Society for the Protection of Ancient Buildings

Technical pamphlet 12

The Repair of Timber Frames and Roofs

By James Boutwood FSA RIBA

This pamphlet is intended to provide architects, builders and surveyors with some simple information about the type of repairs which the Society believes should be used when working on the repair of timber framed buildings and roofs. The repairs are intended to be practical and effective and to cause the least possible aesthetic and archaeological damage. In recent years our knowledge and understanding of the methods of construction used by early carpenters has greatly increased and there is now much more awareness of the archaeological importance of the original timbers in old buildings and therefore the need to preserve them in situ wherever possible. At the same time it is important to ensure that whatever repairs are necessary are carried out honestly and in a structurally sound manner. It is hoped that the methods suggested in this pamphlet make it possible to achieve both these objectives.

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Willis Farm, near Chelmsford: it was decided that the best way to save this magnificent frame and greatly reduce the amount of repair was to put back the rendering which was first applied in the 17th century and removed by an enthusiastic amateur in the 1920s.

Introduction

There are no great mysteries about carpentry; timber is a sympathetic, easily worked and versatile material and it was used structurally and decoratively with great understanding, logic and flair by early builders. These same characteristics are equally at the disposal of the repairer and attending to problems in a timber framed structure should be an interesting and rewarding experience.

The contents of this pamphlet cannot claim to be comprehensive. It is intended to set out guidelines, to outline the general approach to the problems the repairer is most likely to encounter and to illustrate typical methods of repair to some of the most common defects found in old frames and roofs. However, there are no 'standard' solutions and it is incumbent upon the repairer to decide for himself (or to seek advice on) what are the best methods of repair to deal with the problem in hand.

The literature on all aspects of timber and timber framed buildings and their repair is voluminous and much of it authoritative — a short and selected bibliography is given at the end of this pamphlet. If you can, read up beforehand about the particular type of building which you are dealing with and seek the advice of local experts (the conservation officer in the local planning department should be able to advise you whom to approach).

As with all old buildings, before embarking upon the repair of timber framed structures, it is vital to understand the inherent nature of their materials and construction, to appreciate their strength and weaknesses and to know their enemies. Remember that you are dealing with a framed structure, however monolithic it may appear at first glance. Thus whilst masonry buildings usually rely on a mass of material to support and distribute loads, in timber structures these are mainly concentrated and transmitted into the comparatively slender scantlings of its frame. In the process of evaluating

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An example of conservative repair using traditional materials—all external wood and plaster surfaces were limewashed.

Donald Insall Assocs.

This model of timber-framing is a reconstruction of a building allowing the original construction and subsequent changes to be understood in context. The production of a model should be enough to satisfy any urge to 'restore' a timber frame to its original state; leave the building with its historical changes.

the condition of the frame and deciding what repairs are required, the repairer should — as far as he can — analyse what function each timber is required to perform and understand the forces at work.

The integrity of a timber frame often depends wholly or mostly upon the soundness of its joints. When part of a frame is clearly in distress it is important to find out by judicious opening up whether or not the joints are in a state to fulfil their task of restraint or transmission of a load. If they have failed they must be repaired in such a way that they will continue to perform the function intended of them.

Remember that, in general, timber is strong in shear and horizontal bending but less reliable under axial loading, depending upon how it was converted from the log. As an organic material it is not altogether stable, but movement is natural to it and this is rarely, of itself, a weak-

ness. It is important to understand what the individual timbers have to tell you, not only about their condition and characteristics but also about their history. For example, excessively knotted and cross grained material will embody weaknesses not found in healthy, straight grained timber. A long shake in an old timber may look unsightly and alarming but this does not automatically mean that the timber is too weak to carry the loads imposed on it — in fact this is rarely the case. The presence or absence of pegs will indicate whether the timber is an integral part of the frame or a later insertion. Do not be intimidated by this: with guidance and experience you will soon find that you will be able to analyse and understand a frame and its timbers and that on many occasions this will be a rewarding experience.

Finally, two key points to remember. The first is that to approach the repair of an old frame or roof, ignorant of how it is performing or of what condition the timbers are in, is the first step towards the destruction of that which you have been commissioned to save. The second is that given good carpenters (and on important or complicated jobs you should ensure that they are), listen to what they have to say and be prepared to learn as well as to lead.

IMPORTANT NOTE

In the description of various repairs which follow, sizes are either not given or are provided to give an indication of what may be required. The repairer must decide for himself on site what is the correct material to use or the most appropriate joint to adopt and to what dimensions the various components should be cut or ordered.

