2005

Stone Slate Roofing

Technical advice note

ENGLISH HERITAGE

Contents

Technical advice note

This technical advice note gives guidance for architects, surveyors, and building owners, on the repair and reroofing of traditional stone slate roofs in England. It deals specifically with stone slates from sedimentary rocks (mainly limestone and sandstone) rather than with real slates, which are from metamorphic rock. As the material and methods of stone slate roofing vary from region to region, it concentrates on general principles. For guidance on the specific local roofing types and methods, advice should be sought from the local planning authority. Some local authorities provide leaflets on regional roofing practice. Further advice will be available in "Stone Roof Conservation: a best practice guide" (see *References*).

1 Introduction

If any regard is to be had to the general beauty of the landscape, the natural material of the special countryside should be used instead of imported material. (William Morris, *On the external covering of roofs*, 1890)

1.1 Sandstone and limestone slating is a highly regionalised roofing form, fundamental to the distinctive local character of buildings in many parts of the country. However, local character and distinctiveness are under threat and stone slate roofing is becoming increasingly rare. As locally produced stone slates come to the end of their natural lives, declining supplies of new ones have led to the use of imported or artificial substitutes which have little to do with local building traditions. If the special qualities of our built heritage are to be conserved, any repair or reroofing should be based on the principle of replacing 'like with like'. Stone slate roofs are no exception. Keeping the local stone slate roof of an historic building helps to conserve its significant character.

1.2 The gradual decline of the stone slate roofing industry has led to a loss of expertise of both roofers and specifiers, and there is little written information available on best practice methods for reroofing. The revival of traditional methods and the adaptation of historic details so that roofs meet modern performance standards has created confusion and resulted in the unnecessary failure of a number of roofs. This leaflet attempts to clarify these issues and provides information on best practice as we understand it today.

1.3 This technical advice note has been developed from several documents written when stone roofing was a live art; from practical experience, and from advice given by stone slaters, manufacturers, conservation officers, architects and surveyors. Some of the issues raised are matters of conservation principle rather than technical fact, and others may need to be reviewed as more information comes to hand and experience grows. Research into the construction of stone slate roofs is a neglected field. Future research will reveal more information on traditional practice and help us to understand better the regional variations of stone slate roofing.

2 Stone as a roofing material

2.1 Terminology

2.1.1 Stone slates are known in different parts of the country as grey slates, flags, flagstones, thackstones, slats, flatstones, stone tiles, and tilestones. Geologists prefer the term tilestone as these limestone and sandstone products are not, geologically, slates. That is to say that they are made from sedimentary, rather than from metamorphic rocks, and consequently split along bedding rather than cleavage planes. Stone slate is however the most commonly used term and has been adopted in this leaflet.

2.1.2 The word 'delph' (plural 'delves') has been used in preference to 'quarry' and 'quarrying' because of the unpopular image the latter have in the public's perception. Other names are used locally, including 'quar' in Dorset and 'pit' over a wide area of the country.

2.2 Stone types

2.2.1 Stone slates have been used for roofing in Britain since Roman times. Wherever a rock could be split to form a reasonably thin slab, it has been exploited for roofing and examples exist for almost every geological period and rock type. Until the second half of this century, stone slates were quarried or mined extensively throughout Britain and although most quarries were small and served a small locality, collectively they formed a significant industry. The table identifies the regions in which stone slates have been manufactured and used, their

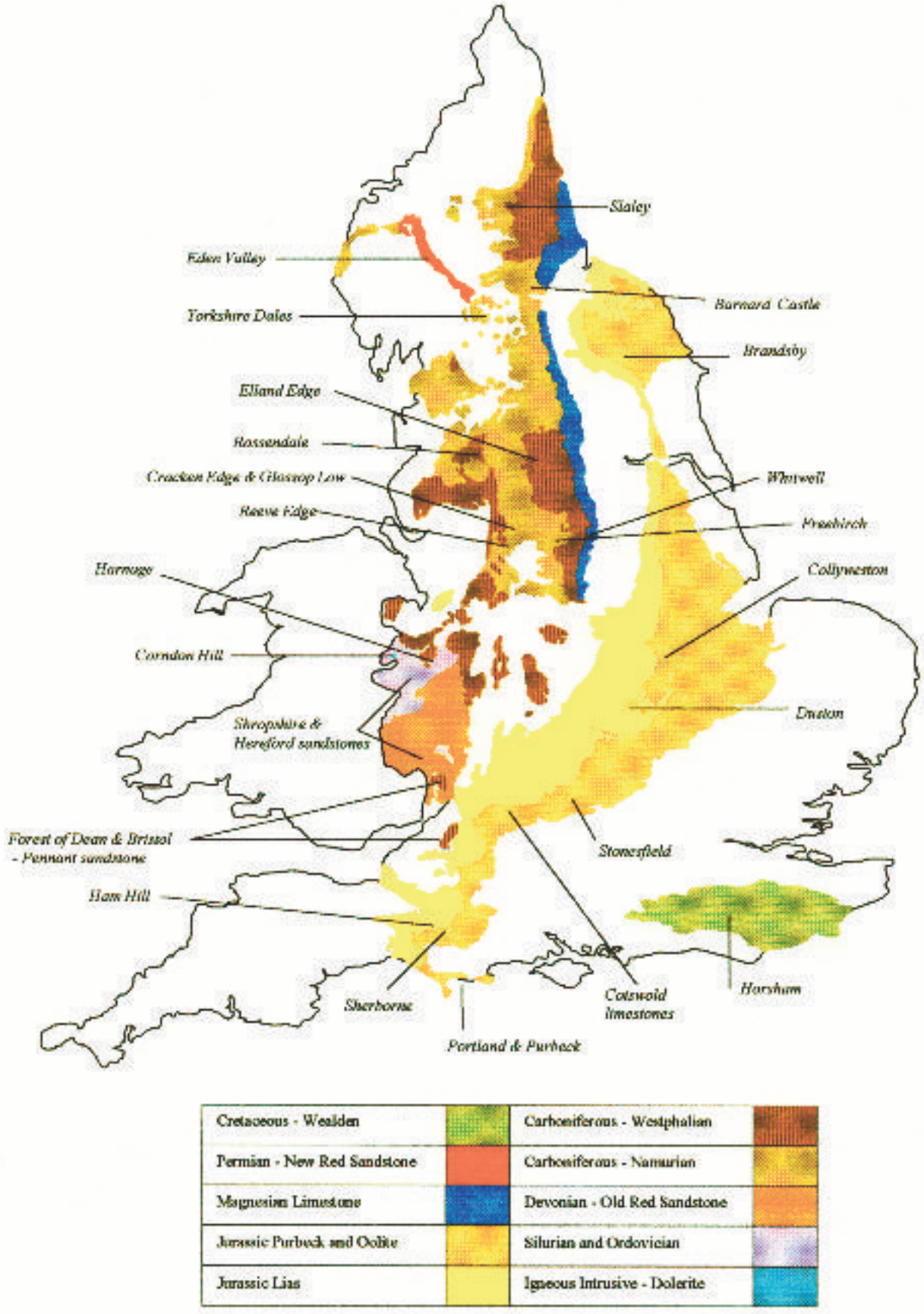


Figure 1 Geological formations important for stone slates in England, and some historical locations for production and use

