TIMBER FOR REPAIRS

Factors for consideration in the selection of new hardwood for the repair of timber frame buildings

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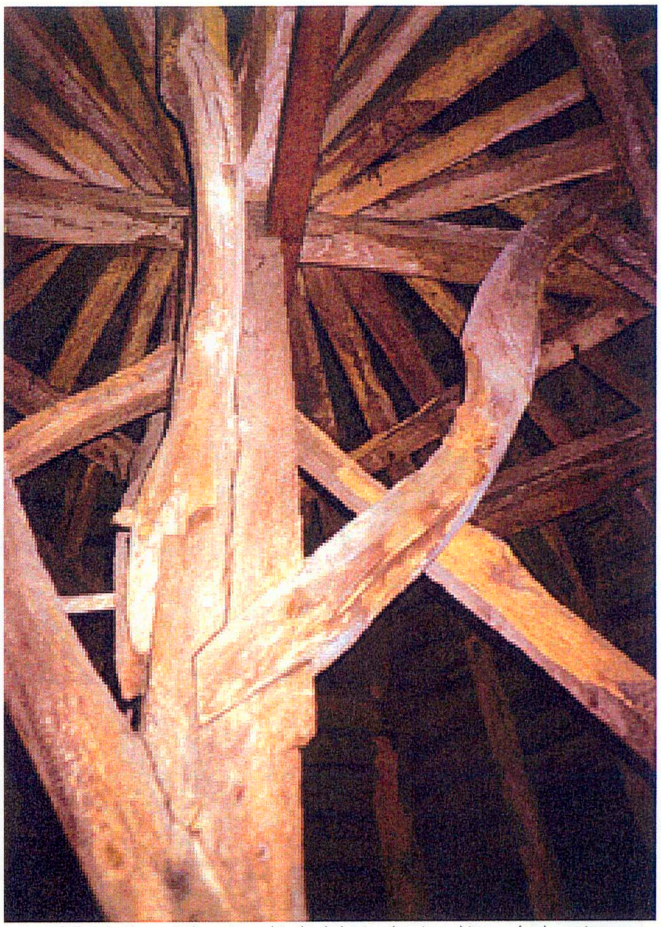


St James' Church, Shere: 12th century, shingle clad spire showing a history of oak repair. (Hutton+Rostron)

Where timber is required for the repair of a timber framed structure, the choice of timber effects the performance of the repair. Particular concerns include the species of tree, the moisture content of the timber, the orientation of the grain, and a variety of defects. Therefore some understanding of the nature of the material and the 'conversion' process (from log to building material) is essential. This article provides an introduction to the selection of timber to be used in a repair.

THE TREE

The selection of timber for use in a repair should be on a like for like basis. Timber of a different species should only be used if there is difficulty obtaining a supply of the original.

A number of British hardwoods are used in buildings, including ash, beech, elm, oak, poplar, chestnut and sycamore. Of these, oak is the best known and is the most commonly used, followed by sweet chestnut, both of which have strong and durable heartwood ideally suited to the repair of timber frames. Where resistance to decay is less important, other species such as beech, ash and elm may be used.

The characteristics of the timber also vary according to the type of wood which is included. The bark does not concern us here because it is usually removed in conversion, but just inside the bark is the sapwood. This is the part of the tree through which most of the sap flows to the branches and leaves. It is generally lighter in colour than the heart and varies in depth, usually from 10mm to 50mm wide. Once dry, it is the least durable part of the tree because it contains the most nutrients, making it attractive to decay organisms.

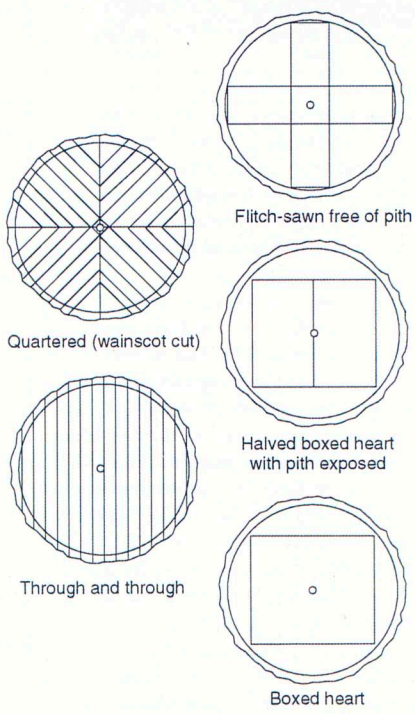
All sapwood should be excluded from the timber if used in an external part of the frame. If its use cannot be avoided, the sapwood should be checked for active insects, particularly Lyctus powder post beetle.

