

# Mechanical fixings for wood

Wood is a versatile material and can be supplied in a wide range of shapes, sizes and products. When fixing wood components together, or to other materials, there are many different methods to consider, from standard and specialist fixings, to modern synthetic adhesives.

The first consideration when selecting fixings is whether the joint has to carry a structural load. If it does, a structural engineer must check the joint design. You should also take account of other factors, such as:

- the type of wood or wood product to be fixed
- what it is to be fixed to
- whether the overall product is to be loadbearing
- if it is for external or internal use.

Mechanical fasteners can be divided into two groups, depending on how they transfer the forces between the connected members:

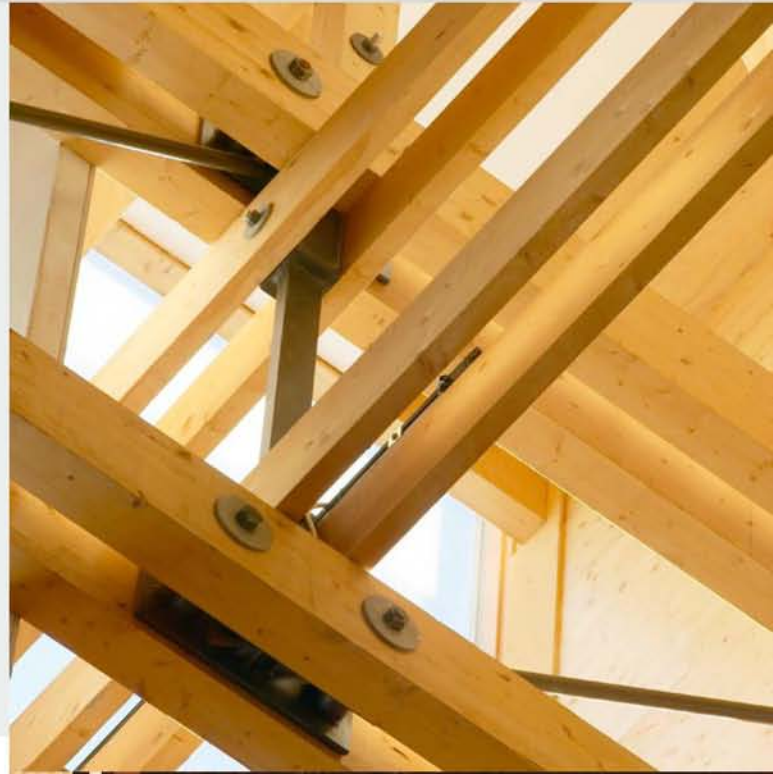
- **dowel-type fasteners** such as nails, screws, bolts and dowels, which transfer the load along the shank or length of the dowel
- **connectors** (or 'timber engineering hardware') such as metal plate fasteners, which transfer the load at the surface of each member.

Joints can also be formed by other types of fixing method, such as adhesives, carpentry and joinery techniques or by a combination of methods.

Generally, bolts and dowels are much heavier-duty fasteners than screws or nails and have the greatest individual loadbearing capacity. Screws are normally chosen instead of nails for their demountability and better pull-out resistance.

Some species of wood react with iron to form a black compound that stains the wood. These include black walnut, Douglas fir, oak, teak and western red cedar. For these species, use fixings with a low iron content, such as stainless steel.

Structural design follows BS 5268-2, which is being replaced by Eurocode 5.



## Sustainable timber

Timber is the most sustainable building product available. It is naturally renewable - over 97% of softwood timber used in the UK comes from Europe, where the forest area is increasing by the equivalent of 90 football pitches every hour of the day and night.\*

For reassurance for softwoods and hardwoods look for certification labels like FSC (Forest Stewardship Council) or PEFC (Programme for the Endorsement of Forest Certification).

Always ask your supplier about their responsible purchasing policies.

\*IIED & ECCM, Using Wood to Mitigate Climate Change, 2004 and UNECE-FAO, State of the Europe's Forests, 2011.



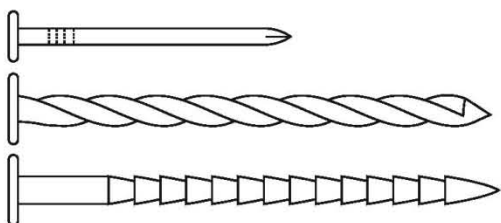
This information sheet provides general advice only and is not specific to the requirements of a particular building project. It is the builder's responsibility to check compliance with Building Regulations and standards.



## Dowel-type fasteners

### Nails

Nails are the most commonly used fasteners for many forms of structural timber, such as timber frame stud walls and floor diaphragms. In timber structures, nails are used primarily for connecting timber, steel or wood-based panel products together, sometimes in conjunction with flat or shaped metal fittings.



