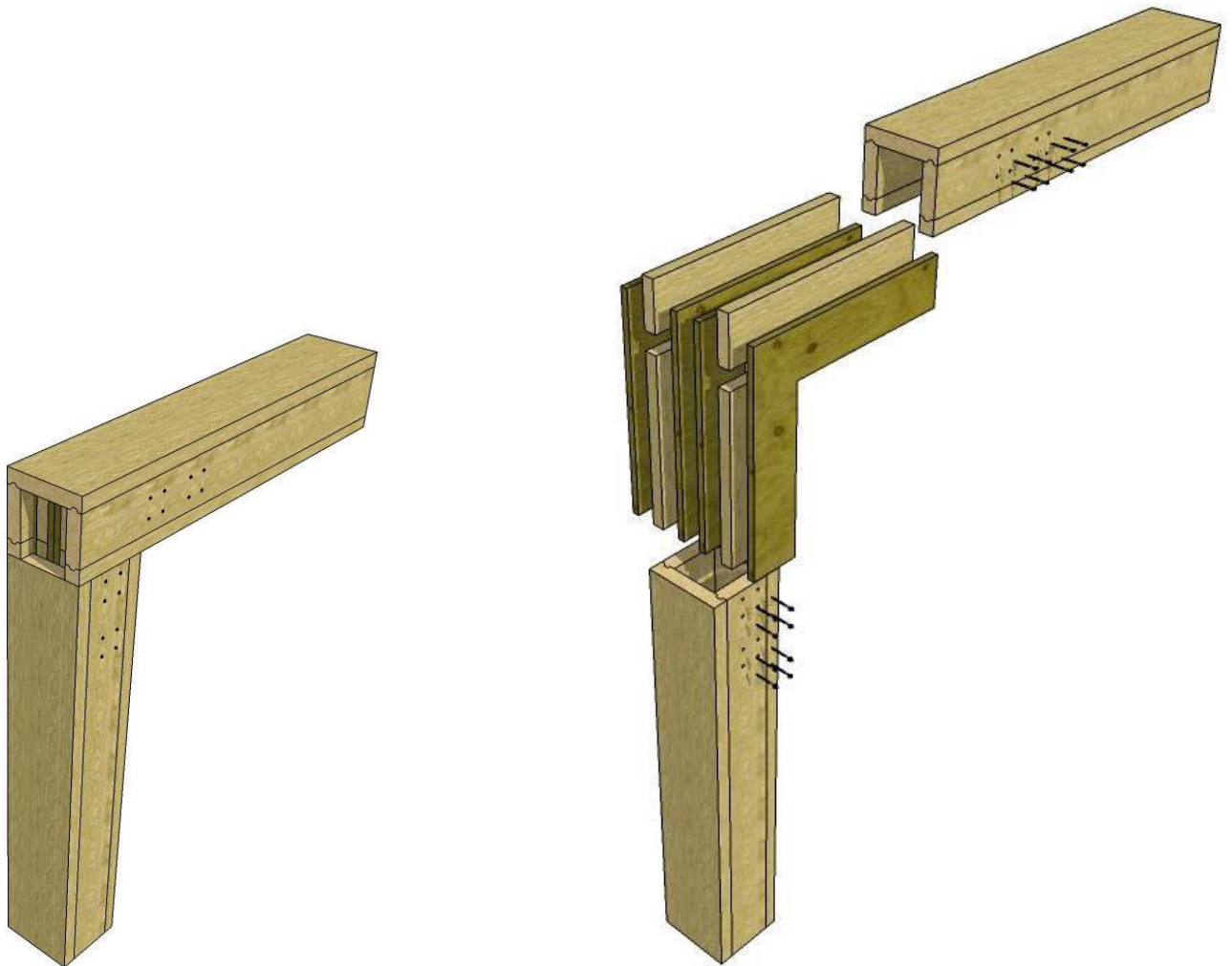
## 2.6. Solid Timber "L" Connection

- 2.6.1. This connection is formed by inserting a laminated timber "L" shape into the ends of each box beam. This is glued in place and secured with screws driven into the face of the box beams.
- 2.6.2. The connection is useful as a shear only connection but has largely been superseded by the plywood connections below.
- 2.6.3. The connection is analysed as bearing on the inside of the box beam. The screws and glue are typically excluded from the analysis. The bending capacity of the timber "L" piece should also be checked.