Table Stone slates: local usage and sources

Limestones, including sandy limestones	
Dorset	JURASSIC: Purbeck, Forest Marble
Somerset (South and East)	JURASSIC: Lias, Forest Marble
Cotswolds East Gloucestershire, North Oxfordshire, and North Wiltshire	JURASSIC: Purbeck, Corallian, Forest Marble, Hampen Marly Beds, Trougham and Taynton Stone (Stonesfield Slate), Fullers Earth, Chipping Norton Limestone
East Midlands Northamptonshire, Lincolnshire, Cambridgeshire, and Leicestershire	JURASSIC: Blisworth Limestone, Upper Estuarine Limestone, Chipping Norton Limestone Lincolnshire Limestone, (Collyweston Slate), Northampton Sand, Lias
Yorkshire (North-east)	JURASSIC: Scarborough Limestone
Nottingham to South Shields, East Derbyshire (Whitwell)	PERMIAN: Magnesian limestone
Sandstones, including calcareous sandstones	
Surrey, Sussex, West Kent	CRETACEOUS: Horsham stone
West Gloucestershire, Bristol	CARBONIFEROUS: Upper Westphalian/Coal Measures – Pennant Measures
Welsh Marches Gloucestershire, Herefordshire, Worcestershire, and Shropshire	DEVONIAN – OLD RED SANDSTONE and SILURIAN – PRIDOLI: Dittonian, Downtonian, Tilestones ORDOVICIAN: Hoar Edge Grit, Cheney Longville Flags, Hope Shale (Corndon Hill)
South Pennines North Staffordshire, North Derbyshire, and East Cheshire	CARBONIFEROUS: Lower Westphalian/Coal Measures Namurian/Millstone Grit
Lancashire, Yorkshire, Durham, Northumberland	CARBONIFEROUS: Lower Westphalian/Coal Measures, Namurian/Millstone Grit
Cumbria	PERMIAN: New Red Sandstone – Penrith Sandstone CARBONIFEROUS: Namurian/Millstone Grit

Note: for more detail see Hughes in Wood (2003)

geological period and formation names, and is a reminder of how extensively they were once used (Fig 3).

2.3 The production of stone slates

2.3.1 Roofing stones are produced from either weathered rock (subjected to glacial and post-glacial weathering) or from deeper, unweathered rock. Depending on the lie of the ground and the amount of overburden, the block for stone slate production has traditionally been obtained by open quarrying or delving (exploiting the near-surface weathered rock), or alternatively by mining (mainly to extract unweathered rock). Sometimes delving began with the extraction of the weathered rock and progressed to mining. In both cases it was (and remains) a manual process although, today, small excavators are sometimes used to loosen the rock before selecting, splitting, and dressing are done by hand.

2.3.2 Stone slates were mined at Purbeck in Dorset, at Collyweston and Duston in Northamptonshire, at Stonesfield and elsewhere in the Cotswolds, in Yorkshire and occasionally in Derbyshire. Access to the fissile rock was by adits or shafts with the rock worked along galleries. At Collyweston and Stonesfield, the splitting was carried out by frost action. The raw block was either stored underground or taken to the surface where it was wetted and covered in earth until the frosts came. The frost then swelled the natural moisture within the stone and split it into slates. Frost-split slates may be thinner and therefore lighter than those split by hand (Fig 2).

2.3.3 However, most stone slates were surface delved rather than mined. Where the rock has been weathered, it is weakened along the bedding planes, allowing it to be split into thin layers of a suitable thickness for roofing. In some areas, the weathering actually completes the splitting process and stone slates are found at the surface or turned up by ploughing. Traditionally the delves tended to be small in scale, supplying one village or even a single farmstead (Fig 3), although some developed into large operations supplying industrial towns. Even so, their markets were always local. Today the remaining delves often supply slates far beyond their traditional markets.

2.3.4 Once the rock had been split to the required thickness, it was dressed to size and shape. In some cases the faces of the slates were also tooled to provide a flatter surface. The slates were holed using a pointed tool, from one or both sides. This provided a tapered or hourglass hole which gripped the timber peg commonly used to hold the slate in place on the roof (Figs 4 and 5).

3 The principles of stone slate roofing

3.1 Local stone slating traditions evolved from the slater's response to the particular geology and climatic conditions of an area – it is a highly regionalised activity. Local practice varies from region to region, with the production of the stone slates, design of the roof, roofing methods and detailing all contributing to

Figure 2 Collyweston, Northamptonshire: stone laid out for splitting by winter frost (Photograph: Daniel Martin)

the special qualities of an area's built heritage.

3.2 Stone slates are randomly sized (see Glossary) and laid in diminishing courses. The principle of random roofing is that the range of stone slate sizes reflected what was available at that time from the quarry and maximised the usable rock. Unfortunately, some manufacturers today have limited the range of sizes they produce and this alters the appearance of a roof. The selection of replacement materials should reflect the original mix of sizes. Stone slates should diminish in size regularly up a roof slope and represent, as far as possible, the range of sizes typically used in the region (see front cover image).

3.3 In many parts of the country stone slates were used at the eaves courses in combination with thatch or tiles for a variety of reasons. Eaves slating has sound practical advantages: it evolved as a means of protecting the eaves of thatched buildings from harm by animals, but also provides a hard edge for resting ladders and a long overhang for water runoff. In most cases, however, where stone slates are present only at the eaves, they are the remnants of an earlier stone roof which has been gradually lost because of lack of make-up slates during successive re-slating. The appearance is now considered to be traditional and should be conserved (Fig 13).

Figure 3 The duck pond of this West Sussex farmhouse may originally have been the quarry for the Horsham slates on the roof.

Figure 4 The rock is split along the bedding planes into a suitable thickness for roofing.

Figure 5 Once split to a suitable thickness, the stone is dressed roughly square and a fixing hole made.

3.4 There is no British Standard for specifying either materials or construction methods for stone slate roofing, although many of the details and recommendations made in *BS 5534: 2003 Code of practice for slating and tiling* are applicable to stone slates. However, it should be recognised that this British Standard does not deal in detail with random roofing. Many of the traditional details typical of stone slate roofing, which have performed satisfactorily for centuries, conflict with its recommendations. However, departure from British Standard practice should be based on sound, proven knowledge of local traditional practice.

4 Planning and historic buildings legislation

4.1 The controls for listed buildings, and buildings in conservation areas, are

covered by the *Planning* (*Listed Building and Conservation Areas*) *Act* 1990, and *Planning policy guidance: planning and the historic environment* (known as PPG 15 – see *References*). Consent is needed for alterations to a listed building if these would affect its character as a building of architectural or historic interest. Obviously, stone slate roofs are very important features whose loss will almost always be resisted by the local planning authority. For all but the most minor repairs it is prudent to speak to the local planning authority to ascertain whether or not Listed Building Consent will be required for the works.

4.2 Unlisted buildings in conservation areas do not have the same protection. Planning permission is required for any change which would represent a material alteration to the external appearance of a building if it is not in residential use. Permission is not usually required if a building is in residential use. However, it is always advisable to check in case the local planning authority has any additional powers under an Article 4 Direction (of the 1990 Act), which could require permission to be obtained to remove or alter a stone slate roof.

4.3 An application for a new building (or alterations to an existing building) in a conservation area will be subject to local planning policies, so an early consultation with the local planning authority's Design or Conservation Officer is recommended. Development proposals are required to preserve or enhance the character or appearance of the area so, where stone slate roofs are common, new buildings may be required to incorporate the same type of roof covering. This is especially likely if the relevant appraisal confirms their positive contribution to the overall character.

4.4 Detailed recommendations for the application of planning legislation to stone roofs is available in *Stone Roof Conservation: a Best Practice Guide* at www.stoneroof.org.uk/best.html

5 Inspection and maintenance

5.1 Planned and regular inspection and maintenance are the best ways of ensuring the continued satisfactory performance of a roof. Inspections, which can be carried out annually by the building owner and (for example) quinquennially by an architect or building surveyor, will enable minor problems to be identified and dealt with before they become serious. Inspections should include an internal and external examination, checking for slipped slates, loose ridges, and defective rainwater goods including flashings and gutters. Signs of decay may be indicated internally by moisture staining of the roof timbers, ceilings and walls, presence of mould or fungal growth, and by timber decay and loss of torching. Leaks can be a symptom of more serious design or construction problems, so it may be necessary to inspect the overall structure. If, for example, the lap of the slates is inadequate, or the pitch of a roof is too shallow, wind-driven rain will penetrate.