Between this thin layer of sapwood and the core of the tree is the heartwood, the material which gives mature timber its structural properties, and in the centre is the pith, the juvenile core which is also vulnerable to decay. Large timbers usually incorporate most of the heartwood with the pith at its core, which is exposed at either end, making them vulnerable to decay from within.

At the end of the log, the annual rings are visible. In fast grown trees the rings are wide. Many people confuse the growth rings with grain. Strictly speaking the grain is the result of the structural orientation of the fibres and vessels.

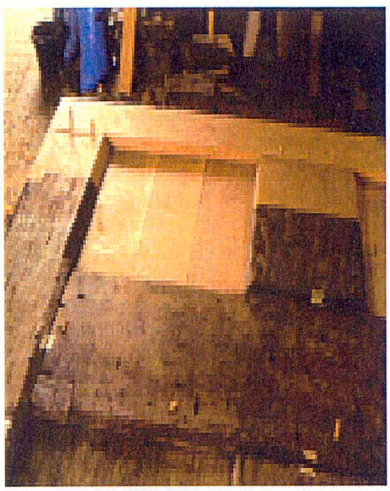
CONVERSION

The timber should be selected carefully, taking into account the type and location of the repair in order to achieve the best match. In addition, the timber should be free of significant defects, which take many forms, some natural, some as a result of seasoning (see opposite).



TIMBER CONVERSION

The location and way the section of timber is cut from the log will greatly affect the way that the piece will behave on drying and during changes in humidity. This is due to greater shrinkage tangentially than radially across the stem. (Tangential shrinkage ranges between 1.4 to 2 times the radial shrinkage in native woods.) Timber used to repair posts and beams, for instance, would generally be simply squared off or 'boxed' heartwood as this has predictable shrinkage and movement. Smaller section timbers may be halved boxed heart, however there will be a tendency for the piece to distort. This type of distortion can sometimes be seen in the floorboards in a house where they appear to 'cup' upwards at the edges as a result of differential movement between the upper and lower faces.



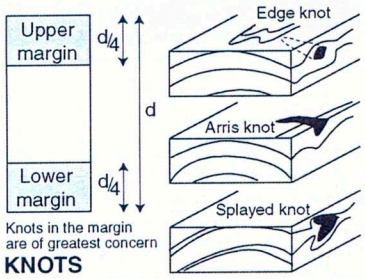
Cleft timbers, which are those split rather than sawn, can produce a more stable end product as there is less chance of splitting across the grain.

Boxed heart, which is a balk of timber taken from the centre of the tree containing the pith, is likely to be the most stable of pieces. However, beams or posts containing boxed heart are more prone to death watch beetle decay as the pith is not durable and can sometimes be infected with fungal decay which in turn encourages death watch beetle. Drying may result in surface cracks, but these do not necessarily affect the strength when installed.

Timber for repairs can be sourced from specialist suppliers of sawn timber or in certain circumstances standing trees are selected where, for instance, a long piece of timber or timber of a particular shape is needed. These should be selected and converted to match the piece to be repaired. Usually a boxed heart post would be repaired with new boxed heart. All repairs must be designed to take shrinkage and movement into account, particularly where less stable sections are concerned.

DEFECTS

All material selected for timber repairs should be inspected carefully for defects such as large, loose or decayed knots, large splits, insect decay and fungal decay. There are no strict rules as the analysis of defects is usually qualitative.