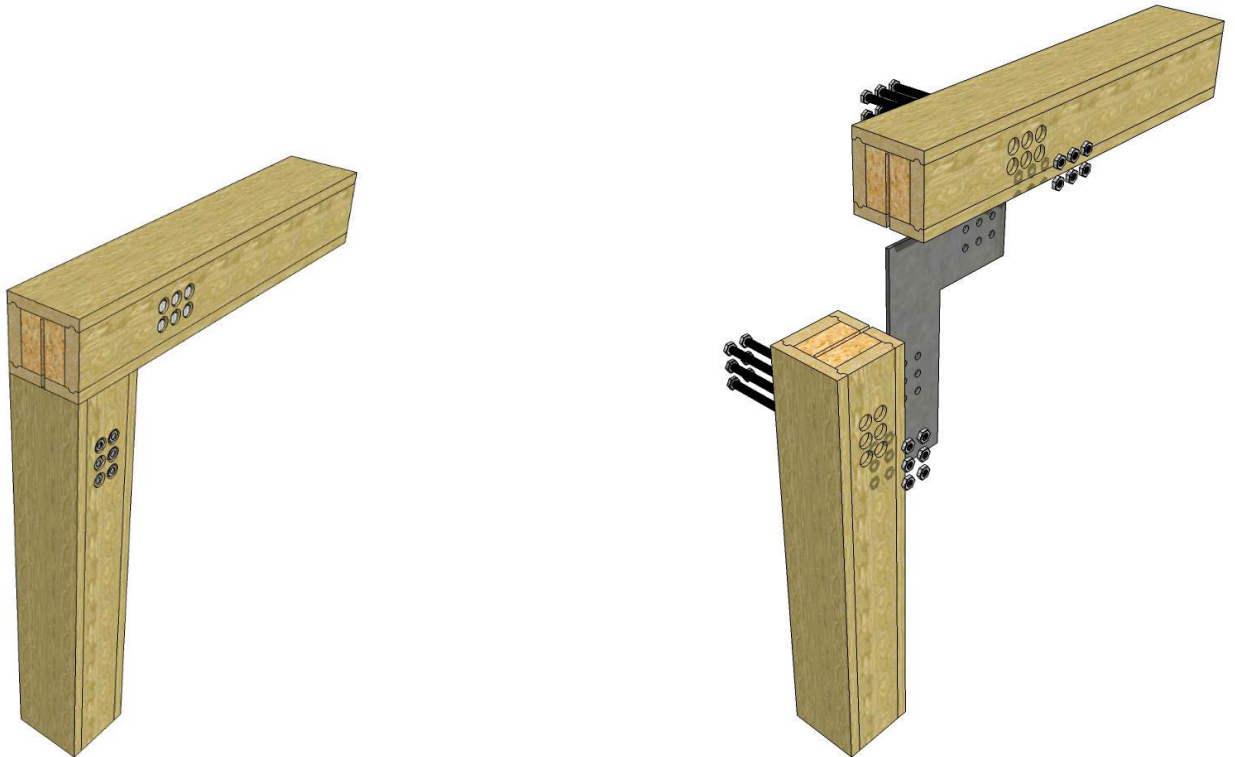
## 2.7. Plywood “L”, “T” and “X” Connection

- 2.7.1. This connection is very similar to the solid timber connection above but uses plywood “L”, “T” or “X” shapes in place of the solid timber “L”. These are cut from single plywood sheets and laminated together to achieve the desired thickness. This is glued in place and secured with screws driven into the face of the box beams. It is also possible to incorporate layers of packing timber to reduce the amount of plywood required.
- 2.7.2. Because the plywood is continuous it overcomes the weakness of the solid timber connectors. Also this means that any shape connector can be formed providing it is in a single plane and fits within a plywood sheet.
- 2.7.3. The connection is analysed as bearing on the inside of the box beam. The screws and glue are typically excluded from the analysis. The bending capacity of the plywood “L” piece should also be checked.



## 2.8. Bolted Flitch Plate Connection

- 2.8.1. This is a standard timber frame connection. For use with box beams it is necessary to fill the inside of the box beam to create a solid section. This then has a slot cut in it into which a steel plate is inserted and bolted in place.
- 2.8.2. It is versatile and could be used to create out of plane connections although it requires significant amounts of steel and bolts.
- 2.8.3. This is analysed as set out in the Eurocodes for bolts in shear with steel plates.