5.2 Regular maintenance is part of the day-to-day responsibility of all owners and occupiers, and a well maintained stone slate roof can last for many generations. Excessive plant growth may affect the performance of a roof but some rare mosses live on stone roofs and may be protected. Before removing a moss building owners should check its status with the local nature conservation organisation. With care it is possible to remove unprotected plants without damaging a protected species. Ensuring that the roof is free of excess moss (which can retain moisture and accelerate delamination) and creepers such as ivy (which can dislodge slates) will save on future repair bills. Leaves, accumulated silt, and debris should be regularly removed from the valleys, gutters, gullies, rainwater pipes, drains, and channels.

6 Investigation and recording

6.1 If the roof covering requires repair, specialist advice from someone familiar with stone slate roofing in the area (either an experienced architect/surveyor, or a specialist stone slating consultant or contractor) should be sought to ensure that the causes of failures are correctly identified. It is particularly important to distinguish between leaks due to inadequate construction (gaps etc) and long-term deterioration of, for example, slates, nails or pegs.

6.2 The roof coverings should be reinstated in their existing form except where inappropriate and unsympathetic earlier changes have occurred, or where there are known technical defects in the existing details. Thus it is essential to record the details of the roof coverings and the supporting structure, both before it is disturbed and during stripping. The materials or products, their dimensions, shape, composition, colour, and texture are all important, as is the way they have been assembled. The checklists in Appendices 1 and 2 should be completed as far as is possible and appropriate, and should be supported with photographs and drawings. When photographing slating always try to include views straight on to the surface, including a scale to provide a record of the size mix (markings on tape measures rarely show up on photographs: a metre length subdivided into 25mm bars, painted alternately black and white, is suitable for most purposes). If a comprehensive investigation cannot be undertaken before the work begins, the checklists should be used as stripping takes place and the reslating methods reviewed as relevant.

6.3 The type and size of the various materials should be recorded as well as their condition and, if they have deteriorated, whether they need to be replaced or can be repaired. The condition of the roof timbers and the slates will be difficult to assess until the roof has been stripped and the slates can be examined on the ground or on a wide, load-bearing scaffold.

6.4 It is important to record as much information as possible about the materials and the detailing of the roof. For the stone slates, information about their colour, texture, edge treatments (square or bevelled, dressed or sawn), and sizes may all be helpful in identifying their origin. Often building owners or local slaters will be able to identify the type of slates and even the source quarry. It is also useful to record any vegetation growing on slates, its type (lichen, moss etc), and its colour – which may be indicative of the slates' mineral composition and origin (Fig 16).

6.5 A careful distinction needs to be made between apparent defects and original subtleties of the construction that contribute to the character and technical performance of the roof. For example, it is easy to assume that the roof has sagged or moved. Apart from the visual implications of correcting this (the charm of many stone roofs is their unevenness), they may originally have been constructed as they

appear today. If, for example, the rafters are installed with a slight concavity it aids the laying of the slates. Elsewhere, roofs with gable copings may have been constructed with the rafters at a slightly steeper pitch than the copings to allow for the reducing thickness of the slates up the slope, thus making the roof surface and the copings parallel. In some regions it was common practice to upturn each course of slates slightly at the abutment in order to direct water away from this vulnerable junction. This was often done by raising the end rafter and using narrower slates to accommodate the tilt.

6.6 Where there is a need to record the construction of the existing roof the important dimensions are the batten gauge (see Fig 9) and the slate length (below the fixing hole) at each batten. The headlaps at each slate length and the minimum sidelap should also be recorded, although because of movement in the roof these may not be as originally installed. If these measurements are to be useful, a record should also be made and related to the above measurements, of any water penetration or timber rotting.

6.7 The interpretation of the constructional details of stone roofs is a complex exercise which is best carried out by specialists with an understanding of how roof slating works and experience of local variations.

6.8 While the appearance of a roof may be of interest, photographs of the exterior will be most unlikely to supply useful information about the way the roof was slated.

6.9 **Bats** Before the roof covering is disturbed, the roof should be inspected internally for evidence of bats. If there is any possibility that bats may be present, or any evidence of occupation is found, English Nature must be consulted before work begins. Because bats return to the same place year after year a bat roost is protected even if bats are not always present. All British bats and their roosts are protected and it is illegal for anyone without a licence intentionally to disturb, injure or kill a wild bat or obstruct access to any place used as a roost. Some timber-preservative chemicals are toxic to bats and must not be used.

6.10 **Plants** Some protected plants, for example a moss *Grimmia ovalis*, grow on stone roofs. The local nature conservation organisation should be consulted before a roof is cleaned.

7 The repair and reroofing of stone slate roofs

7.1 Materials for repair and reroofing

7.1.1 Stone slates are reusable and can last for hundreds of years; a stone slate roof, providing it is well maintained, can last for at least a century and possibly much longer. The need to repair a roof will most frequently arise from the deterioration of the nails or pegs used to fix the slates to the laths or battens, the decay of the laths or battens or of the rafters, or the delamination or cracking of the slates, especially at their top edges. Sometimes the problems will have been compounded by the misguided application of bitumen or mortar patches or covering to the entire roof.

7.1.2 In order to retain historic integrity without compromising performance, as much as possible of the original roof covering and supporting structure should be retained during repair and reroofing. If the defects are extensive enough, reroofing may be necessary and Listed Building Consent may be required (see 4 *Planning and historic buildings legislation*). It is almost impossible to determine the precise cost of reroofing until the roof has been stripped, the materials examined more closely, and the extent of damage to the roof timbers and the condition of the stone slates determined. However, an experienced stone slater should be able to give a reasonable cost estimate before stripping the roof although it should be recognised that it may need to be revised when the roof has been opened up.

7.1.3 The introduction of man-made roofing products, new performance criteria, and the consequent changes in roof detailing have resulted in a standardisation of roof construction. If unsatisfactory results or even roof failures are to be avoided, the adaptation of traditional details to accommodate modern materials must be carefully thought through – will the felt be pierced by the pegs, will the introduction of insulation and ventilation affect the lie of the slates and result in leaks? Roof innovations such as the introduction of insulation may well require the roof surface to be elevated, leading to problems at eaves, verges and abutments. A fully thought-out solution, which will probably need specialist advice, may lead to the conclusion that traditional details are best for traditional materials.

7.1.4 Stone slates

7.1.4.1 Stone slates are remarkably durable. It is usually possible to salvage a large proportion for reuse, making them among the most sustainable of all roofing materials. As long as the slates are sound, with no cracks or delamination (see *Glossary*) through their whole length, they will be suitable for reuse. Where they have softened or delaminated at their heads, or where they have been damaged along their edges, they should be redressed, using appropriate hand tools, rather than sawn. This means that salvaged slates are often smaller than the originals. Slates should be discarded if delamination is extensive and severe. Where the fixing hole has broken or enlarged, a new hole can be made at the same end of the slate.

7.1.4.2 Wherever possible, new stone slates rather than second-hand should be used. Reclaimed slates should be used only on the building or group of buildings from which they were removed. The trade in second-hand slates inevitably leads to the unnecessary destruction of roofs and undermines the viability of quarries producing new slates; it also often results in inappropriate regional exchanges and the use of non-local slate. Substitute materials, such as artificial slates made of fibre resin, concrete tiles, 'reconstituted stone' and so on, are inappropriate alternatives to real stone slates and are not suitable for use on historic buildings.

7.1.4.3 New stone slates should match the existing ones as closely as possible in terms of geological type, colour, texture, size, thickness and edge dressing. It is important to recognise the slates particular to an area and know that even within the same region that a variety of slates was sometimes used. If difficulties are encountered in achieving a good match locally, it may be acceptable to source slates from outside the region provided that they are geologically and visually similar. However, it is important to ensure that they have suitable weathering and durability characteristics, and are finished in the local tradition. Sandstone and limestone slates and

ridges, including sandy limestones, should never be substituted for each other, nor should they be used together.