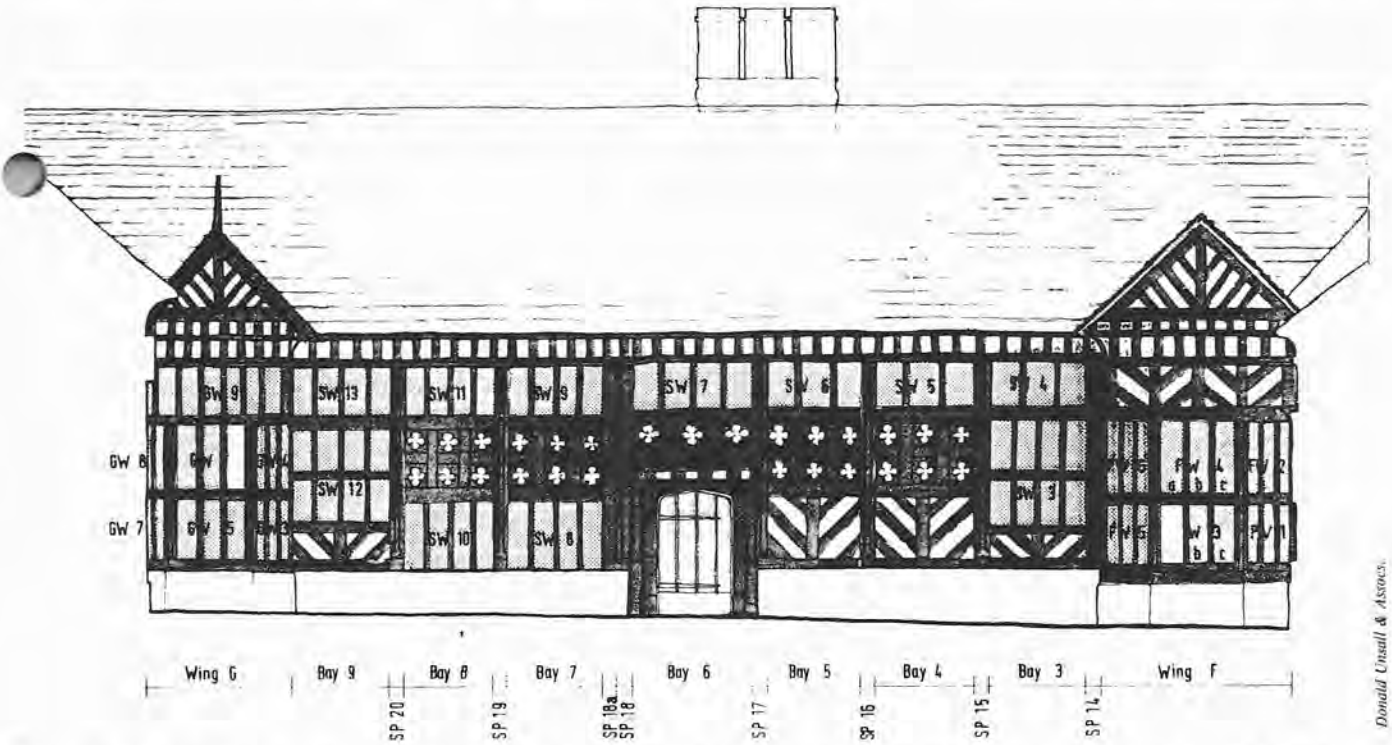
Archaeology and Recording

The dating of timber framed buildings from their methods of construction is now a well-developed technique. However, timber structures also often retain evidence of their origins and structural history in less obvious ways and to an extent not found in other forms of construction. This can be in the form of numbering (usually Roman), cut into main timbers when the frames were first fabricated, or from inconsistencies in the construction — ranging, for example, from doubled-up members (where a structure has been built up against an older one) to empty housings, mortices, and peg holes, where framing has been removed.

This evidence will provide useful — and often valuable — clues to a building's original construction and subsequent historical changes. It should be most carefully preserved wherever possible and recorded by sketches and photography (this is particularly important if timbers have to be removed or destroyed). It is essential that such records are carefully preserved (the local records office is the ideal place) so that anyone working on the building in the future, either as a scholar or as a repairer, will be able to make use of this information.

Site Control of Repairs

If the repair of a timber framed building involves work or disturbance to its numerous separate components, record drawings and photographs are essential. A means must be devised of labelling each component and recording this information on the drawings. By doing this you can ensure that each com-



Recording is vital before any repair is undertaken. In this example the elevation has been measured and drawn and a labelling system devised to allow accurate and detailed design of repairs.

ponent is kept track of and reinstated in its original position. If working under cover, labelling can be done by marking firmly in chalk, but if in the open, timbers must be marked with plastic or plywood tags securely fixed to the timbers. The best method of coding is to draw the building up on a numbered and lettered grid and labelling the components accordingly (e.g. C2 on a post would identify it as coming from the intersection of lines C and 2 on the grid).

A piece of chalk is also vital to the repairer throughout the contract and he should develop a code of ticks, crosses, salvage and cut marks etc. to help in communicating his ideas and instructions to the carpenters. Wherever possible detailed repairs should be sketched out on a timber whilst it is in situ. This will help to ensure not only that the repair will be effective from a structural point of view, but also that the carpenter knows what is required of him so that he can say if it is practicable to execute. Drawings of repair details, although important, are useless if the carpenter cannot get his saw to the cut.

It is in these aspects particularly that site collaboration will be the most effective and rewarding. There is no better way for the repairer and the carpenters to get to know both the building and each other than by marking up the structure together, timber by timber.

Decay and Infestation

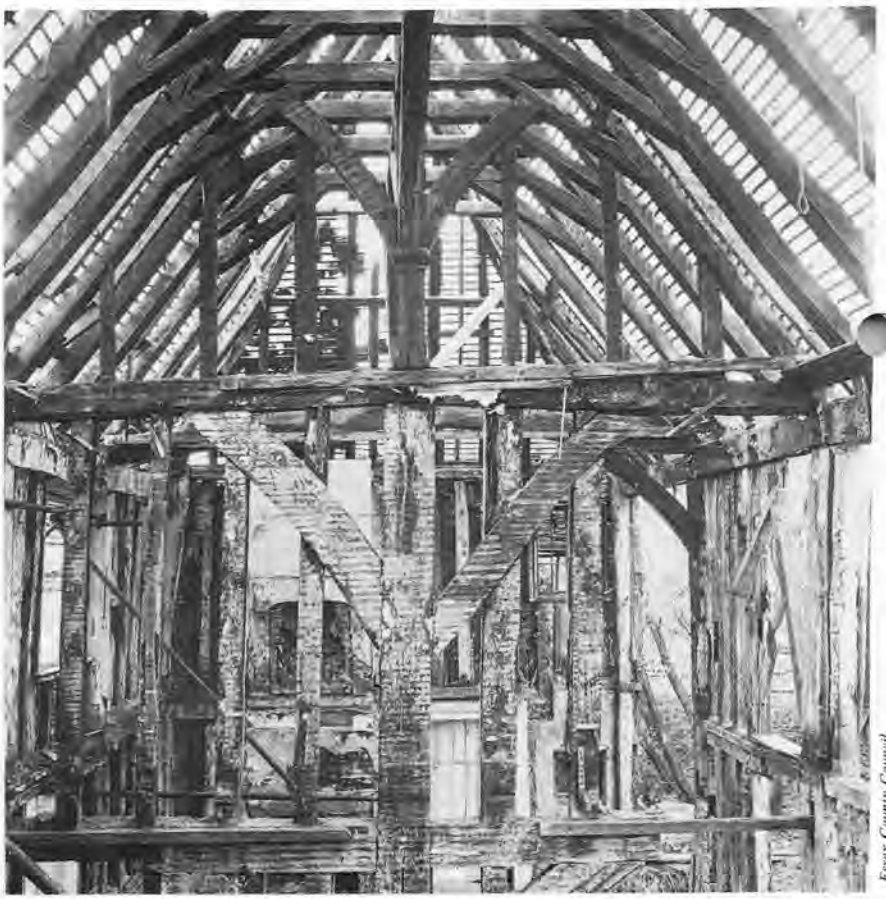
Timber has many enemies which feed upon it and thus weaken and destroy it. Decay, either by insect or fungal attack, is usually a major cause of failure in a timber frame, especially since it is most common at joints where the more vulnerable end grain can be exploited by wood-boring insects. However, over-reaction to decay is unfortunately still commonplace and needlessly to condemn a timber as rotten is to display ignorance. It is important that the repairer should recognise that many timbers in old buildings are considerably over-sized relative to their functional requirements for structural strength and thus can accept a great deal of loss without being weakened to the point where they are no longer able to provide the structural strength required of them. Nevertheless it should be borne in mind that the oversizing of timbers relates much more to older structures rather than later ones, when the timber used in building (particularly from the 18th century onwards) was generally of much poorer quality and frequently undersized or second-hand.