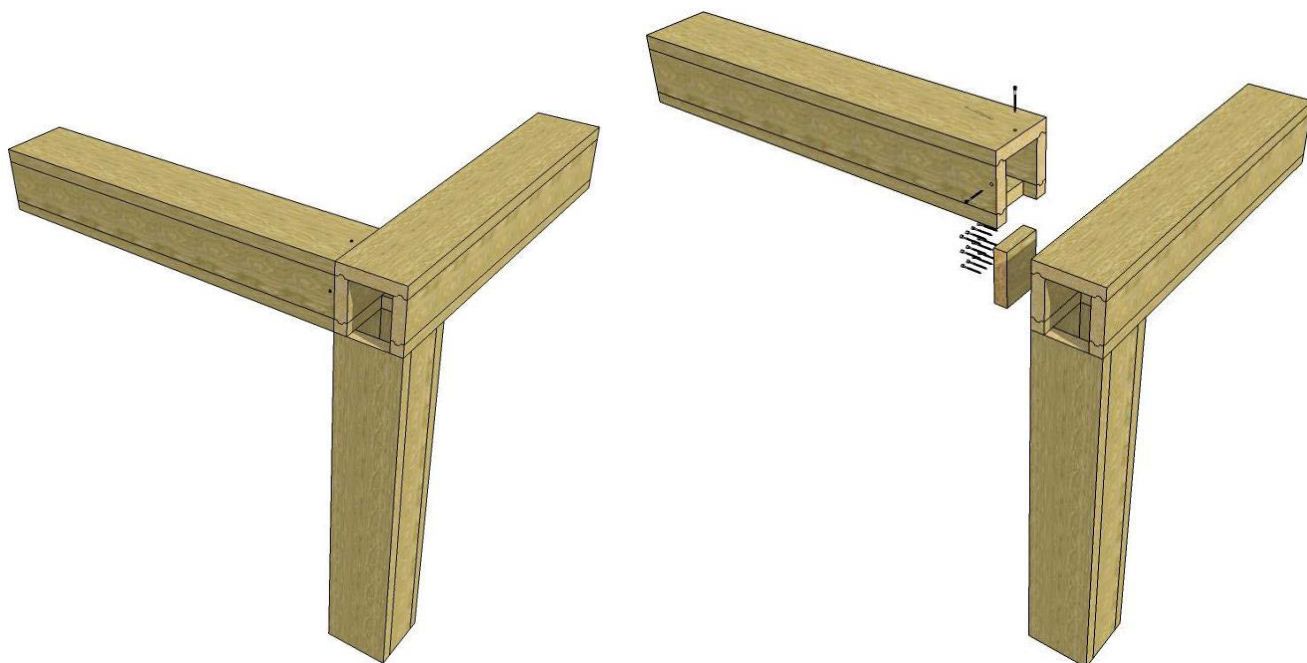


## 3.0 Box Beam Secondary Connections

- 3.1. Typically these connections are between box beam frames and secondary box beams spanning between frames.
- 3.2. They are generally required to transfer shear loads from the beams to the frames.
- 3.3. One connection type has been used in Ty Unnos projects to date. This is outlined below with a brief description.

### 3.4. Shear Plate Connection

- 3.4.1. This connection is formed by screwing a solid timber plate to the frame. The plate is the same size as the inside of the box beam so that, with the lower flange cut back, the box beam can slide onto it. Locating screws between the box beam and the plate are used to provide robustness.
- 3.4.2. If required the timber plate depth can be increased to be deeper than the beam providing the frame members have sufficient depth. This enables more screws to be installed between the plate and the frame.
- 3.4.3. When analysing this connection two interfaces are considered. The box beam to plate connection is considered to be via bearing of the top flange on the plate (the location screws are typically ignored). The plate to frame connection is by shear in the screw fixings.
- 3.4.4. This connection does not provide any tension resistance and therefore for robustness this should be provided by another mechanism such as a plywood diaphragm or robust joist connections.

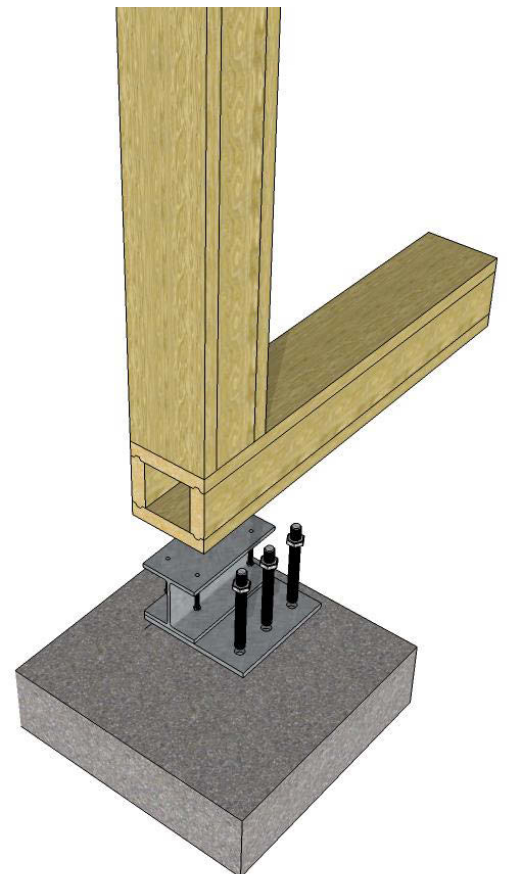
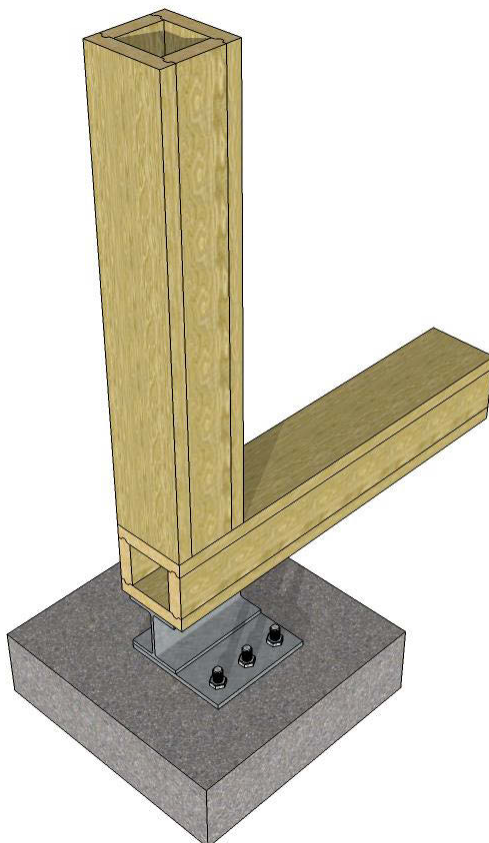


## 4.0 Foundation Connections

- 4.1. Typically these connections are between frames and concrete foundations.
- 4.2. They are generally required to transfer axial loads from the columns to the footings
- 4.3. Often they are also used to transfer moments from columns to the footings to improve the efficiency of stability frames.
- 4.4. Two different connection types have been used in Ty Unnos projects to date. These are both outlined below with a brief description.