7.1.4.4 Some manufacturers are offering stone slates sawn to thickness. These can be technically and aesthetically unacceptable and, if they fail to meet these criteria, their use on historic buildings should be resisted. If traditional split slates are available they should always be used in preference. If they are not currently available but might be specially manufactured in a traditional way, this option should be investigated. If fissile stone is no longer available a local and building specific decision will have to be made whether to use sawn slates, or similar imported slates, or some other substitute. If sawn slates are used they must always be sawn along the naturally occurring bedding planes or they will weather differentially and may eventually break.

7.1.4.5 Slates should preferably be dressed rather than sawn to size. Sawing reduces the likelihood of producing the natural mix of random sizes, and is aesthetically unpleasing, leaving a straight, blunt edge. Sawn edges can be dressed subsequently – albeit at an additional cost.

7.1.4.6 Slates should be reused with their original orientation (top face up, top edge up). This is because the underside and the head of the slate deteriorate most rapidly and may not be as weather resistant as the originally exposed surface.

7.1.4.7 **Laths and battens** The issue of like-for-like repair or replacement of laths or battens will depend on the particular situation. Wherever possible and practical, the retention of historic detail should be achieved in all elements of re-roofing. Vernacular details such as cleft laths form intrinsic parts of historic roofs and year by year they become rarer.

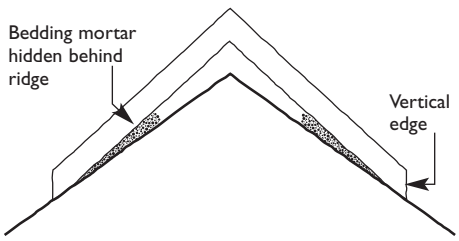


Figure 6 The edges of the ridge should be formed as shown to avoid large and unsightly mortar fillets. Similarly ridges should not be edge pointed, rather the bedding should be neatly struck off as work progresses.

7.1.4.8 Cleft laths are split from hardwood and whilst they can be nailed to rafters, they are unsuitable to receive slating nails. Battens, on the other hand, are sawn from softwood, being nailed to rafters and able to receive nails which retain slates or tiles in place. Decisions on the retention or replacement of existing laths may be based on many issues:

- the age of the roof
- the importance and condition of the roof
- the listing grade of the building
- the rarity of riven lath in a particular area
- whether or not the appearance of the underside of the roof is important
- whether or not the laths are part of the ceiling construction
- if the use of slate nails is desirable or acceptable
- the extent to which other components of the roof structure are authentic
- if insulation and/or an underlay are to be incorporated
- if the roof is to have batten space ventilation installed.

The basic principle which should be applied is to change as little as possible unless there are sound legal or technical reasons for more extensive changes.

7.1.5 Ridges

7.1.5.1 Ridges were traditionally made from stone, sawn or chiselled from a block, and should be reused if they are sound. It is possible to obtain from masonry quarries new ridges selected to match the original type, colour, and texture of the stone. The exterior faces of a new ridge should be dressed or tooled in the manner traditionally employed in the locality. In some regions clay ridge tiles are traditional.

7.1.5.2 Ridges are back-bedded in mortar so that, as far as the undulations in the slating permit, the mortar does not show at the long edges. They are also haunched at the butt joints.

7.1.6 Fixings

7.1.6.1 Traditionally, stone slates were fixed with pegs hung over laths, frequently head bedded in lime mortar, and the underside was often torched. Laths were split from oak, fir, or more rarely sweet chestnut, and are again readily available. From the nineteenth century, sawn softwood battens and nails began to be introduced. Modern preservative-treated softwood sawn battens are more commonly used today, and the slates are frequently nailed rather than pegged. Whether modern methods are acceptable or not will depend on the specific conservation objectives and the importance of the building; the local Conservation Officer should be consulted (Fig 7).

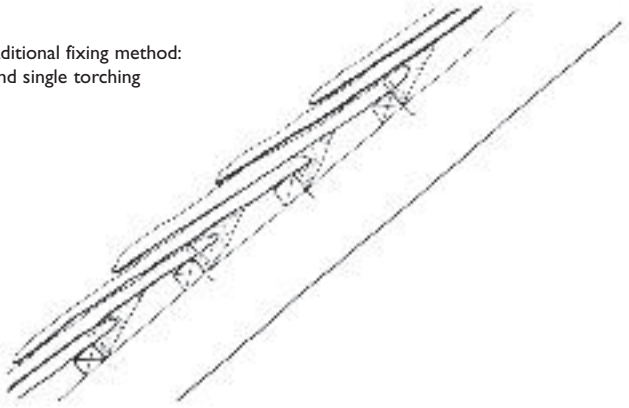
7.1.6.2 Pegs were most commonly of oak, although other woods and, in some parts of the country, animal bones were used. New oak pegs and treated softwood versions are available in a variety of dimensions. Green pegs should not be used as they are likely to shrink, and slip from the peg holes. Pegs should be roughly square sectioned and dried before use so that after fixing absorbed moisture makes them swell, locking them into the holes. The fixing holes for wooden pegs were traditionally tapered or hourglass shaped: this also helps to grip the pegs and is still good practice.

7.1.6.3 Large headed non-corroding metal, preferably copper, pegs 38–63mm long are also used to hang stone slates. Aluminium pegs should be avoided where they may be in contact with alkaline materials such as limestone slates or mortar. If the existing peg holes are large, pegs with large heads will lock in position and prevent the slates slipping. Where the stone slates are to be drilled or re-drilled, for nailing or metal peg hanging, the holes should be parallel sided at a slightly larger diameter than the peg shank and countersunk to receive the head. Electric drills without hammer action are suitable and each slate, properly supported, should be drilled individually. Attempting to drill through a pile of slates will inevitably damage them.

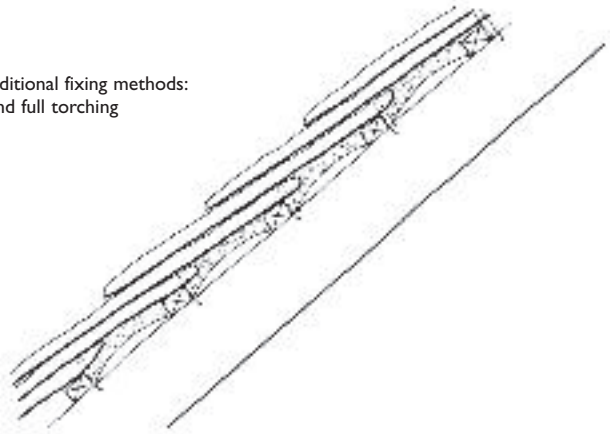
7.1.6.4 Nails for fixing slates should be large-headed, large-gauge copper. Nails for fixing battens, laths, or boards may be stainless steel for maximum durability, provided that they are strong enough to drive into hard timber, otherwise galvanised or sheradised nails are adequate. Length, gauge, and type should be appropriate to the batten size and wind uplift requirements in the particular location *(BS 5534, 2003)*.

