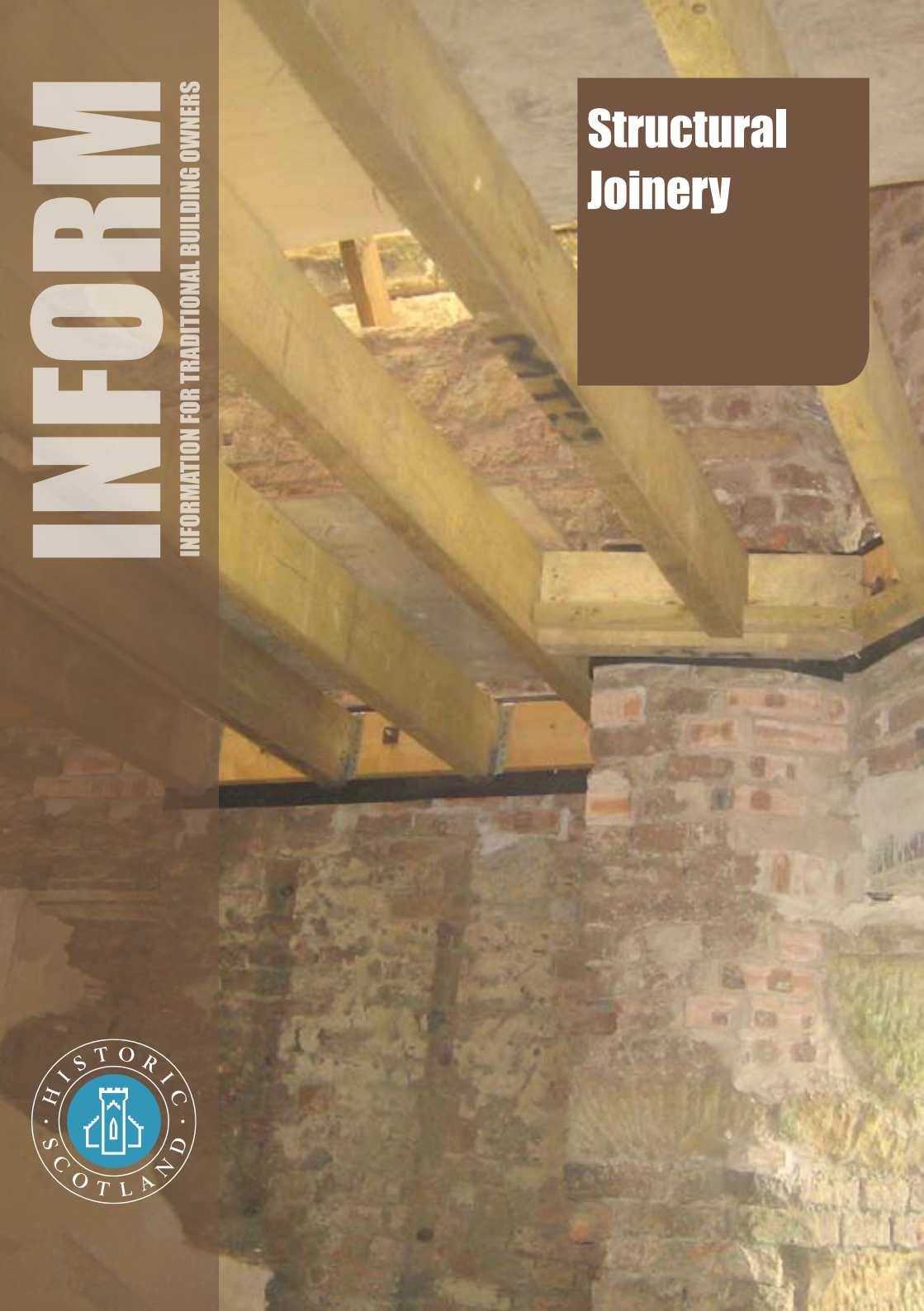
INFORM

INFORMATION FOR TRADITIONAL BUILDING OWNERS

Structural Joinery



HISTORIC SCOTLAND

Strenthening of the joint with bolts

Structural joinery elements make up some of the key parts of a traditional building and their correct function is of crucial importance. Structural joinery refers to the timbers which form the roof and floor construction, and this INFORM will cover the survey, inspection and repair options and principles associated with work on these elements of a traditionally built property.

From middle ages there continued a long tradition of timber house construction, that survived in many Scottish Burghs until the 17th C, when increasingly local bye laws prohibited building in timber. This was due to fear of fire; nonetheless examples of timber construction survived in provincial towns and some cities until the 1960's. Despite this since the 17th C there has been much skilful and accomplished timber work done in Scotland, although by its nature much of it is rarely seen.