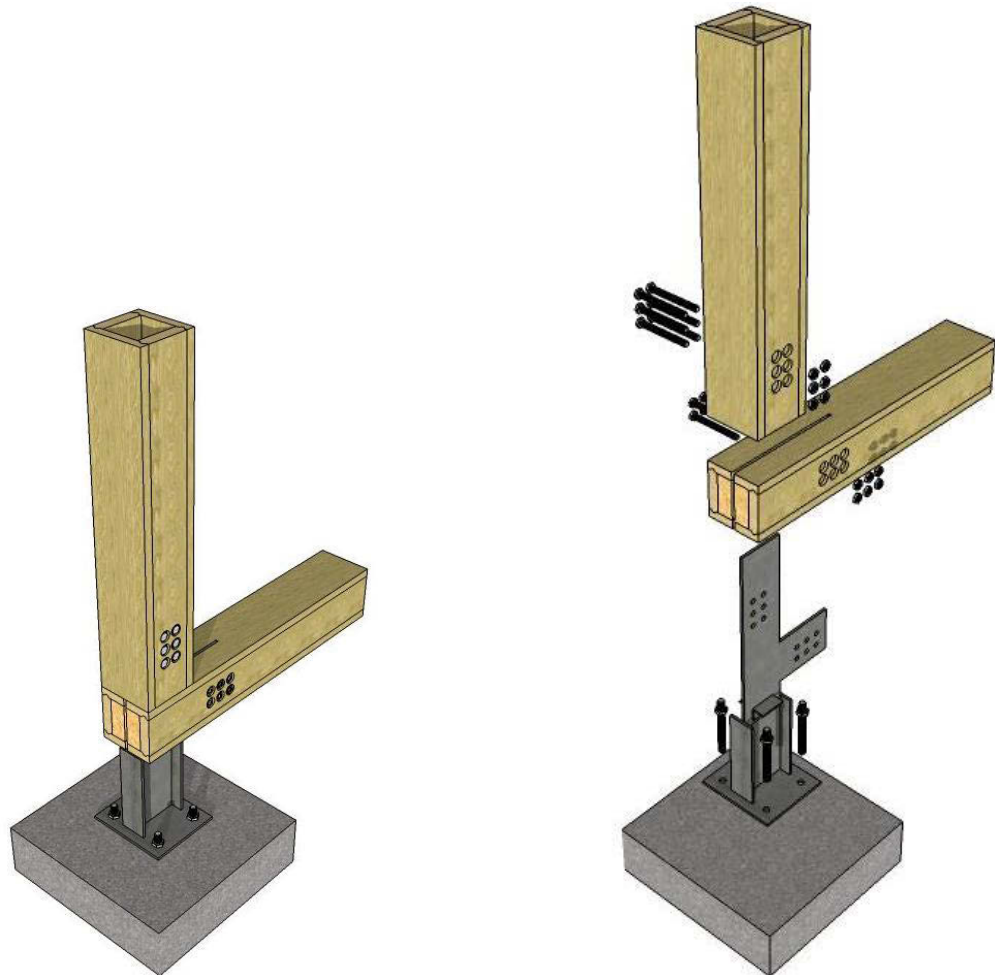
### 4.5. Steel Foot Connection

- 4.5.1. This connection is formed with a length of steel universal beam with a plate welded to its top and bottom flanges. The top plate has four holes allowing it to be fixed to a box beam flange with coach screws. The lower plate has three holes for resin anchors bolts fixed into the concrete footings.
- 4.5.2. The holes in the lower plate are offset from the frame to allow the resin anchors to be drilled with the module (or frame) in place.
- 4.5.3. When this connection is used in conjunction with threaded bar connection described in section 2.5 the coach screws can be omitted. In this case the threaded bars are used to connect the steel foot to the frame.
- 4.5.4. This connection is not capable of transferring moments between the frame and foundation. This is due to their only be three resin fixed anchors fixed to the foundations.