7.1.6.5 All metal fixings should be checked for compatibility with the

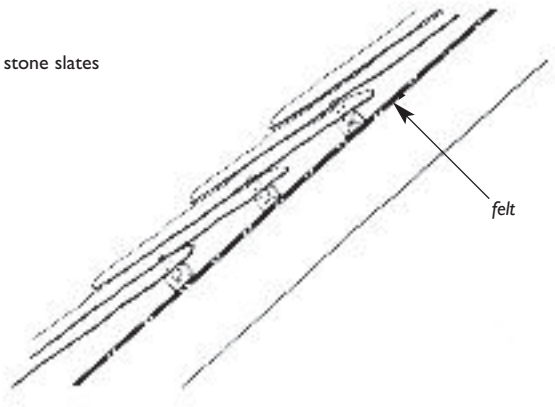
7i Traditional fixing method:
pegs and single torching



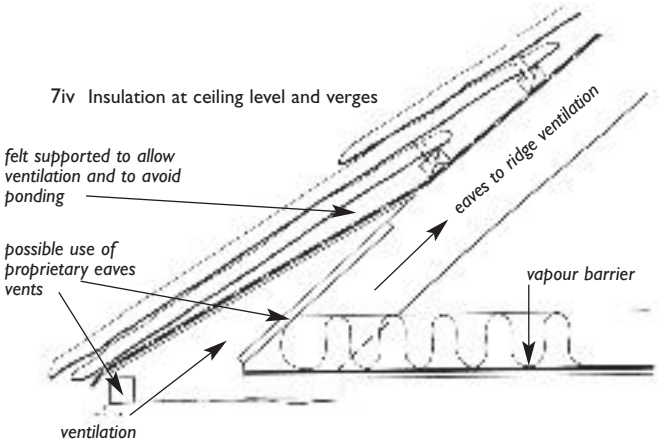
7ii Traditional fixing methods:
pegs and full torching



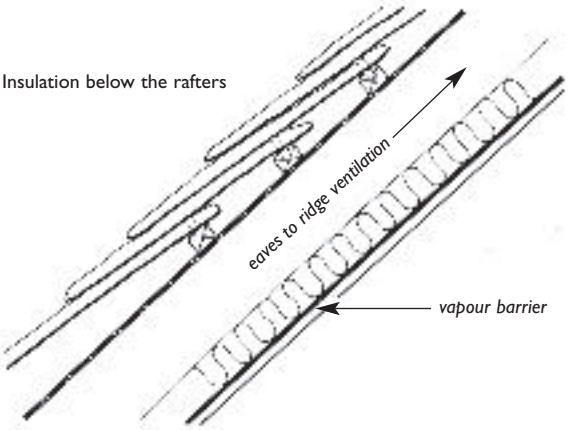
7iii Nail fixed stone slates



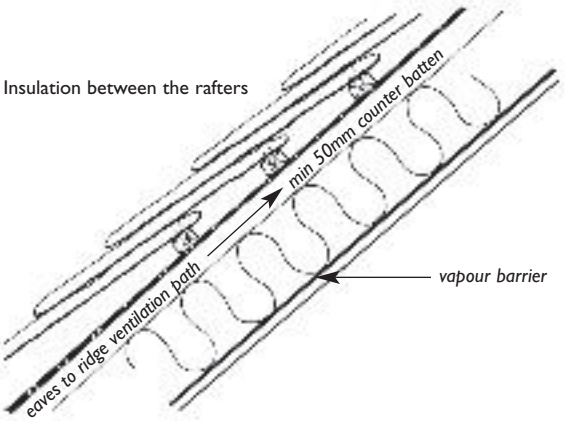
7iv Insulation at ceiling level and verges



7v a Insulation below the rafters



7v b Insulation between the rafters



7v c Insulation above the rafter
(which changes the roof line)

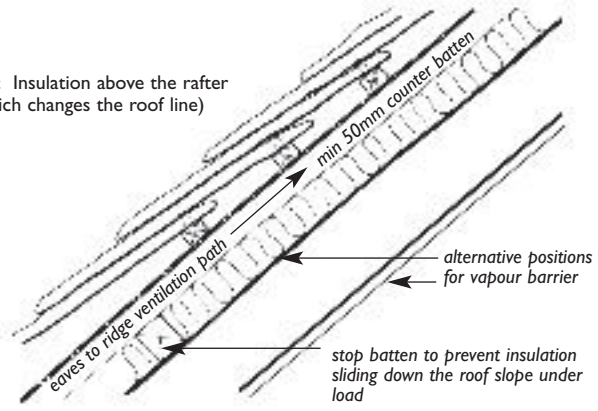


Figure 7 Fixing methods and the use of different types of torching and roofing felts for stone slating

materials they come in contact with. Very large, wide slates may require double fixing.

7.1.6.6 Where methods of fixing are altered, the appearance of the roof may be inadvertently changed. For example, the horizontal alignment of the tails of slates will be much more even and regular when the stone slates are drilled and nailed than where they are pegged and hung on laths. This can be avoided by drilling the fixing holes freehand rather than in a jig or against a stop.

7.1.7 Torching, roofing felts, vapour permeable membranes and vapour barriers

7.1.7.1 Pegged roofs were traditionally torched to render them windproof. 'Mossing' (driving moss into the joints of the slates with a mossing iron) was another means of achieving the same result. These methods have now been largely superseded by the use of roofing felts. Torching, or tiering as it was also known, was traditionally a mix of lime and aggregate (sand and/or crushed stone), usually with animal hair added, and was applied to the underside of the roof either as half or full torching. Half, or single torching, was applied at the upper edge of the laths, and full torching filled the space between the laths. The torching had to be applied carefully avoiding forcing mortar down between the joints, which would draw in moisture. Torching also served to hold the pegs in place and stop them tilting and falling out (Fig 7i and ii). Traditional roofs and roof spaces were very well ventilated. Any change in the construction, especially introduction of felts or vapour permeable membranes (VPM) with or without insulation, may well reduce this and lead to deterioration of the fabric. Careful consideration should be given to all the aspects of such innovations. If the roof can be wind-proofed without the use of felt or VPM this may well be the best option.

7.1.7.2 It is preferable to retain all historic details, including torching. This is still a successful and appropriate technique if carried out correctly and, properly applied, allows the battens to dry out even after occasional wetting by driving rain. A mix of 1:3 mature lime putty to aggregate, with approximately one handful of clean hair, well teased out, added to one bucket of the mortar, and evenly mixed, will produce a satisfactory torching mortar.

7.1.7.3 If the slates are pegged over felt, thicker battens, or counter battens of an appropriate thickness will be required to prevent the felt being pierced (Fig 7iii). If the slates are pegged but not torched, large-headed metal pegs may be used to stop the pegs tilting. In recent years, double battening has been adopted to prevent pegs tilting but for conservation purposes the mortar methods are more appropriate.

7.1.7.4 Underslating felt should conform to BS 747 type 1F or 5U, and be fixed to the rafters with large-headed clout nails, with a minimum vertical lap of 150mm below 35 degrees pitch and 100mm at 35 degrees and above, and a horizontal lap of at least one rafter space. It should be nailed to each rafter. The use of roofing felt is no substitute for good workmanship, which by itself will result in a weather-tight roof (Fig 7, iii-v).
(NB *BS 747* is to be withdrawn. The specification for 1F and 5U felts is given in *BS 5534:2003 Annex A*.)

7.1.7.5 If insulation is introduced into the roof, increased ventilation may be required and it may be necessary to use a VPM and a water-vapour barrier. There is a British Standard specification for VPMs – *BS 4016* – and their selection and use should be based upon calculations using realistic (extreme not average) parameters for the internal and external environments. Vapour barriers may be formed by closed-cell insulation with taped joints, or by use of 500 gauge polythene or similar material. *BS 5250: 2002* and *BRE 2002* (see *References*) give further guidance on performance requirements for such materials (Fig 7iv and v).

7.1.7.6 Ventilation can be introduced into gables, at the eaves, at the ridge, or within the roof slope. Proprietary eaves vents are usually unobtrusive but may require adjustment of the eaves tilt to ensure that the slates lie properly. Proprietary ridge vents do not match stone slates, thus the use of gable ventilation is the preferred solution where this is an option. Where clay ridges are traditional vent ridges may be acceptable. Individually designed ridge ventilation solutions such as open joints, raising of ridges and so on, should be designed with care, as they may not provide adequate ventilation and may leak. There are currently no slate-vents suitable for stone roofs, so in-slope ventilation is not a practical option.

7.1.8 Bedding and pointing

7.1.8.1 Ideally, mortar (other than torching) should not be used in stone slating, as there is always a danger of drawing moisture between the stones and into the roof. However, the use of mortar bedding and pointing seems to be regionally specific and local practice should prevail. It is preferable and cheaper to increase the lap rather than to rely on these methods to make a roof water-tight, and the use of mortar for bedding and pointing should be carefully considered. Spot bedding in lime mortar is used in some parts of the country, but only as a means of helping the stone slates to lie flat without rocking. This is also a method sometimes employed in minor repairs to isolated patches on roofs. It should be used very sparingly and the spots of mortar kept away from the tails of the slates and the perpendicular joints to avoid drawing moisture into the roof. In some very exposed areas, the heads of slates are bedded in a thin band of lime mortar.