**Common nail types (from top): round wire, helical/twisted shank, annular ringed shank**

Nails come in many different sizes, shapes and materials, but the most common is the round wire nail. Nails with a square cross-section are also suitable for similar applications. Oval nails are often used to reduce the risk of splitting the wood.

Pre-drilling holes for larger nails may be necessary when driving into dense hardwoods, or to prevent splitting in softwoods such as larch and Douglas fir. The hole diameter should be less than 80% of the nail diameter.

Galvanised nails, or those with other forms of coatings, have greater corrosion resistance than uncoated nails, which in turn can have a small effect on the loadbearing capacity.

### Screws

Wood screws can be used for plain timber-to-timber joints but are especially suitable for steel-to-timber and panel-to-timber joints.

Screws should be inserted by turning and not by driving with a hammer, which will reduce the load-carrying capacity significantly.

The diameter of a screw is measured on the smooth part of the shank, or the outer edge of the thread, and ranges from 6mm to 20mm for coach screws, and from 4mm to 8mm for countersunk screws. The root diameter of most screws in the threaded portion is about 70% of the outer diameter.

The depth of the thread varies from  $0.125d$  to  $0.140d$  and the thread pitch from  $0.4d$  to  $0.5d$  ( $d$  being the diameter of the screw). The length of the threaded portion is normally about 60% of the total length of the shank. Screws with a diameter greater

than 5mm should be turned into pre-drilled holes to prevent splitting of the wood.



**Coach screw**  
**Photo: Wurth**



**Countersunk head**

Coach screws always require a washer and must always be inserted into a pre-drilled hole. They can be found in lengths of 25mm to 300mm. In large connections, they hold timber connectors conveniently in place or replace bolts when only single-sided access is available.

### Concealed fixings

Hidden fasteners are an alternative option for projects such as timber decks, for example, particularly where appearance is key. Not all of them are suitable for use with all types of wood, however, so it is essential to follow the manufacturer's recommendations and guidelines for installation.

Because they allow for closer fitting of decking boards, concealed clips should only be used with properly dried timber with a moisture content of 16% or less to avoid problems caused by the natural movement of the wood.

Other factors when considering concealed clips are:

- individual boards are difficult to remove once fastened
- installing hidden clips may be more time-consuming than the traditional method of fixing with screws.

### Bolts and dowels

Bolts and dowels are used to hold two or more members together to form a joint, generally loaded in shear (meaning across the fastener).

#### Bolts

Bolts are threaded dowel-type fasteners with nuts, usually made from mild steel with a minimum tensile strength of  $400\text{N/mm}^2$ . The most common diameters for use with wood range from 8mm to 30mm. A typical bolt size is M8, meaning metric 8mm diameter.

When installing a bolt, the pre-drilled hole must include a clearance to allow for easy insertion of the bolt. This also reduces the risk that the wood will split on assembly or after drying out. Eurocode 5 allows a hole diameter up to 1mm larger than the bolt diameter.

Bolts should be tightened so that the members fit closely. If the wood shrinks in service, the bolts should be retightened.



**Hexagonal head**  
**Photo: Würth**



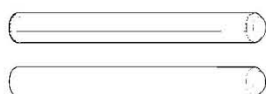
**Carriage bolt**

Whenever a bolt is used, either on its own or through a connector, it should be installed with a washer under any head or nut that is in contact with the timber. The diameter of washers used in timber work should be at least three times the bolt diameter. The washer thickness should be at least 0.3 times the bolt diameter. Washers for bolt heads and nuts in contact with steel surfaces on either or both sides of the timber follow normal rules for metalwork.

### Dowels

Dowels are cylindrical rods, generally with a smooth surface (but some are ribbed), available in diameters typically from 6mm to 30mm. Timber-to-timber joints made with dowels have a better appearance than bolted joints and are also stiffer because dowels are 'snug' fitted whereas bolts are 'loose' fitting in the hole.

Dowels are inserted into pre-drilled holes with a diameter not greater than that of the dowel itself, so the holes must be accurately positioned. The most common approach is to restrain the members in their assembled positions and drill through all the members at once.



**Dowels**

If steel members are incorporated in a dowelled joint, the holes in the steel members must include a clearance, and due allowance should be made for any extra slip that may occur as a result.

Timber engineered connections are possible in which dowel heads are welded to steel plates. In large dowelled connections it may be necessary to replace some of the dowels with threaded bolts in order to stop the joint from opening laterally.

### Spacings for dowel-type fasteners

The values for spacings and edge distances vary from one fastener type to another, as well as between the various material types and should be designed by an engineer.

Factors taken into account in producing the Eurocode recommendations include the cleavage (resistance to splitting)

and shear strength of the timber, the timber density, the fastener diameter and, in some cases, the angle of load to the grain. The recommended spacings and distances are based upon testing and years of experience.