In some cases, usually in 18th C buildings, there exist the last remains of a framing tradition - timber frames with brick infill, sometimes called nogging. These partitions are often load bearing and frequently subject to distortion and movement. Such partitions are halfway between structure and subdivision, but due to the weight of the brick noggin should be treated as structural. There are also likely to be stiffening and supporting adjacent elements for floors above; although they are often only one brick thick, they can contribute to the overall structural integrity.

Materials

Structural timber, on the whole, was carefully selected for quality on every level - free from knots and shakes (drying cracks and splits along the grain), with only close grained timber being selected. A lot of timber was imported, initially from the Baltic, then latterly from Canada and the USA. It must be emphasised that the quality and durability of older timber cannot be matched today, and this appreciation of the material affects the approach to repairs described later in this INFORM.

Most jointing of timbers was using wrought iron nails and sometimes straps and bolts were used; the tradition of wooden pegged joints had died out with the increasing shortage and consequent cost of native hardwoods in Scotland in the early 17th C.

Roofs

Most roofs consist of a frame of rafters formed in the triangular pattern called and A Frame, braced or tied at regular intervals with tie beams or collars. A ridge plate links the apex or top sections, whilst the rafter feet are fixed to a timber wall plate running along the wall head. Jointing was simple – simple lapped joints for the apex, and a similar lapped or occasionally a gunstock joint for the ties. Fixing to the wall plate was normally by nails only.

In some earlier roofs, the A-frames are fewer, and joined longitudinally by timbers called purlins, shorter and smaller rafters then carry the roof. As the rafters have to carry more weight, they are referred to as principal rafters. This type of roof became rare by the 19th C, and standard A frame roofs became the most common.
Early roofs were assembled on the ground and marked (usually with roman numerals) to allow correct reassembly in situ. Other marks that may be seen are gouged symbols called "shipping marks" believed to denote quality and grading. Their use declined during the 19th C.

A roof of the Late 18th under repair, showing the purlins midway in the span.

Floors

Floors are built up from the joists, which normally run across the shortest length of a room, with the boards at right angles to them. In early floors, up until the 17th C, complex jointing and layouts were used to minimise the lengths of timber required - often fewer longer and thicker members, in -filled with a range of shorter thinner pieces.

Joists were often built into the wall (into pockets) as the building progressed, sometime continuing almost to the outside face. On occasion the floor was stiffened with timber spacers, although the subsequent addition of deafening boards, laths on the underside and floorboards above contributed to stiffness and rigidity.

Most rooms had fireplaces, and a special arrangement was required to carry the projecting hearthstone without having joists terminating under the hearth. In this case a "trimmer beam" was fitted at right angles to the joists, parallel to the line of the hearth. Deafening boards were fitted and packed with cinders or clinker, and the hearthstone laid on top. The floorboards were then laid flush with the hearthstone. A raised hearth stone is modern practice.

Modern metal pre drilled straps used in rafter splices.

Common problems and solutions

Roofs, by their nature, are normally well ventilated, and timber decay and consequent structural problems are invariably due to failure of roof water drainage. Likely areas of decay from continued saturation are rafter feet, wall plates and timberwork adjacent to or part of a valley, where 2 roof pitches meet.

Insect attack however is common on the lower grade timber used for sarking and the outer layers of the rafters, containing the younger softer timber is often vulnerable to insect colonisation. Woodworm in the sapwood of a rafter should not be seen as a big problem. A small drill hole should be made into the centre of the timbers and the drill residue examined. Clean cut fragments, with a rich resin smell indicate sound, strong timber. Dusty residue with no smell indicates decayed and unsound material, where consideration should be given to replacing weaken sections.

Due to the orientation of roofs, decay tends to be more pronounced on the Northern pitch of a roof, as there is less warming and drying by the sun, with timber consequently at a lower temperature – and water, from condensation or leaks, tends to linger longer. In such cases, the timber is decayed by various types of rot, and the element settles, distorting the structure and leading to further ingress. Eventually failure is total and substantial parts of the roof are affected.

Areas of sound timber can become less stable by the loosening or failure of the iron nails, common at tie beams and the apex joint. Where possible the old nail should be removed if it has failed, and a stainless steel bolt and washer set fitted, remembering that old nails can assist in dating the building. Normally one bolt is sufficient for stiffening.

Floor joists, while very durable in a dry properly maintained wall, are very vulnerable in a wall that has become saturated as wet or dry rot will quickly compromise the structural integrity. (such decay can be localised, and largely invisible, although settlement and distortion of the floor should give an indication). Repair techniques are the same as for roof timbers, although removal of boarding will be required. Where possible, repair such elements from above or below to avoid unnecessary destruction.