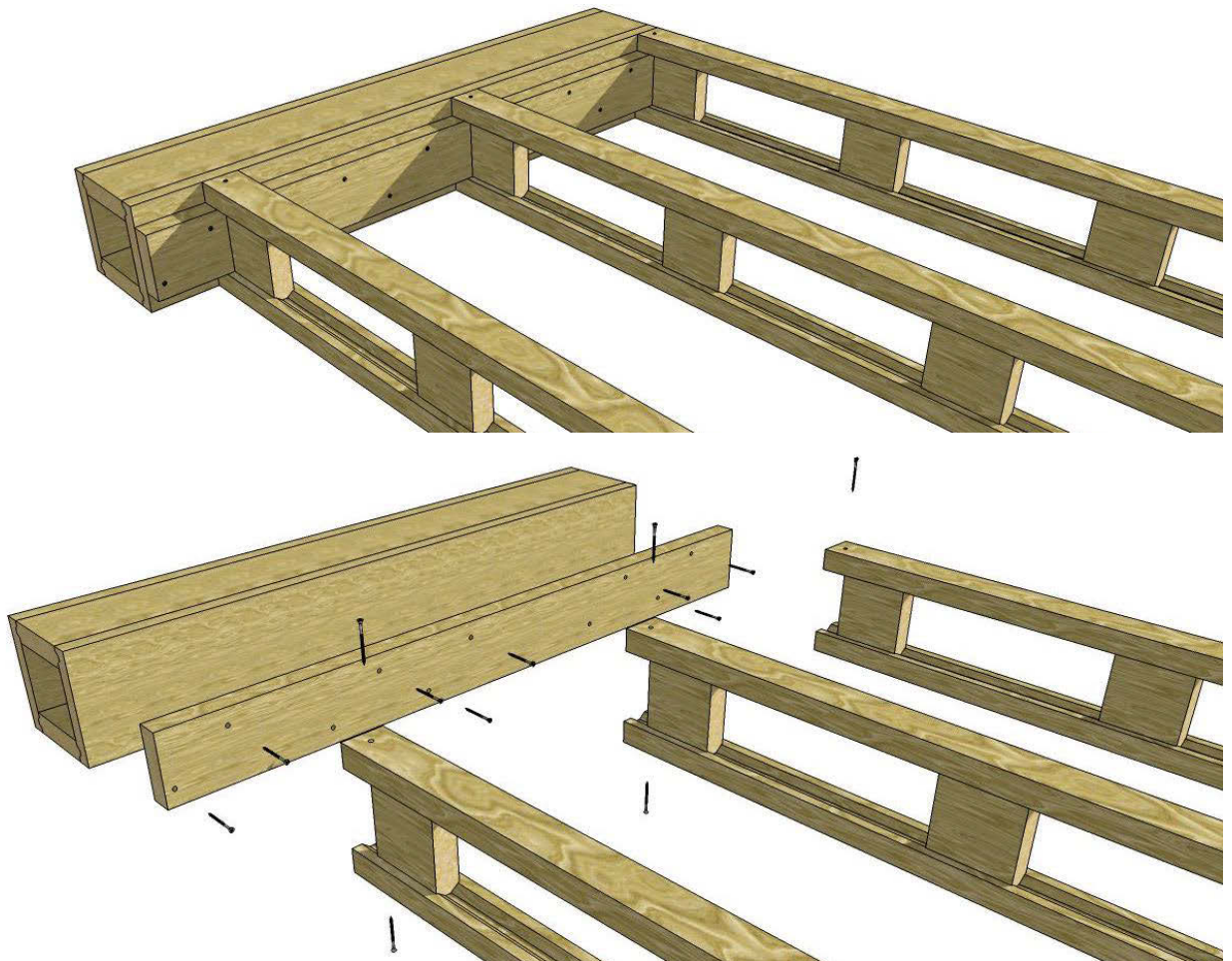
#### 4.6. Flitch Plate Connection

- 4.6.1. This is a variation on the standard frame flitch plate connections. A flitch plate is connected to the columns section, and possibly beam sections, with an additional length of steel plate. The additional length of steel plate is welded to a steel baseplate and stiffened if required. The baseplate can then be fixed to the foundations with cast in bolts or resin anchors.
- 4.6.2. This connection is capable of transferring moments to the foundations as well as accommodating large differences in levels between the foundations and timber frame. Where the steel is to be buried it should be encased in concrete.