7.1.8.2 Pointing applied at the tail of the slate and at the perpendicular joint is a method employed in some regions and can be carefully reinstated where it represents traditional practice. As with spot bedding, it has the potential to draw moisture into the roof structure. It also dries out very slowly after rain, with the consequence that the roof structure can be wet for long periods. Furthermore, pointing can exacerbate frost damage to the backs of the slates. In some regions, pointing is held back from the edges of the slates, or raked out, so it is not visible; elsewhere, it is exposed – this is visually undesirable. If it is applied, pointing must penetrate upwards or sideways between the slates as little as possible to minimise the extent of resultant wetting. If the roof is laid to the correct pitch and sufficient head and side laps are applied, pointing will not be necessary to keep the roof weather tight.

7.1.8.3 Pointing and bedding should never be combined with torching. It is almost impossible to prevent the two coming into contact and forming a wick which continuously draws in water. This can result in total failure of a roof within 25 years of reslating.

7.1.8.4 Where bedding and pointing are used careful consideration should be given to the use of underslating felt. Where they

are used together the humidity in the batten space may be high for extended periods resulting in the deterioration of the slates and battens.

7.1.8.5 If the water vapour passing through VPMs is not vented from their upper surface they will not be effective. For this reason they should never be used with bedding and pointing unless effective through-ventilation of the batten space is provided by some other means.

7.1.9 Roof timbers

7.1.9.1 To avoid unnecessary loss of existing material, timbers should be cleaned down without defrassing (see *Glossary*) and inspected for signs of active decay or infestation. Replacement of roofing timbers should be restricted to those which threaten the structural soundness of the roof. Repairs to roof timbers should be carried out as far as possible in the same timber, using appropriate repair methods which minimise loss of existing timbers, and do not regularise the appearance of the roof.

7.1.9.2 Where alterations to the roof structure of a listed building are necessary, such as the replacement of rafters, purlins, or valley boards, Listed Building Consent may be required. Advice from the local planning authority should be sought before any timbers are removed.

7.1.9.3 New timber should be dried to a moisture content of between 15 and 20 per cent and should match the existing in size and species. Softwoods should be pressure-impregnated with preservative before being brought to the site and any cut ends or bored holes should be treated with insecticide/fungicide before being used.

7.1.9.4 When timber treatment is considered necessary and appropriate, work should be confined to areas obviously affected by active insect infestation or fungal decay. Remedial work should be carried out with reference to current legislation including the *Control of Substances Hazardous to Health Regulations 1998, The Health and Safety at Work etc Act 1974*, and the *Control of Pesticides Regulations 1986*. If bats are present, advice should be sought on the suitability of treatments so as not to cause them harm (see 6.9 *Bats*).

Figure 8 Stone slates removed from the roof and sorted according to size. The roofer will now be able to calculate the amount of new material required for reroofing.

7.2 Construction and workmanship

7.2.1 Specification

7.2.1.1 The specification is relied on by the roofer to provide a full description of the works and the quality of the materials and workmanship required for a job. It is also likely to become part of any contract documentation. Estimates will be prepared on the basis of the specification and thus it needs to be clear and comprehensive, ensuring that anything which is likely to have a cost implication on the work is included. A thorough specification will enable a fairer and more accurate cost estimate to be prepared by the roofers pricing the works.

7.2.1.2 It is outside the scope of this leaflet to provide a model specification, which needs to reflect local roofing traditions and practice. Some local authorities provide guidance on suitable specification clauses. As a minimum the specification should cover the following

- scaffolding
- security (stone slates are valuable items)
- stripping, stacking, sorting and redressing (see 7.1.4 and 7.2.2)
- timber and carpentry (see 7.1.9)
- roofing felt/torching (see 7.1.7)
- insulation and ventilation (if applicable – see 7.1.7.5–6 and 7.2.5)
- slates, battens and fixings (see 7.1.4 and 7.1.6)
- slating (see 7.2.3)
- valleys (if applicable – see 7.2.4.6)
- ridges, abutments, hips and verges (see 7.2.4.6–9)

Where new stone slates are needed, the specification should include source (geological/geographical/delph), sizes, thickness, edge dressing style and, if required, surface dressing.

7.2.2 Stripping, sizing and stacking

7.2.2.1 Once the roof covering is recorded as far as is possible, the stripping of the roof can begin, starting at the ridge. The slates should be carefully removed, cleaned, inspected for damage and delamination, and then carefully stacked. Damaged slates should be put on one side for redressing. Stone slates should be stacked on end, in piles sorted by length (measured from the fixing hole to the tail). **They should NOT be stacked flat**. Once sorting to length is completed, sorting to thickness can follow if this is the local practice (Fig 8). It is not possible to stack, inspect, and sort stone slate at roof level unless a large working platform is provided. Such practice is unsafe on all but the largest roof platforms, and does not encourage the rigorous standards of inspection and sorting required. Stone slates are valuable and will need to be stored in a secure place.

7.2.3 Reroofing

7.2.3.1 *Cover* The sorting of the slates will identify the amount of existing slate which is reusable. Sometimes, there will be sufficient to re-cover the roof with some patching-in of replacements. Lower rates of recovery will necessitate the consolidation of the surviving slates on a single roof slope, with new slate required to re-cover the remaining slopes. Either

way, it will now be possible to calculate the total width of cover available for each length of slate, and the quantity of new slate that will be required. The number of courses for each slate length and the batten or lath gauging can also be calculated. This will be dependent on the size of the available slates and should be adjusted as their length diminishes up the roof to ensure that the minimum head lap is achieved for each course (Figs 9 and 10). The risk of unbalancing the loading on the roof should be considered where stone slate is used on one pitch and lighter slates or tiles on the opposite pitch.

7.2.3.2 *Slating gauge* Reslating should always be carried out by measuring how many courses of each slate length can be achieved with the recovered and new slates together. It is inadvisable to try to reproduce slavishly an existing pattern of margins. This is not the correct traditional method, is unnecessarily expensive and risks the use of inadequate headlaps. The preferable method is to specify the largest and smallest sizes of slate and a reasonably even gradation of sizes between them. The specific gradation of the margins will then be the natural outcome of the mix of sizes and the correct headlap. In practice new slates in the largest sizes specified may simply not be available due to the limitations of the rock.

7.2.3.3 *Laying* Stone slates should be laid one course or a few courses at a time, depending on local practice, working from thicker to thinner slates across the roof if this is the local tradition. The slates should be laid to avoid rocking on uneven surfaces, and to avoid variations in thickness from one slate to the next. If bedding and/or pointing is to be carried out, this should be applied as work progresses, using the minimum mortar required.

7.2.3.4 *Backers* Wider slates should generally be reserved for use with backers, which are narrow slates placed roughly centrally over wide slates to make provision for the larger number of slates in the upper courses (Fig 9).

7.2.3.5 *Wide slates* should also be reserved to close the half bond at verges, hips and abutments.