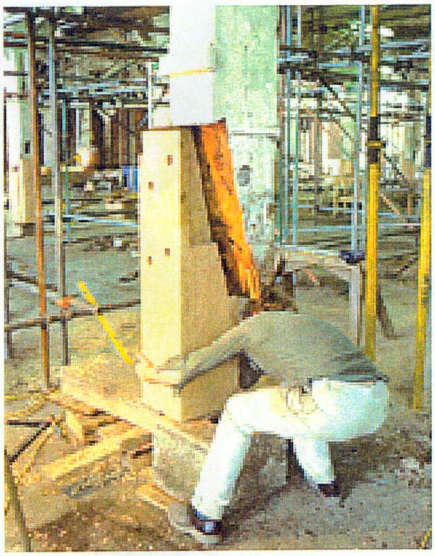
Knots in the margin are of greatest concern

KNOTS

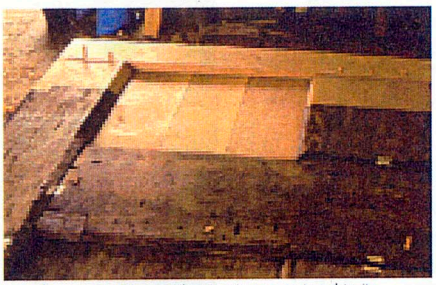
Knots are probably the most common and easily recognisable defect. The size, position and type of knot (live, loose, splay, arris, edge, margin for example) will greatly affect the strength of a piece of timber. The strength is affected because the cells of the knot are at right angles to those in the rest of the wood, and also because of the irregular grain surrounding the knot. The greatest strength loss is in bending parallel to the grain. Compression along the grain is not so greatly affected. These two points should be taken into account when selecting timber for a post or beam.

Generally, the effect of the size of the knot is proportional to its cross sectional area. The location of the knot is also significant. For instance, in a beam a knot on the tension edge will have a much greater effect than one on the compression edge. If located centrally it will have little effect on strength. The further a knot is from the end of a beam the greater its effect.

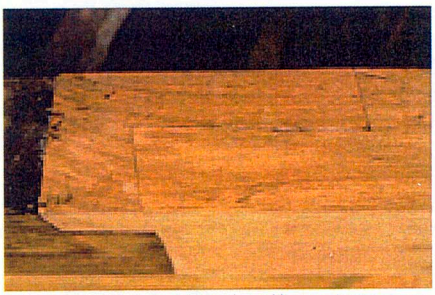
Tension wood is another defect that can also affect the strength of hardwoods. This defect is found on the upper faces of branches and on the uphill sides of leaning stems where the wood is in tension. Tension wood is very weak in compression parallel to the grain and this should be considered if used for repair to a post. Tension wood is characterised by being paler than normal wood and may be identified



Scarf repair at the mast house and mould loft, Chatham Historic Dock Yard (McCurdy & Co Ltd)



An oak room partition at Kingston Lacey, restored to its original height (McCurdy & Co, for the National Trust)



A short scarf joint on an oak panel moulding at Kingston Lacey, (McCurdy & Co, for the National Trust)

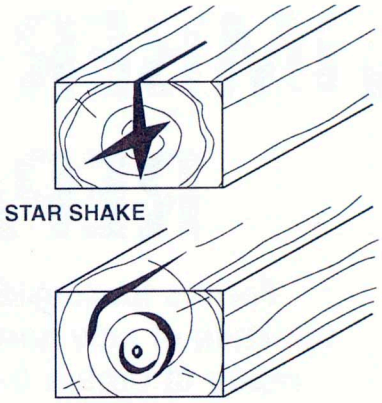
by an off-centre pith. Greater shrinkage is also encountered tangentially when drying.

The direction of the grain in a piece of wood also affects its strength. Straight grained timber has the grain parallel to the axis of the tree and is preferable to all other types when considering strength.

If the natural orientation of the grain/fibre deviates from the long axis this is also considered a defect. This occurs often in sweet chestnut when the grain spirals and also in elm where the grain is more random.

Diagonal grain is due to the conversion process where straight grained timber has been cut so that the fibres do not run parallel with the axis of the piece. This timber is obviously weaker than straight sawn timber.

The slope of the grain affects the strength of the wood considerably. For instance, with a 1 in 25 slope of grain there is a reduction in strength of four per cent in bending. If this is 1 in 5 then the reduction is 45 per cent. The slope of the grain can be difficult to assess without the proper tools, however, some indication of its direction may be gained by lifting a few fibres with the point of a penknife.