Simple inspection at close quarters and probing with a penknife or a similar tool will normally indicate whether or not the damage by infestation or fungal attack is significant. A slight tug on the blade as it is withdrawn will indicate that the timber — even if it is 600 years old — is still sound at that point. Another useful tool is an artist's palette knife which is ideal for probing into joints or junctions between timbers to see how they are joined together or if — for example — a tenon still exists.

Engineering calculations can be invaluable in evaluating the strength of eroded timbers in difficult cases, but with experience the repairer should also learn to rely on an intuitive feeling for the structural stability of the frame he is working on.

Dry rot in oak is rare. Wet rot (often confused by the ignorant as dry rot) is less so but is limited to wet material, cannot travel and stops when the timber is dry. Lyctus and furniture beetle attack is generally confined to sapwood which does not contribute much strength to the timber but may carry valuable mouldings.

In such cases wherever possible these should be treated and not destroyed unless they are literally disintegrating. Death Watch beetle poses a more serious problem because it removes a greater amount of timber and tends to work in dark, confined areas such as in roof plates and the ends of beams and trusses where it can cause serious structural damage. The affected areas are generally confined and the timber adjacent to the galleries and flight paths cut by the beetles often remains sound, thus restricting the amount of cutting out and replacement necessary.



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The reduction of this building to a skeletal frame has meant the loss of all the old plaster and decorative finishes. In this photograph the only surface finish of histori importance remaining is the smoke blackened timber, evidence of an open hall.

This pamphlet does not attempt to deal with the problem of the recognition and treatment of rot and infestation as this is a subject in itself. The repairer, with knowledge and experience, should be able to tackle most of the problems he encounters but should not hestitate to seek expert advice if necessary. It is important to choose someone with experience in this field; much needless damage and unnecessary expense has been caused by inexperienced or over-zealous operators.

Stripping and Cladding

The SPAB is strongly opposed to the widespread practice of stripping timber frames back to their bare bones before embarking on repairs. By doing this the amount of repair work necessary is often greatly increased and the original infill and finishes (plasterwork, cladding and flooring) are destroyed; all too often the end result will be a carefully repaired frame wholly or partly concealed within an otherwise modern building.

But the wall cladding, infill and roof battens are not only of historical and aesthetic value. They are an important but often unappreciated part of a frame's overall structure and this should be recognised when trying to decide how much of a frame needs to be repaired or replaced. For example, a stud wall will be greatly strengthened by the external cladding of boarding or laths and plaster and this may make it unnecessary to replace studs which have been weakened by decay but still have some structural strength. Similarly, by using generously sized battens on a roof, the strength and stability of a comparatively weak frame can be greatly increased.

Distortion and Movement

Timber framed buildings, unlike stone and brick structures, have a tendency to move and distort and this often adds greatly to their quality and character. Although it is obviously essential to analyse why any movement has occurred and to take what action is necessary to ensure that it is arrested, you should not necessarily attempt to correct it. By forcing a frame back into its original position you may set up a damaging chain reaction which could cause distortion elsewhere or fracture joints which have settled into their distorted positions. Likewise, frames have often been repaired or added to in their distorted positions in the past and it is not possible to correct this without unpicking later alterations or repairs which may be of interest in their own right. No attempt should be made to do this unless it is necessary for other, overriding, reasons.

Choice of Timber to be used in Repairs

For most repairs to simple structures like barns and the roofs of the great majority of old buildings it is now generally agreed that 'green' (i.e. unseasoned) oak can be used. Any subsequent distortion due to drying out of the new timber can be contained within the frame. This in fact adds to its strength, as, for example, tenons twist and grip the sides of their mortices. Any timber used should have been felled for about three years and be straight grained, free from sapwood and waney edges and any major shakes exceeding 150mm long. Large members should have the heartwood well boxed and small sections should be free of heart. For more complex repairs or when working on structures containing a high proportion of carved or moulded work, it is essential to use fully seasoned timber with a moisture content of 15% and to select it carefully so that the grain matches the original.

The choice of timber to be used should always be discussed with the supplier, not with the builder.

The use of secondhand timber salvaged from other buildings should be avoided wherever possible, for not only is it archaeologically misleading but it is also difficult to work, being hard and often full of buried nails which can ruin good tools.

Another reason for not using bought-in secondhand timber is that members become distorted, however imperceptibly, in their original positions, and such distortions can never be compatible in a different frame. The fact that a timber is old does not necessarily mean that it will not twist or crack if inserted into a new frame.

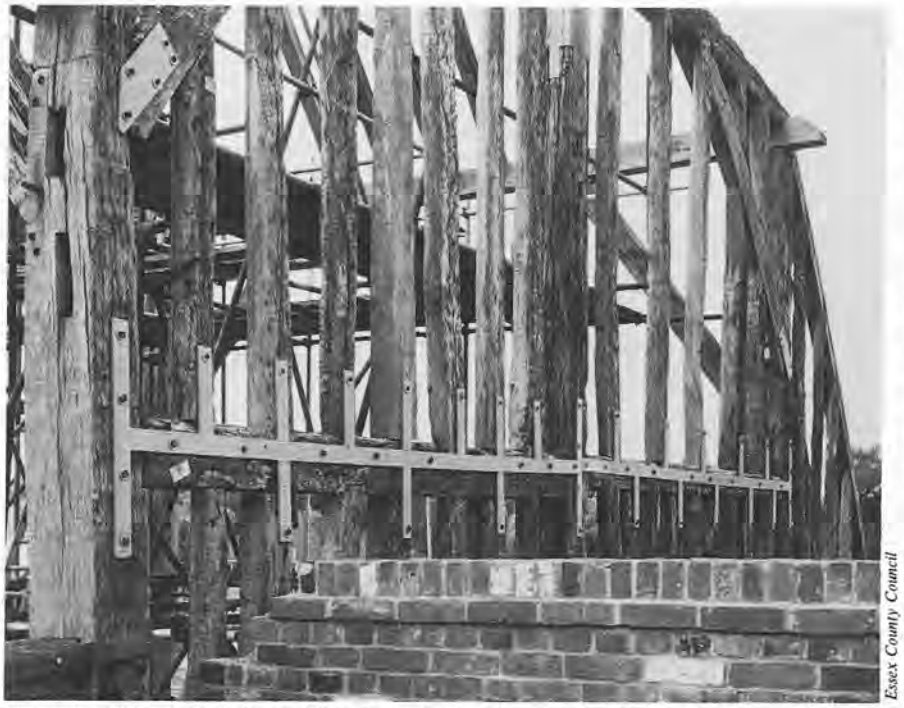
Pegs

Pegs should be made from oak which is as dry as possible so that they will not shrink; ideally they should be 'baked' in an oven before use. They must be tapered and rounded at the entry end, but left square at the projecting end unless they are to be finished flush with the surface of the timber they are holding. They should be firmly tapped in and then again on completion of the job and, if possible, again after a period of one to two years. Do not use secondhand pegs.