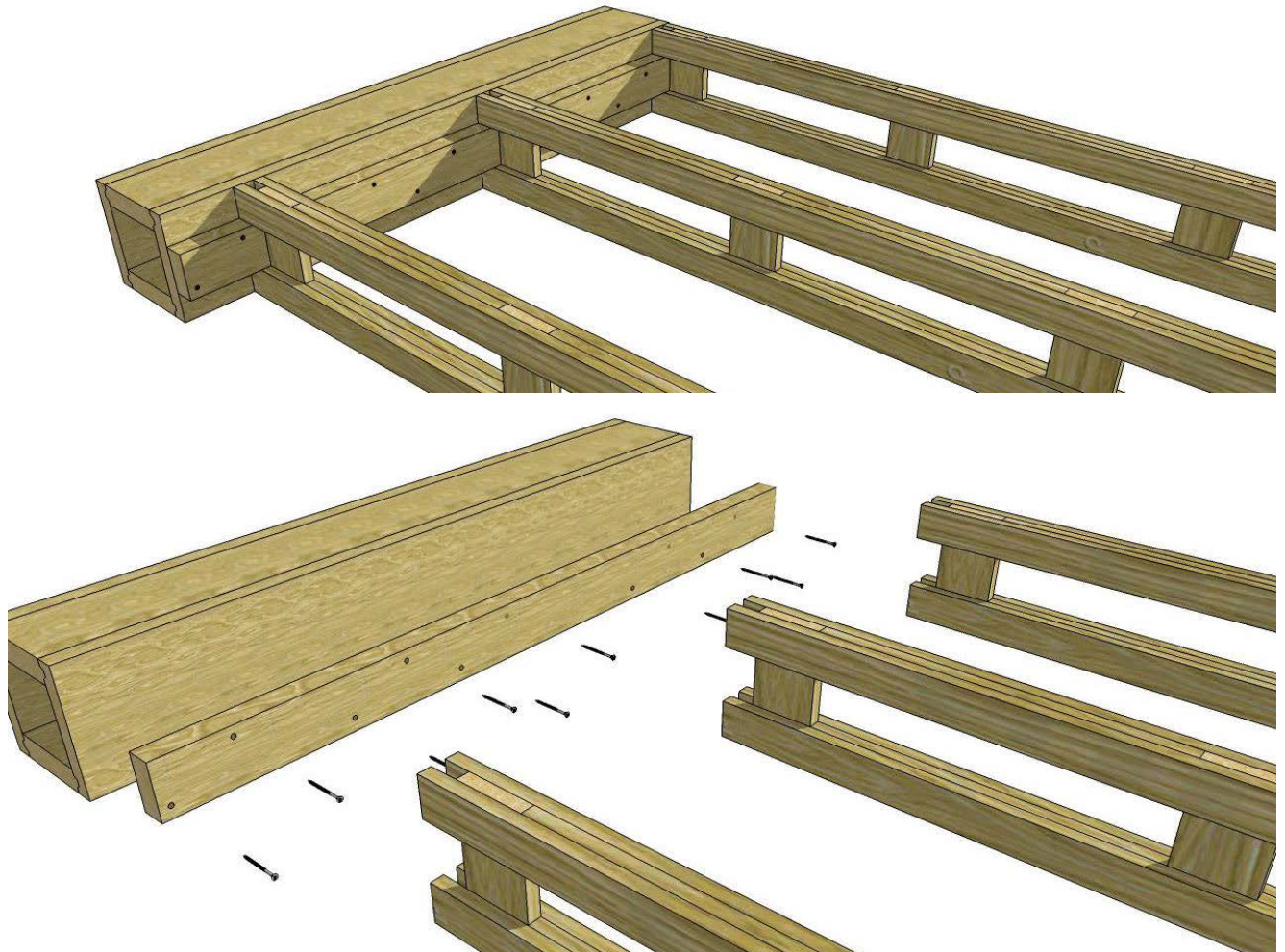
## 5.0 Ty Unnos Modular™ Ladder Beam Connections

- 5.1. Typically these connections are between ladder beams and box beams in the floors and walls. The ladder beams are typically arranged in panels with 2-4 ladder beams in each.
- 5.2. They are generally required to transfer shear loads from the ladder beams to the box beams.
- 5.3. One connection type has been used in Ty Unnos projects to date. This is outlined below with a brief description.
- 5.4. **Timber Plate connection**
  - 5.4.1. This connection is formed by fixing a timber plate to the ladder beams between the booms. This is screwed to the booms and to the end rung, which is hard against the plate. To accommodate this the ladder beams are constructed with the top and bottom flanges extending past the last rung. The plate is then fixed to the box beam with screws along its length between the ladder beams.
  - 5.4.2. For panels the plate is the same width of the panel and fixed to each of the ladder beams in that panel. This acts as a temporary brace for the ladder beams as well as the permanent connection.
  - 5.4.3. When analysing this connection two interfaces are considered. The ladder beam to plate connection is considered to be via bearing of the top flange on the plate (the location screws are typically ignored). The plate to box beam connection is by shear in the screw fixings.