7.2.3.6 *Underslating* Historically, stone roofs were laid without underfelt or membranes, although they would

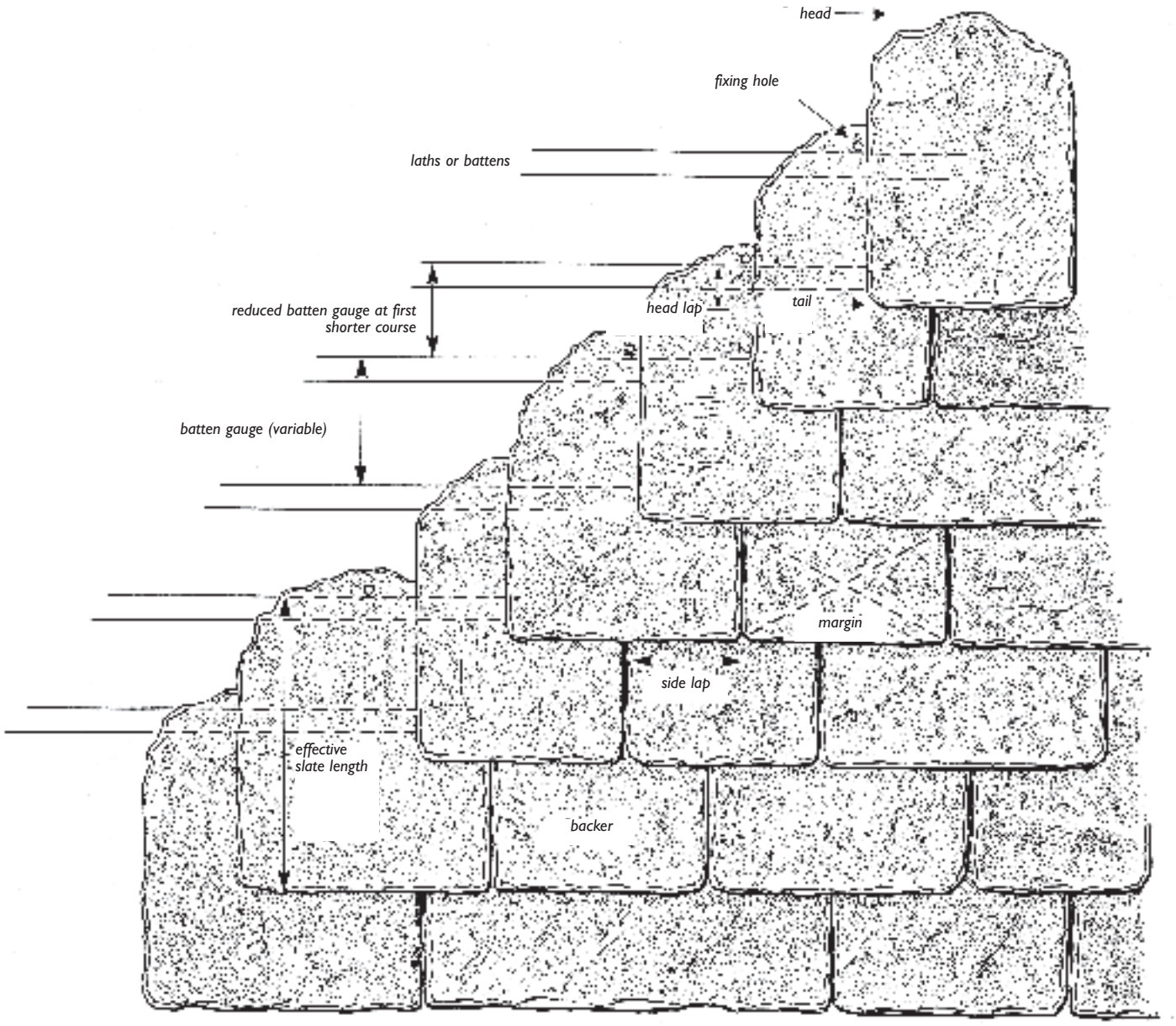


Figure 9 Measuring slates. The length is measured from the fixing hole to the tail. The head lap is the amount by which a stone slate overlaps the fixing hole of the slate in the next course but one below.

generally have been torched to make them draughtproof. Where torching is an option or draughtproofing is not required, there may be no need to include a felt or membrane. If a modern specification is to be adopted, the underslating system might include a vapour barrier, insulation, and roofing felt (see 7.2.5 *Insulation and ventilation*). Ideally, the laths or battens should be fixed in place as the felt is laid (Fig 7).

7.2.3.7 *Weather tightness* Water penetration is resisted by ensuring an adequate pitch, head and side lap and, most significantly, making certain that the largest slates (which provide the largest side lap) are placed at the bottom of the roof. It is important for the weather tightness of the roof to ensure that the stone slates are properly sorted, selected, and laid, and sit together as well as possible.

7.2.3.8 *Pitch* It is for good technical reasons that stone slates are seldom laid at so low a pitch that they cannot be seen from ground level. The temptation to alter the pitch of a roof should always be resisted: traditional pitches may have evolved in response to regional and very localised conditions. They may also differ for slates of differing roughness or sizes, even from a single quarry (Fig 19).

7.2.3.9 *Head lap* There are no set guidelines for determining the minimum head lap of stone slates; it seems to vary from area to area and relates to the pitch of the roof. Head lap (the amount the third course overlaps the first, the fourth overlaps the second, etc) can be specified as a value or as a fraction of the slate length. In either case it should not deviate from established local practice (unless this is known to be inadequate). Lap measurements are taken from the peghole rather than the top of the slate. As the stone slates are laid in diminishing courses, it is important to ensure that the minimum lap is maintained as the slate length changes up to the roof (Fig 9). Failure to do so will lead to insufficient headlap indicated by pigs, courses where the margin is bigger than courses lower down (Fig 15). The head lap should not exceed one third of the slate length.

7.2.3.10 *Side lap* The minimum side lap is commonly not specified. Frequently, local rules of thumb are applied, such as 'not less than 75mm' or 'not less than the head lap'. Genuine local methods known to be successful should be respected.

7.2.3.11 *Gallets or shales* In some regions where stone slates are thin, they are supported with small pieces of stone slate or metamorphic slate, known as gallets or shales, which are bedded in a small amount of lime mortar at the head of the course below. The technique prevents the slates breaking if, for example, they are loaded by a roof ladder: it is mainly required at the eaves where the tilt produces a gap between successive courses. Gallets must be used carefully to avoid forming a path which would draw moisture into the roof. In some limestone slating traditions similar small pieces of stone or metamorphic slate known as