Repairs using Resins

The use of epoxy resins and other chemically based products to make good defective patches in individual timbers or to repair joints has developed considerably in the last few years. Although not totally opposed to such methods, the SPAB nevertheless advocates that wherever possible traditional methods of repair should be used, including repairs utilising steel plates and straps. The SPAB is opposed to methods of repair using resins which change a pinned joint into a rigid connection because it is a basic principle of timber framed construction that the joints should be allowed to move to a similar degree throughout.

Recent experience has shown that resin based fillers on exposed timbers can have a limited life and, where water has managed to penetrate behind the resin, the rate of decay has been accelerated.



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East end of Coggeshall Barn. This frame had collapsed. In its repair the use of steel strapping allowed much timber to be saved. The strap shown above is purpose-made and is covered by the external weatherboarding.

The Use of Metal in Repairwork

As a general principle it is always better to use new timber rather than steel when repairing a timber frame. However, by judiciously using mild or stainless steel plates, bracing or straps it is frequently possible to preserve much more of the original frame than could otherwise be achieved. In the past wrought iron straps were extensively used in repair work, particularly at the junction of main posts and tie beams where the outward thrust of the roof, decay or general distortion of the frame frequently cause failure of the joints at this point. Literally thousands of buildings owe their continued existence to such repairs and they should not be spurned today. Two repairs described in this pamphlet give some indication of the uses to which steel can be put to carry out economical repairs to timber frames and at the same time allowing more of the original frame to remain than would otherwise be possible. The illustration above shows a situation where mild steel has been used in an imaginative way to strengthen part of a timber frame and at the same time keep as much of the original as possible.

Fixings must be devised so that they cannot pull out and twisting or rotation is minimised. Wherever possible steel plates or bars should be held in position with nuts and bolts which pass through the steel and timber. As subsequent movement in the frame can cause coach screws to be forced out, their use should be avoided wherever possible.

Because of the corrosive effect of the tannic acid which is found in oak, any mild steel plates or flat bars should be galvanised or at least painted in red oxide paint. If possible, any bolts used should be of stainless steel, but if used in conjunction with mild steel they should be separated with nylon washers to ensure that, should they get damp, no electrolytic action is set up.

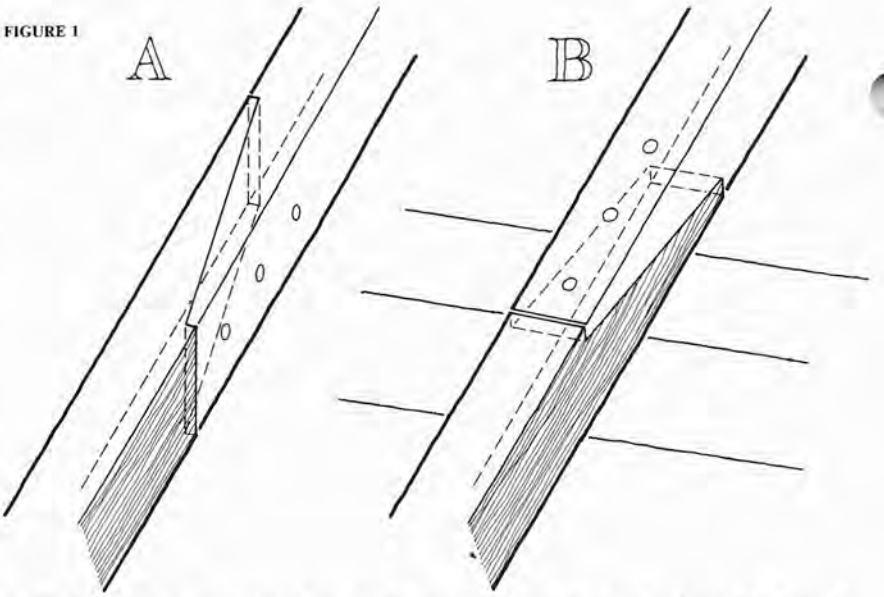
When repairing buildings where wrought iron straps have already been used, make sure that they remain in position even if they are no longer required; they are a part of the building's history and are often fine examples of the craft of the blacksmith.

Repairs to Timber Roofs

The following notes and the repairs recommended are generally applicable to the roofs of simple design and construction such as are found on the great majority of historic buildings, but many of the principles apply equally well to more important roofs.

The need to repair old roofs is generally due to lack of maintenance, subsequent alterations which weaken the original structure or the use of inadequately sized timbers which, when overloaded or weakened by rot, deflect or fracture. This leads to roofs

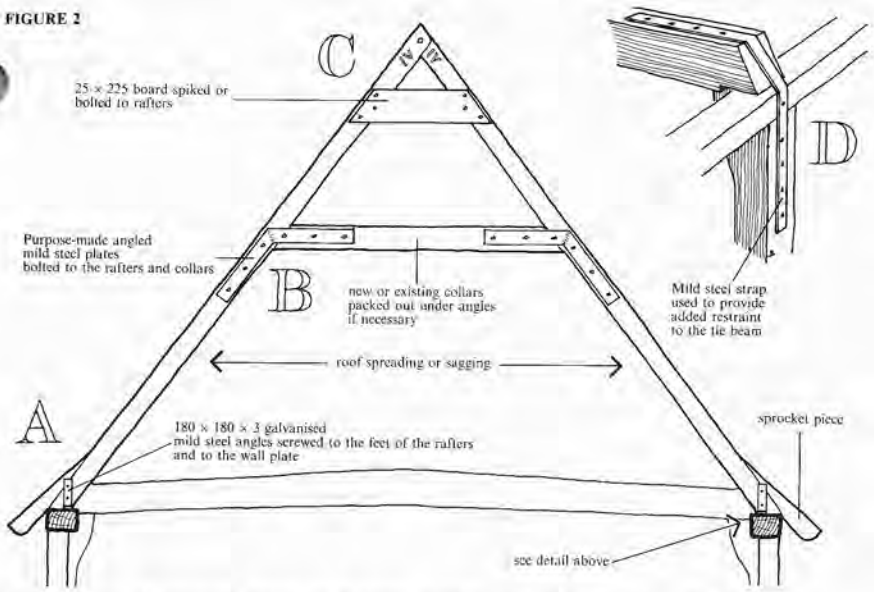
FIGURE 1



'A' shows a face splayed scarf joint for piecing on new ends to rafters. The length of the scarf should be three times the width or depth of the rafter, whichever is the greater.

'B' shows the same joint turned through 90°. This can be used when the joint is supported on a purlin or wall plate.