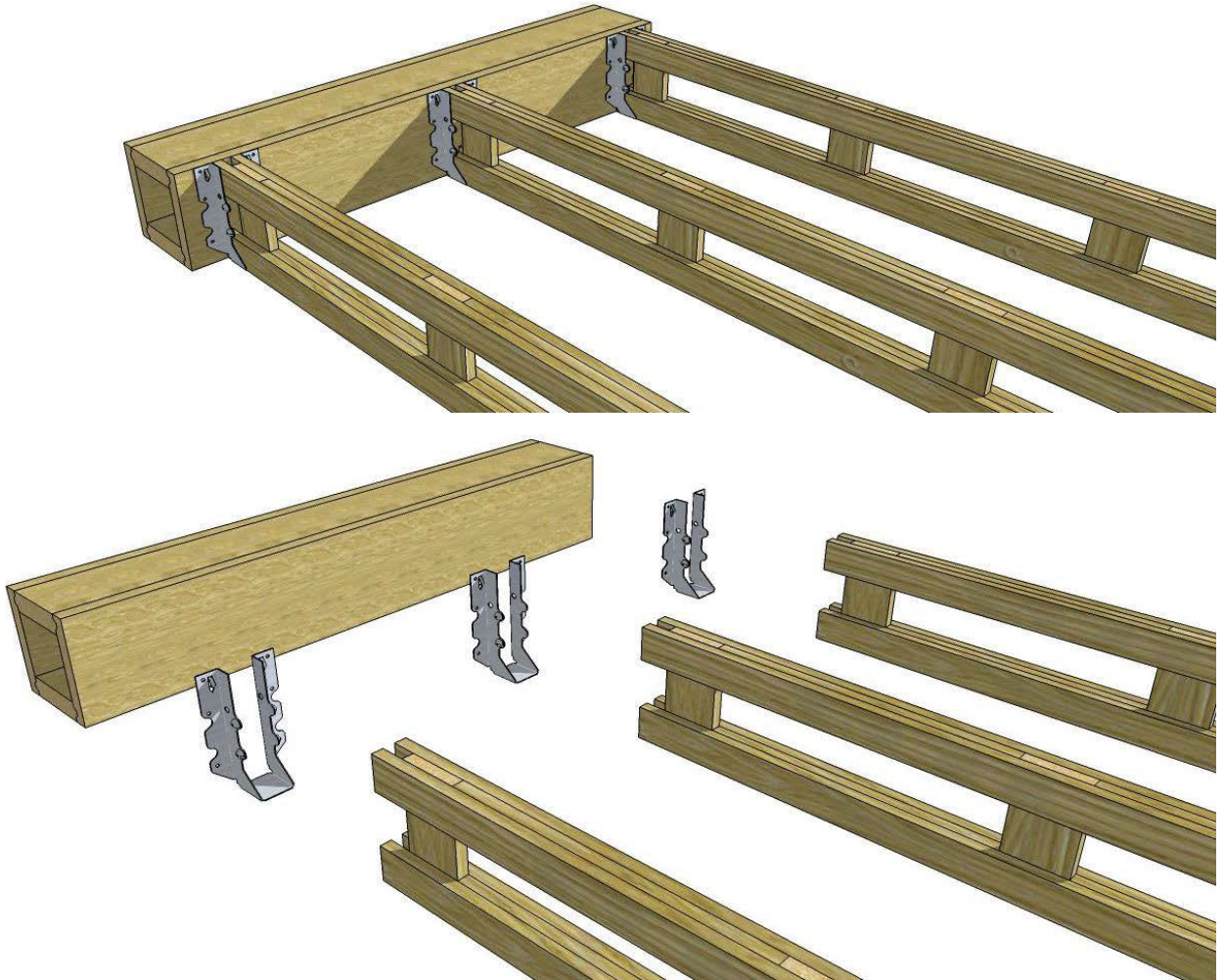
## 6.0 Coed Cymru Ladder Beam Connections

- 6.1. Typically these connections are between ladder beams and box beams in the floors and walls. The ladder beams are typically arranged in panels with 2-4 ladder beams in each.
- 6.2. They are generally required to transfer shear loads from the ladder beams to the box beams.
- 6.3. One connection type has been used in Ty Unnos projects to date. This is outlined below with a brief description.
- 6.4. Timber Plate connection**
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  - 6.4.2. For panels the plate is the same width of the panel and fixed to each of the ladder beams in that panel. This acts as a temporary brace for the ladder beams as well as the permanent connection.
  - 6.4.3. When analysing this connection two interfaces are considered. The ladder beam to plate connection is considered to be via bearing of the top flange on the plate, a positive connection is only provided by the floor sheathing. The plate to box beam connection is by shear in the screw fixings.



6.5. **Joist Hangers**

- 6.6. This connection is formed with standard proprietary joist hangers fixed to the box beam face or top flange. The ladder beams can then be installed in the same manner as standard joists.
- 6.7. This connection is only suitable for floors (not walls) and although possible for panels is significantly more complex to set out correctly.