In larger spaces, where the joists have a long run, the floor can become quite slack, or springy. While unlikely to be structurally dangerous, damage to the ceiling below is likely from vibration, and stiffening may be required. This will oblige the removal of the floor and some deafening. Timber spacers are inserted in lines at right angles to the joists, and a series of wires are threaded through holes made in the joists. The wires are then tightened up and the floor is thus bonded together and stiffness is restored.

Supporting a ceiling during work on the joist ends

Strenthening of the joint with bolts

Sometimes, where wall repairs prevent the joists being located in the wall, joist hangers can be used, keeping timber away from a wall, which even after repair, may remain damp for several months.

Structurally unsound timber should be removed back to a sound base, and new sections scarfed or lapped on. There are different techniques for this which essentially apply to roof and floor timbers alike:

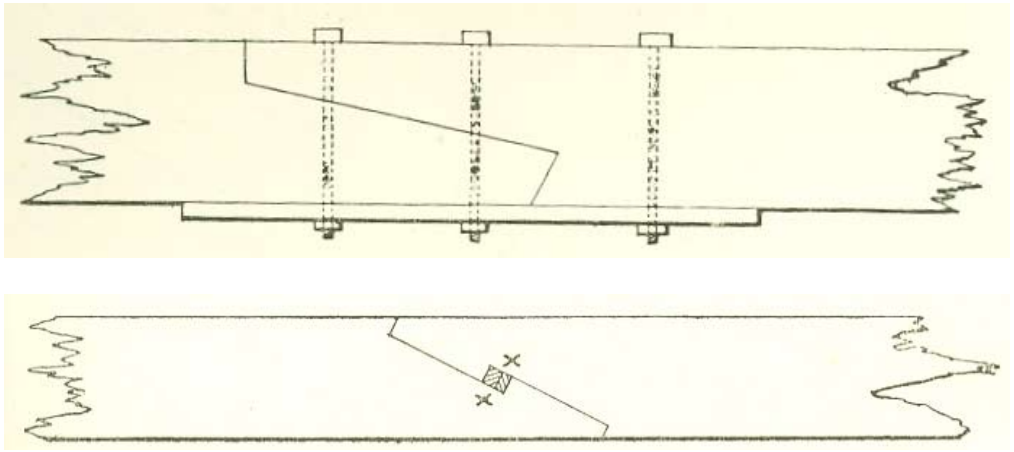
Strapping is the standard technique of fixing timber or plywood plates either side of the joist and the new section, they are normally secured with a determined pattern of bolts. While simple in execution, they take up space and are visually obvious.

Plating using modern steel is a similar approach, but using preformed steel plates, angled to fit the joist. They are fixed with ringshank nails. This repair is simple and takes up much less space, although the steel is highly visual.

Steel fitchplates can be used where space and appearance is important, especially when using exactly matched timber. A thin section is cut in the centre of the existing and new section, and a steel plate is inserted within and fastened with bolts.

Jointing. A skilled repair, used where craft, material and appearance are important. Historically common as no metalwork was required and often used on exposed horizontal timbers of above average dimension, but probably not an option in the domestic context. Whatever technique is used, it is vital that good quality timber is used.

Resins and glues. Some engineers specify an epoxy resin to be used in structural repairs, especially in areas where the thrust is in more than one plane of the timber element (for example valley beams). Such resin is normally a slow setting resin, giving time for the resin to soak into the matrix and fibres of the timber.



19 C illustration - Joining of timbers, with iron plate and bolts for additional strength

While some repairs may appear self evident, it should be remembered that as timberwork of such size is structural, a structural engineer with conservation experience may be required, especially on larger projects.

Composite repair using resin, new timber and steel plate

In many cases, replacement of rotted elements is dealing with the symptom, equally important is dealing with the cause. In the case of rot caused by damp for example, the cause of the damp must also be addressed. Preserved timber wrapped in plastic will not survive in a damp wall; identify the water source and cure the problem. Frequently problems in joinery elements are caused by small but persistent defects, for example a small crack in a lead gutter can lead to progressive saturation. Sometimes a failure of a timber element can lead to distortion and damage to other parts of the building. A series of failed roof ties, for example, can lead to the downward pressure on the roof forcing the walls apart. The nature of lime masonry, especially if progressively wetted, is to slowly give way with pressure, eventually causing collapse. This distortion can happen in all but the thickest walls.

Further reading

The Care, Conservation and Repair of Georgian Houses, A Davey et al, Butterworth (4th edition) 1995
The Tenement Handbook, John Gilbert & Ann Flint, RIAS, 1992
Building Construction Drawing, R B Eaton, Donhead 2009 (Reprint)
Rivingtons Building Construction, Percy Smith, Donhead 2009 (Reprint)

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