FIGURE 2



Simple ways of strengthening an historic roof without dismantling it. All these repairs are reversible, inexpensive and help to keep the line of an old roof. It is important that the sprocket pieces should be retained or copied as they are often an attractive feature which should be preserved.

sagging and spreading, an effect which, although picturesque, clearly indicates that action must be taken to prevent further movement or collapse. The total replacement or firring up of such roofs can result in a serious loss of character and possibly the destruction of important historical timbers. It is important to stress that unless the distortions have resulted from fundamental weaknesses, the repairer should work 'with' rather than 'against' them, particularly resisting pressure from roof tilers or slaters to level out undulations to make their job easier. There are simple and relatively inexpensive methods of repairing such structures so that much of the original timber and character of the roofs can be retained. Ways in which this can be done are outlined below.

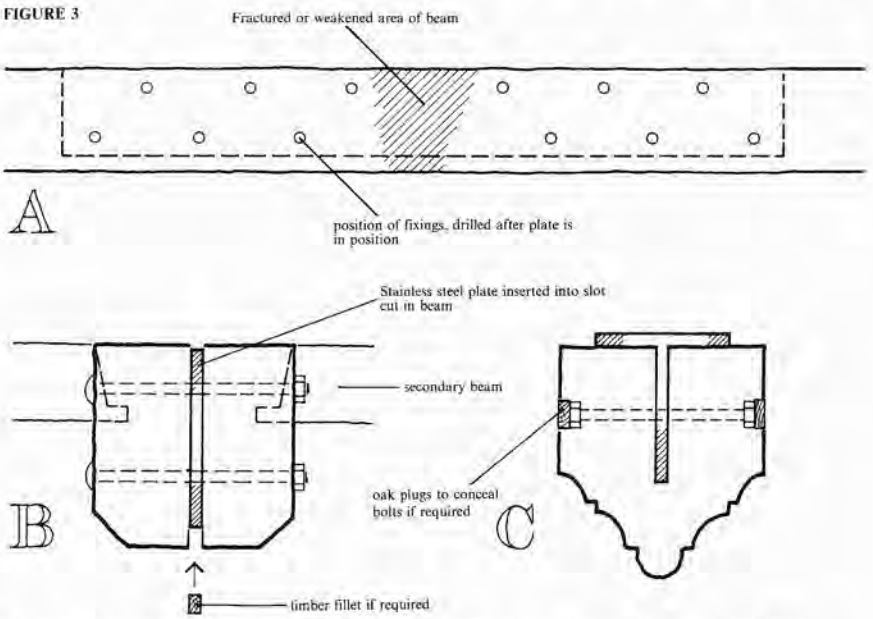
When the head or feet of rafters have broken or are badly rotted they can be repaired by piecing on new ends using the simple scarf joint shown on figure 1. This repair is economical (it is a good way of using up off-cuts from other repairs) and enables you to re-use much of the original rafters. It must be remembered that if new rafters are inserted from eaves to ridge they may well not follow the line of the original which, almost certainly, will have deflected. When this is the case, it is then necessary to firr out the old to bring them level with the new. For this reason wherever possible the old should be repaired and retained as otherwise you may well end up with a brand new roof which will sit uncomfortably on the old building below.

To strengthen the connection between rafter feet and wall plates in order to resist spreading a simple repair is to use 180 × 180 × 3mm galvanised mild steel angle screwed to the feet of the rafters and onto the wall plate (see figure 2A).

A method of strengthening a roof along the line of the collars, particularly if it is spreading, is to attach purpose made angled mild steel plates to every third or fourth pair of rafters and collars so that the outward thrust of the roof is thoroughly held at about mid span of the rafters. Unless the collars are already housed into rafters it will be necessary to pack out under one arm of the angle piece (see fig. 2B).

At the ridge, where failure is often found in old roofs, a simple method of strengthening the rafter to rafter connection without having to undertake elaborate repairs, is to spike on 25 × 225mm boards spanning from rafter to rafter just below the ridge as shown on figure 2C. This non-destructive repair is not only cheap but has the added advantage that it saves the carpenter's numbering marks so often found at this point.

FIGURE 3



The use of steel flitch plates to strengthen beams which have fractured or been weakened by decay. When working out if this repair is practicable it is important to note if the beam has deflected; if so the steel plate will stand pround of the beam at the centre and allowance must be made for this.

'A' shows the elevation of a beam strengthened by a flitch plate. The length of the plate on each side of the weak point must be determined on site—it must be long enough to secure a good fixing into sound wood. The bolts should be staggered if possible and at least 50mm in from the edge.

'B' shows a simple flitch repair and illustrates how a main beam can be repaired in situ without disturbing the secondary beams. The gap at the bottom can be filled if considered unsightly, but otherwise it should be left to show the repair.

'C' shows a steel 'T' section used to strengthen a carved beam. The cut is more difficult to make than in 'B' and this repair is only really practicable if the beam has not deflected.

Flitch Plates

A method of repairing timber beams which have fractured or rotted and need strengthening is to use a steel plate (known as a flitch plate) which is slid into a slot cut along the vertical centre line of the beam (see fig. 3A and 3B). This is a particularly suitable repair for use on carved or moulded beams where the use of any of the scarf joints illustrated on figures 4 and 5, would mean the loss of too much original material. Beams tend to decay from the top and at the bearing ends where they suffer from damp and beetle attack whilst the undersides, when exposed to the air, remain apparently sound and so hence the need to find methods of repair which will leave the carving on the undersides as intact as possible.

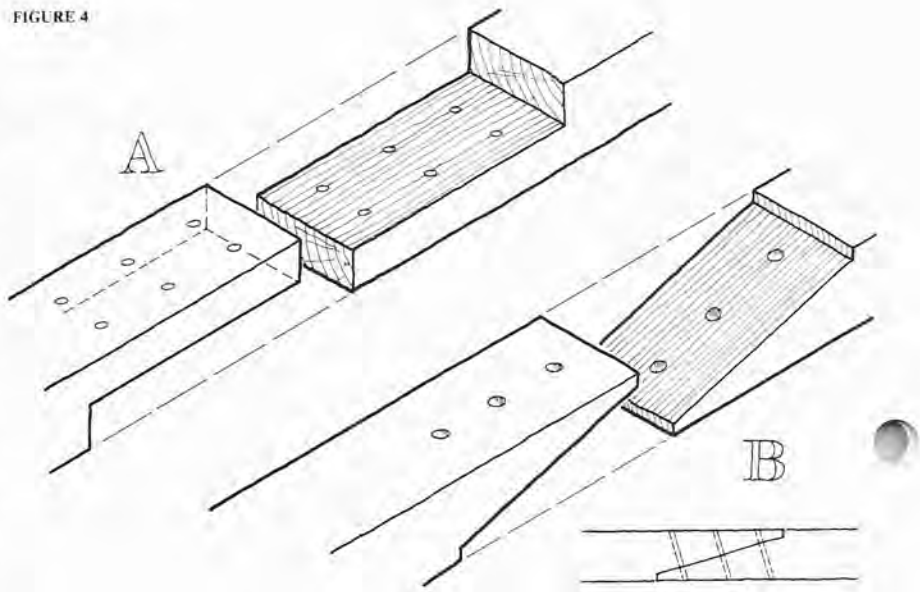
Although no hard and fast rules can be laid down, the steel plates should extend sufficiently far from the centre of the fracture or unsound wood to enable a sound connection to be made by bolting through the wood and steel; three times the depth of the beam on each side of the fracture is generally about right. The nuts and bolts can be recessed into the beam and faced with oak plugs. If you want to conceal the repair from below, the depth of the steel plates should be slightly less than the depth of the beam so that the underside can be recessed and concealed by a fillet of oak. A flitch plate is also an effective way of joining new oak to old when a scarf joint may not be suitable, for example when repairing an arcade plate in situ.