Dowel-type fasteners must be spaced at suitable distances from each other and from the ends and edges of timber or wood-based materials to avoid splitting.

## Timber engineering hardware

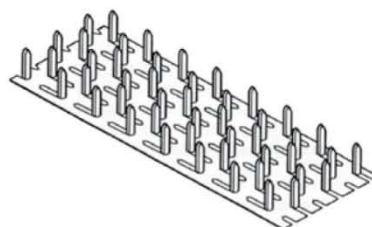
'Connectors' or 'timber engineering hardware' includes metal components made of steel plate, sheet or strip used to connect timber members together, usually in conjunction with one of the dowel-type metal fasteners already described.

Timber engineering components are widely used in place of traditional carpentry joints. They are easy to use, readily available and do not require complex timber machining. Common types include joist hangers, framing anchors, truss clips and wall ties.

Mass-produced connectors are usually made from pre-galvanised mild steel, 1mm to 3mm thick. Heavier components, up to 12mm thick, are available for larger structures. Some manufacturers also supply stainless steel components to order.

### Two-dimensional plates

Punched metal plate fasteners are suited to factory prefabrication and are able to transfer member forces with smaller connection areas hand-nailed plates. They are widely used with trussed rafters, but also for in-plane joints in other components. Take care in handling since the joints are flexible out of plane and can be damaged during erection.



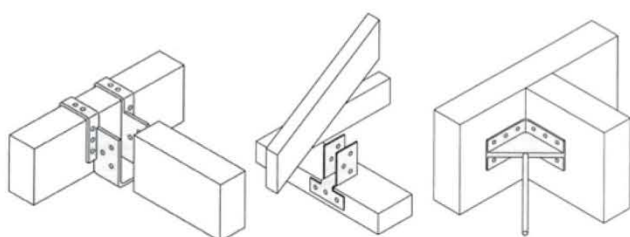
**Punched plate metal fastener**

### Three-dimensional plates

Three-dimensional plate fasteners are widely available for many applications, such as joist hangers, as brackets, or as multi-angled connectors. They can be face mounted or fitted over a girder as 'stirrup-type' hangers.



It is essential that you follow the manufacturer's instructions and loading guidelines when fixing three-dimensional plate fasteners. Using the correct number of nails, screws or bolts, and fixing them in the right way, is essential to avoid potential failure. Using fewer than the prescribed number of nails in a joist hanger, for example, can reduce the strength of the connection without any noticeable increase in deflection.



Three-dimensional plates (from left): joist hanger or shoe for principal beam, truss clip, anchorage for steel tie member

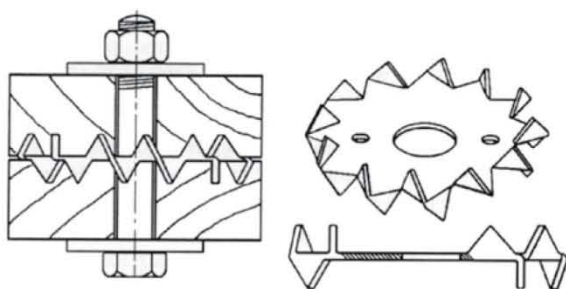
### Connectors used with bolts

While the majority of common fasteners have already been covered here, bolted connectors can sometimes be useful in particular situations, such as site-assembled timber-to-timber joints. These connectors transfer any load directly between the surfaces of the connecting members.

Eurocode 5 includes three types of bolted connectors:

- split-ring connectors
- shear-plate connectors
- toothed-plate connectors

The strength of the connection often depends on the density of the timber. Toothed-plate connectors, for example, cannot easily be used in hardwoods.



Double-sided tooth plate connectors

### Further information and advice

BS 5268-2:2002+A1:2007 Structural use of timber. Code of practice for permissible stress design, materials and workmanship, BSI

BS EN 1995-1-1:2004+A1:2008 Eurocode 5. Design of timber structures. General. Common rules and rules for buildings, BSI

WIS 2/3-52: Fasteners for structural timber: nails, screws, bolts and dowels, TRADA Technology, 2012

Ross, P., Hislop, P., Mansfield-Williams, H. and Young, A. Concise illustrated guide to timber connections, TRADA Technology, 2012

Timber Decking Association: [www.tda.org.uk](http://www.tda.org.uk)

Other *Choose and Use* factsheets are available in this series, including 'Timber decking', 'Timber species', 'Storing timber and wood-based products on building sites', 'Sourcing sustainable timber' and 'Timber strength and spans'.

**Choose and Use** is a series of information sheets for builders produced by TRADA, The Timber Research and Development Association.

They offer up-to-date advice on how to select the right timber and timber products for different applications.

You can often save time and money by choosing the correct timber material or timber products as well as ensuring you comply with current Building Regulations and Building Codes. For more information about specific products visit [www.trada.co.uk](http://www.trada.co.uk) or contact your local supplier.

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