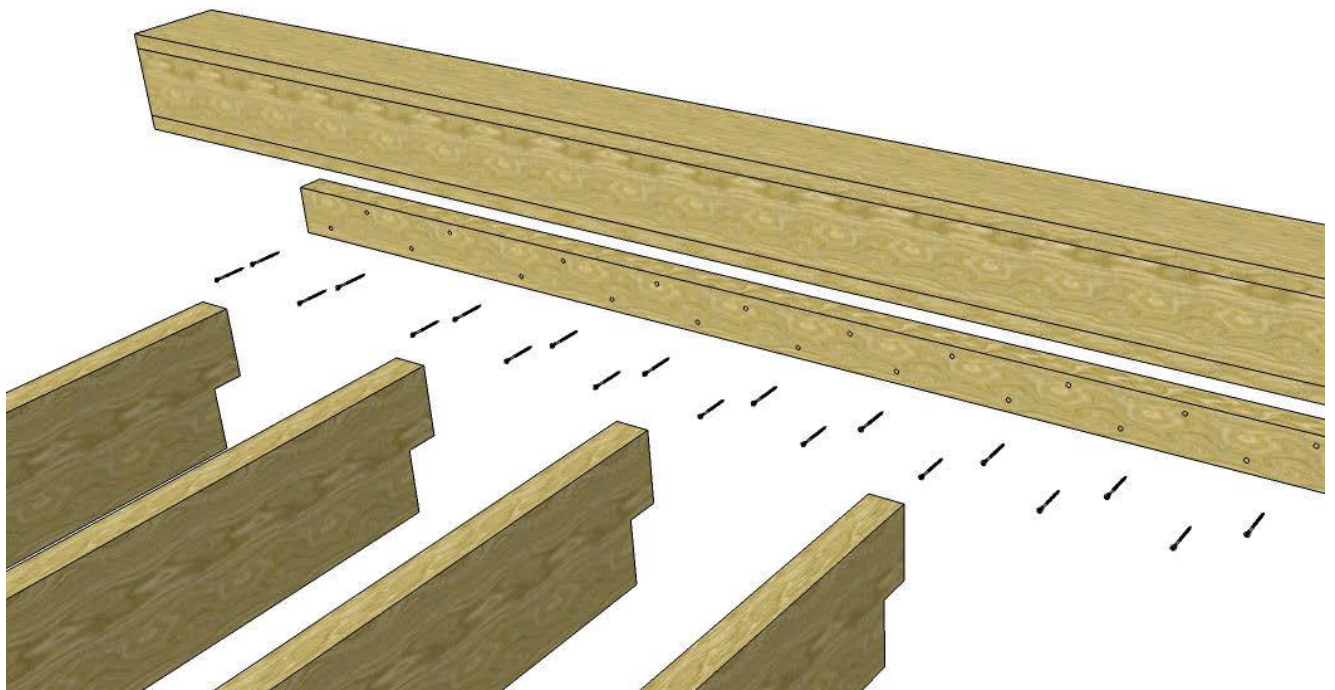
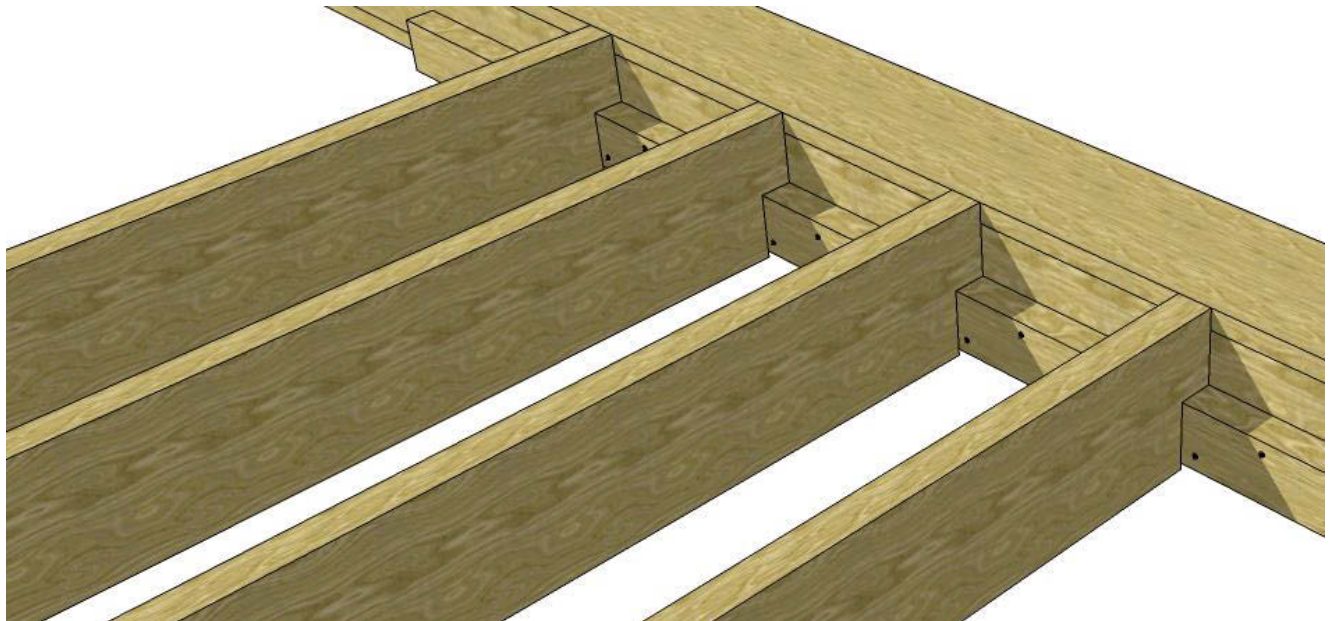
## 7.0 Other Connections

7.1. A series of other connections for specific interfaces within Ty Unnos structures have also been developed. Some of these are project specific and have not been included in this report but others have wider applications.

### 7.2. Standard Joist Connections

7.2.1. Where standard floor joists have been used in place of Ty Unnos ladder beams for floors they have been connected to the box beams via a halving joint onto a timber wall plate. This is usually formed with a wall plate depth equal to half the joist depth and a half depth notch in the end of the joist.

7.2.2. As with ladder beams the joists are often assembled into panels and in this case the joists are connected via half depth noggins at the end of the joists which will also bear on the plate. This noggin also provides a positive connection between the joists and box beam via screws through it, otherwise this is only provided by the floor sheathing.



### 7.3. Diaphragm panel Connections

- 7.3.1. For some structures it has been necessary to design diaphragm panels with positive connections to the foundations and to lower storeys. This has been achieved with flat steel plate connections. These are fixed to the outside face of the diaphragm panels with coach screws or standard screws as required by the loads.