An alternative to cutting through the beam is to cut a deep trench into the beam from above, the same width as the plate and as deep as is necessary and then inserting either a flitch plate or a tee section as shown on figure 3C. Cutting such a trench can be a hazardous operation and it is only worth doing if it is important to conceal the plate from below. This technique is also useful to strengthen a timber which has joints in the underside as it can avoid much dismantling.

In any of these cases cutting the slot for the flitch may reveal the presence of hidden cavities in the heart of the timber. Since it is important that the steel plate should be largely in contact with the beam material, especially at bolt positions, if possible the cavities should be filled with suitable fillers at the time when the plate is inserted.

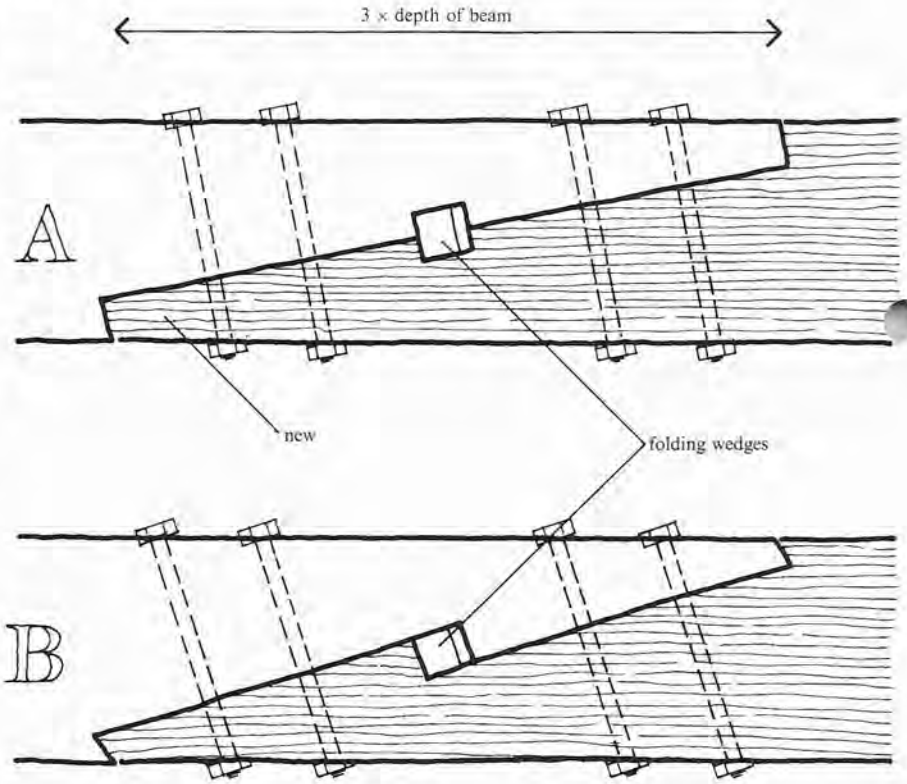
Cautionary Note: in the event of a serious fire, the steel will carry a very high temperature into the heart of the timber very quickly and so in some cases fire protection from above may be appropriate.

FIGURE 4



Two simple scarf joints for use in repairing cill or wall plates. The joints should be between $2\frac{1}{2}$ to 3 times the depth of the plate.

FIGURE 5



Two variations of a scarf joint which can be used in repairing horizontal members in situ and which can resist tensile, bending or compression stresses. 'B' is the stronger of the two but is difficult to cut accurately on an old beam in situ because the carpenter cannot get his saw to the recessed section of the joint. If the repair is being done on the bench and if oak pegs are to be used, this joint is the better of the two.

Scarf Joints

When working on a timber frame it is important to identify the type of scarf joints used in the original structure because they can provide important evidence about its age and history. It almost goes without saying that these should be carefully preserved and that if one half of an original scarf joint has to be replaced, this must be done to match the original.

There is no 'standard' scarf joint for use in repair work. The following are examples of joints frequently used because of their simplicity and effectiveness.

A simple scarf joint which can be used for piecing in a new section to a cill plate is shown on figure 4A. This relies on the pegs or bolts for its strength and is not suitable for jointing members subject to any bending stresses. Figure 4B shows a simple splayed scarf which, as it can resist bending stresses, is suitable for use on repairs to wall plates. Figure 5 shows the most common scarf used in repairs to members such as tie beams and the arcade plates of large barns. It is similar to the joint used in the 13th century on the Wheat Barn at Cressing Temple in Essex and was again used in its repair. The joint is able to resist 'hogging' and 'sagging' stresses as well as sideways movement. It is an easy joint to cut, even in situ (although this does not apply to the version shown in figure 5B), and its only drawback is the length of timber required to make it.

The direction of incline of a scarfed end to spanning timbers will normally be best decided so that the scarf is providing support to the cut-away end — i.e. with the greater part of the new timber on the underside. However, if the timber to be repaired has original mouldings on the underside, or if decay is confined to the top side, the scarf can be inverted to preserve the maximum amount of original material.

All these joints should either be held with pegs or with stainless steel bolts if greater strength is required as, for example, on reversed scarfs. The

Donald Insall & Associates

An inverted scarf joint introducing a new end and retaining the existing moulding to the underside of the tie beam.

—Shaping end of tie beam to receive scarf

—New scarfed end being swung into position

—Completed scarf
note: inverted to retain existing mouldings on underside of tie

great virtue of all scarf joints when used in repair work is that, apart from the bolts, (if used) they are made entirely from timber and do not require steel plates or straps.