STAR SHAKE

RING SHAKE

Major splitting or shakes along the length or a piece can be included provided they do not exceed 150mm in length as a general rule.

SEASONING OF TIMBERS

In 'Green' timber (newly felled) there is a large amount of water present within the cell cavities. As a general rule trees with higher sapwood content usually have higher moisture content, and in this respect, the best time to fell a tree is winter, when the sap has not yet risen.

It is a fact that some element of drying or seasoning must be undertaken to reduce the moisture content before wood can be used in service. Dried wood has many advantages because its strength increases with dryness; the compressive strength of beech wood for example, is more than doubled on drying. Drying also increases the timber's resistance to decay. Unfortunately, thorough and even drying is difficult to achieve, particularly where large timbers are concerned, and uneven drying leads to distortion as one part of the timber shrinks more than another. Where this occurs after the timber has been installed, damage to the structure can be caused. Therefore the primary aim of seasoning timber is to render timber as stable as possible.

Initially, water readily leaves the cells by evaporation but a lot of the water is still contained within the cell walls and is more difficult to remove. This is known as the fibre saturation point (FSP) and is usually around 28 per cent (dry weight of wood). Shrinkage and distortion begins to occur only when drying takes the moisture content of the timber below this level. Further drying can affect the performance and selection for a timber repair. In round timbers, the shrinkage becomes apparent in surface checks and splits together with loss of diameter. In sawn wood drying manifests itself in shrinkage and surface checks.

The drying of timber can be done naturally ('air drying') or through forced drying in a kiln. Both methods have their advantages and disadvantages. The major disadvantage of air drying is the length of time and space necessary to dry the timber. For instance, for every 25mm in thickness 12 months of air drying should be allowed for oak. This could be cut to less than a week by kiln drying. The disadvantage of kiln drying is that larger section timbers are difficult to dry without causing damage to the structure of the wood. This arises because the surface of the wood dries before the middle of the piece has had time to catch up. This results in stresses being formed within the wood. This can

Weald & Downland Museum: New oak repair to a death watch beetle decayed post, ensuring the retention of the maximum amount of the original material. (Hutton+Rostron)

manifest itself as twisting and bowing once the timber is installed in the building.

Smaller sections of timber can be successfully kiln dried to a moisture content that would be expected in service.

'Green' timber can be and is used. An experienced carpenter using green oak can take account of any subsequent distortion due to drying. This can be used to advantage because distortion can add to the strength of the frame, for example, a tennon may twist and grip the sides of a mortice.

There is often confusion between the terms shrinkage and movement. Shrinkage is the dimensional change when timber in service is dried from green to a moisture content of 12 per cent. Movement is the dimensional change when timber is subjected to changing environmental humidities after drying. Values are usually quoted on changes between 60 and 90 per cent humidity. Both of these are important in repairs to timber frames as both 'Green' oak and air or kiln dried oak are used.

Movement varies greatly between species, for instance alder, poplar and sweet chestnut have small movement; ash, cherry, elm, oak and sycamore have medium movement; and beech and birch have large movement. For this reason mixing of species is not recommended as it can result in, for instance, opening of joints and stresses forming in repairs.

The timber changes little in length in drying below FSP but in cross section the greatest movement is in the tangential plane. This should be born in mind when making any repair to the timber frame.

To conclude: timber used for repair of timber framed buildings should be installed as near as possible to its desired end-use moisture content. It should also be selected to minimise dimensional changes once installed. Defects may be included in repair pieces but their significance should be carefully assessed for each situation. Ideally, repairs should be carried out by a carpenter experienced in the repair of timber frames and, wherever possible, repairs should incorporate improvements over the original to reduce the need for repairs in the future. Finally, consideration should be given to the use of modern materials such as resin where a traditional timber repair would necessitate excessive cutting out of the original frame to provide an adequate repair.

Recommended reading

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BS 5450 (1977) *Specifications for sizes of sawn hardwoods and methods of measurement.*

BS EN 350-2 (1994) *Durability of wood and wood based products. Natural durability of solid wood, guide to natural durability and treatability of selected wood species of importance in Europe.*

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