Repairs to Posts and Studs

The most frequent cause of failure in posts and studs is due to decay at their feet. This can be remedied by cutting back to sound wood and scarfing on new timber. Figure 6A shows a simple joint for use on secondary members such as studs where there is little chance of any major sides movement. Figure 6B shows the stronger and more complex (and therefore more expensive) scissor scarf joint for use on fully load bearing members, the many planes of the joint providing greater resistance to movement in all directions than that given by the simpler joint. Because both these joints are in compression it is essential that complete contact must be made on all faces. The joints should be held with pegs or with stainless steel bolts.

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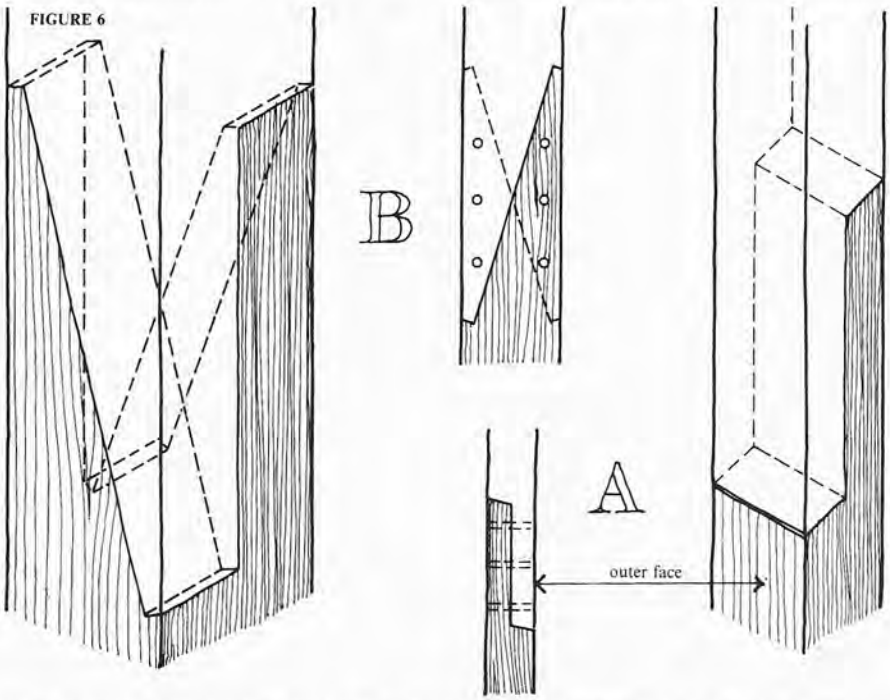
Myriad timber repairs to an early barn frame leaving much of the original timber remaining, and thus the evidence of structural changes in the past.

FIGURE 6



Two methods of repairing members in compression such as studs. 'A' is the same joint as in figure 4 except that the horizontal cuts are splayed to throw water clear if the stud is exposed to the elements.

The scissor joint shown in 'B' should be used in preference to that shown in 'A' for all repairs to posts as the eight faces of the joint help to resist lateral movement. The elevation shows the position of the bolts for fixing.

When only the tenons have failed and the uprights are otherwise sound they can be renewed by inserting false tenons as shown on figure 7C. Any trenches cut in the cills or beams to enable the false tenons to be inserted must be filled with timber with the grain following the line o the original.

Cill Plates

Because they are vulnerable to rising damp and subsequent decay, the parts of a timber frame where the need for renewal most frequently occurs are the cill plates. If a plate has to be replaced and the supporting brick or stone plinth is also being rebuilt, it is a comparatively simple matter to prop up the frame above and to remove the old cill. The new timber is then offered up from below with mortice holes already cut to house the tenons on the studs and posts. If the plinth is not being rebuil

FIGURE 7

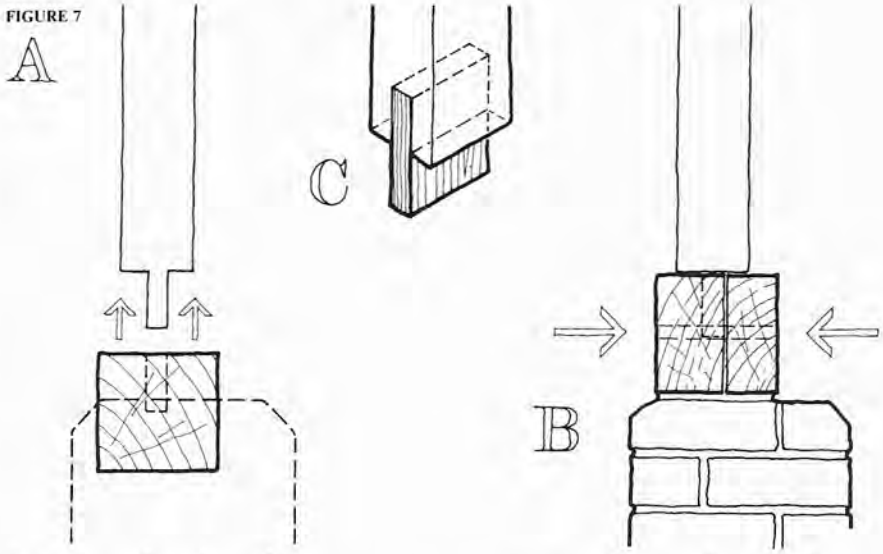


FIGURE 7: Repairs to cill beams: If a cill beam has rotted and the supporting plinth has to be rebuilt (although this is something which should be avoided if at all possible) the new plate can be inserted from below with the mortices already cut to receive the tenons on the studs as shown in 'A'.

'B' illustrates a simple method of replacing a cill beam in two sections so that the masonry plinth can remain undisturbed. One half of the plate is cut to receive the tenons from the studs and the bolts must be positioned to avoid them.

If the tenons on the studs have to be replaced, this can be done by cutting in a 'false' or 'slip' tenon as shown in 'c'.

FIGURE 8

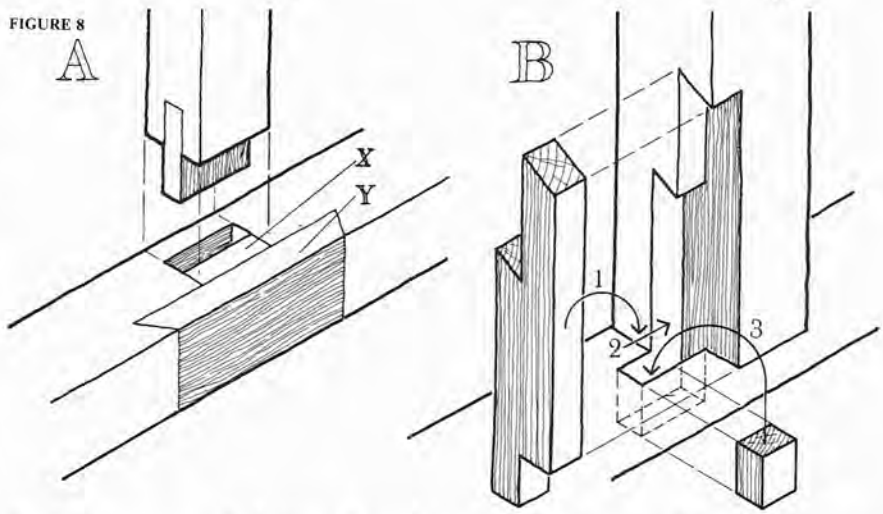


FIGURE 8: 'A' illustrates how a new cill plate can be slid into position horizontally and then held with infill pieces, piece 'X' being slid in from the front and piece 'Y' then being slid in from above. It is a superior repair to that shown in figure 7B but also more time consuming and therefore expensive. This repair can also be used for piecing in new sections to a plate in situ.

'B' shows an example of how infill pieces can be used to repair a damaged timber in situ, in this case a post. The large section is prepared and then offered up into the enlarged mortice and slid into position and glued. The small section is then tapped into position from above to fill the mortice.

one method of renewing the cill plate is to form it from two sections cut lengthwise and offered up on each side of the tenons, one side of the plate having already been cut to receive them. The two halves are then bolted together with stainless steel bolts. This is shown on figure 7B.

An alternative and more sophisticated method of inserting a new cill plate is shown on figure 8A. This is a more satisfactory solution but it is more expensive as it involves more work. It is an excellent repair when renewing short lengths of cill or inner wall plate.

Filling Holes and Shakes in Old Timbers

Although there are no entirely satisfactory methods of dealing with filling holes, shakes and other blemishes in old timbers the following methods have been generally used for many years:

Shakes: because of their awkward and irregular shape shakes are difficult to fill successfully with timber inserts and this should only be done externally when it is necessary to stop rainwater from penetrating into the timbers. Any parts which cannot be filled with timber should either be packed with mastic or filled with lime hair plaster and limewashed over. The timber inserts must be of well-seasoned wood with its grain running parallel to the parent and fixed in position with glue. An alternative method is to pack the shakes with hemp and then seal them with mastic, but this should not be done where the timbers are clearly visible as it is unsightly. Shakes on internal timbers should be left unfilled or packed with lime hair plaster.

Old mortices and peg holes: if they have to be filled this should be done using well seasoned timber cut to fit and glued into position. Where old joints are being filled the inserts should be slightly recessed so that the history of the timber can still be clearly read. On external timbers all inserts should be carried out in such a way as to ensure that rainwater is thrown clear.

Piecing-in new sections: when part of a timber has rotted away or is miss-

Michael Reardon Assocs.

Left: Repairing a timber frame which has suffered decay in the sole plate is complex. Rarely is it necessary to replace the whole plate as shown here, but in this case the plate is a beam supporting the granary above.

ing, but it is not necessary to replace the whole member, the rotten wood can be cut back to a clean profile and new wood inserted and held by glue. Whether the exposed face should follow the line of the original or the line of the eroded face (as invariably exists) or should be left in the block (i.e. uncarved) is a matter for individual judgement. It is essential that such a repair should only be done if really necessary (the loss of original material should always be avoided wherever possible). As with shakes, the inserted timber must be well-seasoned in order to avoid shrinkage cracks, with the grain running parallel to the original.

Concealed hollows in old timbers (such as are formed when decayed wood is scraped away) can be filled with a mixture consisting of one part of 'Araldite' to six parts of coarse hardwood sawdust. Because this mixture is viscous it can only be used on horizontal members or where the cavity can be shuttered up. It has considerable compressive strength. It is not suitable on exposed surfaces. In cases where strength is not important a mixture of waterproof p.v.a. adhesive (e.g. Unibond EVA) and coarse sawdust can be used as a filler. A 50-50 mix is stiff enough to be used on a vertical plane and can be worked down when set. This method can be used on exposed surfaces.

With all methods of filling holes and crevices in timbers exposed externally it is essential to ensure that rainwater is allowed to run off and is not trapped by the filler or let into the hole.

Dating Timbers used in Repairs

All principal replacement timbers should have the date of the repair carved or branded on to them in numerals about 25mm high.

Carpenters should be encouraged to inscribe the work with their initials and the date of its execution; such information can be invaluable both to historians and to those working on the repair of the building in the future.

Finishing New and Old Timbers

New timber members inserted into an old frame and new timber used in repairs to individual timbers will look very raw for a while but will soon take on the rich colour which makes untreated oak (and other native hardwoods) so attractive. For this reason you should resist the temptation to tint or stain new work to make it blend with the old, however great the contrast may be when the repairs are first carried out. The possible exception to this is the insertion of new timber into a frame which has been tarred; this is discussed in more detail below.

When sawn timber is used the saw marks can be removed with a draw knife or adze in those situations where the timber is clearly visible and its appearance is important. Otherwise work to the surface should be restricted to removing the dirt or stains which often appear on new timber.

When the timbers are exposed externally (and, in some cases, internally) and are badly disfigured by weathering or small shakes, nail holes etc. the best treatment is to cover the timbers and surrounding plasterwork with one or two coats of limewash, which can then either be left on or lightly brushed off with a stiff bristle brush, leaving the holes and crevices filled with lime.

This treatment is unsuitable where the frame has been coated in the past with tar. In such cases either the new timber and old timbers should be retarred in accordance with local custom and tradition or the new timber should be left to weather naturally so that it gradually blends with the old. In the latter case the old tarred or stained timbers must be left without further treatment and allowed to fade.

If you want to enrich the timbers internally you should use beeswax polish applied with a cloth or brush. Contrary to popular belief you should not use linseed oil either internally or externally as it becomes sticky and attracts dirt. The use of stains should be avoided wherever possible.

Further reading

English Historic Carpentry by Cecil Hewett. Phillimore.
(This is particularly valuable for readers wanting to learn more about the historical development and use of joints).
Timberwork: Notes on the Repair and Preservation of Historic Buildings. HMSO 1965.
SPAB Information Sheets nos. 1 (Limewash), 2 and 3 (Timber).

Conservation of Timber Buildings by F. W. B. and Mary Charles. Hutchinson.
Practical Building Conservation Vol. 5. by John and Nicola Ashurst. English Heritage/ Gower.
Timber Building in Britain by R. W. Brunskill. Gollancz.

Acknowledgement:

The author is indebted to colleagues and members of the Society's Technical Panel for much help and advice during the preparation of this pamphlet, particularly to Peter Locke and Graham Burges.

Oak Suppliers

J. S. Agate Ltd., Maitlands, Faygate Lane, Horsham, W. Sussex RH12 4SJ. Tel: 0293 851482
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Printed by Eyre & Spottiswoode Ltd. London & Margate
First published 1991. Reprinted 1993