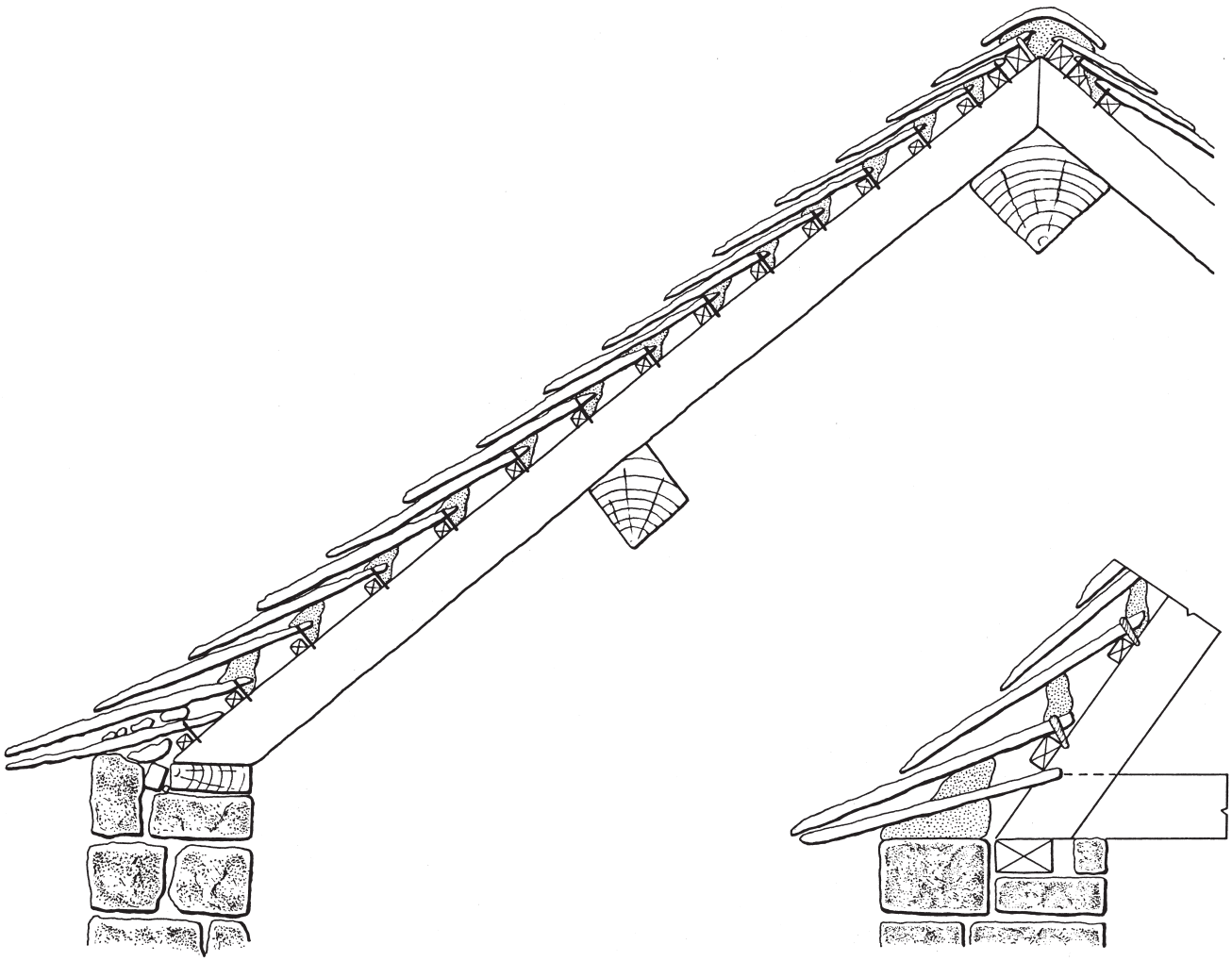


Figure 10 Section through a typical sandstone slate roof showing structure, diminishing courses, ridge and eaves details. The inset shows a typical Cotswold cussome detail.

Figure 11 The limestone slates of the Cotswolds, which are lighter and smaller than most sandstone slates, require a steep pitch and can accommodate curves in swept valleys.

shadows or shales are used to improve the weather tightness where the slate's shoulder is not quite good enough. Usually they are bedded in lime mortar and act by blocking the wind from blowing through the slating and carrying in water. The way they are laid also turns any water which reaches them down and out of the slating. This is acceptable traditional practice although it is better to avoid the need for them by careful selection of slates of suitable shape. Today, it is also acceptable to use lead soakers for the same purpose.

7.2.3.12 *Eaves slates* The under eaves and eaves slates should be laid to project over the wall and discharge water away from the building, or into the gutter where one is to be fitted. Local details should be applied (Fig 10). Gutters were not always used for stone slate roofing.

7.2.4 Detailing

7.2.4.1 The detailing of a roof – its pitch, and the treatment of the eaves, valleys, ridges, and dormers – was evolved by local craftspeople in response to the local stone and regional climate, and may vary according to the building type and period. A roof may exhibit a number of stages of a building's development and incorporate a number of different details which may be equally important.

7.2.4.2 The existing features of an old roof, such as the mix of slate sizes within the limits described in 7.2.3.2 (which will determine the number of courses), verge, ridge, hip, and valley details should be retained wherever possible. New techniques should not be applied without a careful assessment of their technical implications, and the adaptation of traditional methods to modern practice should be treated with caution. Correct detailing not only ensures that the character of the roof is retained but also that it fulfils its function.

7.2.4.3 To ensure the roof was watertight, the valley, hip, dormer, and abutment details evolved when lead was unavailable (or too expensive to be used). These details also influence the pitch of the roof. In regions where slates are small and thin, the roof pitch will be generally steep (about 50 degrees), enabling curves (such as the swept valleys of the Cotswolds) to be formed at the intersection of the roof planes. Where stone slates are very large and thick, such as the sandstone slates of the Pennines, the pitches are lower and the roof forms are simpler, with the valleys formed with chevron slates (Figs 11 and 12).

Figure 12 The heavy, flat sandstone flags of the South Pennines are suitable for lower pitches, and the detailing of the roof is simpler to accommodate their large dimensions. The chevron valley is an example of the craftsperson's skill in forming a weather-tight roof.

7.2.4.4 The decision to restore original details, such as swept or chevron valleys, which have been replaced by leadwork in the recent past, should be based upon sound evidence for their former existence rather than upon speculation. Changing the details of the roof may require Listed Building Consent, and advice should be sought from the local planning authority.

7.2.4.5 A roof must be capable of withstanding wind forces and preventing the penetration of driving rain, so the fixings must be strong and secure enough to hold the slates in place without slipping. Different parts of the country have achieved these objectives by evolving various methods, some of which may be quite localised and unlike those applied to similar materials in other regions. They may also conflict with the recommendations of the British Standard (*BS 5534 2003* does not deal with stone slate roofing specifically but is the accepted standard usually referred to). However, many of these traditional details have a proven track record and should be conserved where it is practical to do so. Care must be taken when replicating traditional details to implement them correctly. Modification of traditional details can be problematic: confusion and poor amalgamations of traditional and modern methods have resulted in failures (Fig 17).

7.2.4.6 *Valleys and hips* should be formed as work progresses, using the appropriate weathering technique. Extra fixings may be required for hips, which should be formed with wide slates. Some valleys are made without fixings. Solid bedding of valleys should be avoided. Some traditional valley detailing requires the setting of the valley board at an appropriate level and angle by the slater, in anticipation of the need to align the

eaves levels of adjacent roof slopes with the valley slate (Fig 18).

7.2.4.7 *Abutments* should be formed with lead soakers and cover flashings or fillets to the specified detail. Fillets for abutments to uncoursed stonework and render should be formed with a suitable mortar which may require a stainless steel reinforcement mesh. Back abutments, such as at chimneys, should always include an adequate lead gutter and upstand, and be carried up under the slating. At the intersection of dormer valleys and the upper slope, it is traditional in some regions to use an inverted ridge piece to weather the joint. If this detail is adopted it may need to be backed up with a discreet lead soaker. An alternative detail carries the dormer ridge up into the slating of the main slope.

7.2.4.8 *Verges* should be bedded and the bedding struck off as work progresses, rather than pointed up after completion. Where verges are formed without bedding or an undercloak, they may be pointed in and a fillet formed under the slates after slating is complete.

7.2.4.9 *Ridges* should be back bedded in mortar and solid bedded at the joints. To avoid the need for unsightly pointing along the ridge it is preferable if ridge stones have a vertical edge at the bottom of the wing. Mortar should not be visible and the wings should not be pointed except where there are large undulations in the roof surface. Gallets can be introduced under the ridge joints and over the vertical joints in the slating where they coincide (Fig 10).

7.2.4.10 If torching is specified, it should be carried out after slating is completed to avoid damage.

7.2.4.11 The use of large stone slates as eaves courses below thatch, tiles, and metamorphic slates may be an original detail or may be a solution to the shortage of stone slates during the last reroofing. In either case, this is now regarded as a traditional detail in many parts of the country and should be reinstated as found (Fig 13).

Figure 13 Eaves slating is a traditional roofing practice in some parts of the country. In some areas stone slate has been gradually replaced by other roofing materials such as metamorphic slate, and the stone slates at the eaves are a remnant of an earlier roofing material. The example shown here is in the village of Montacute, where the local Ham Hill stone slates have become increasingly scarce.

7.2.5 Insulation and ventilation

7.2.5.1 Wherever an old roof is altered in a way that reduces airflow through or beneath it, careful consideration should be given to the effect on the ventilation of the roof space. This is especially important if roofing felt is used. Failure to provide an alternative ventilation route can result in condensation and extensive wetting of the fabric, or at least a raised moisture content, with an increased risk of mould formation and deterioration.

7.2.5.2 If insulation is to be introduced into a roof space, a specialist should carefully consider the implications, especially the need for ventilation. Insulation can be positioned above or below the ceiling, or between, below, or on top of the rafters (Fig 7iv and v). The first two options are relatively straightforward and ventilation can be provided fairly simply. However, when insulation follows the rafter line, the situation is more complex and the success of any method relies on good workmanship. Where insulation is laid on top of the rafters, and

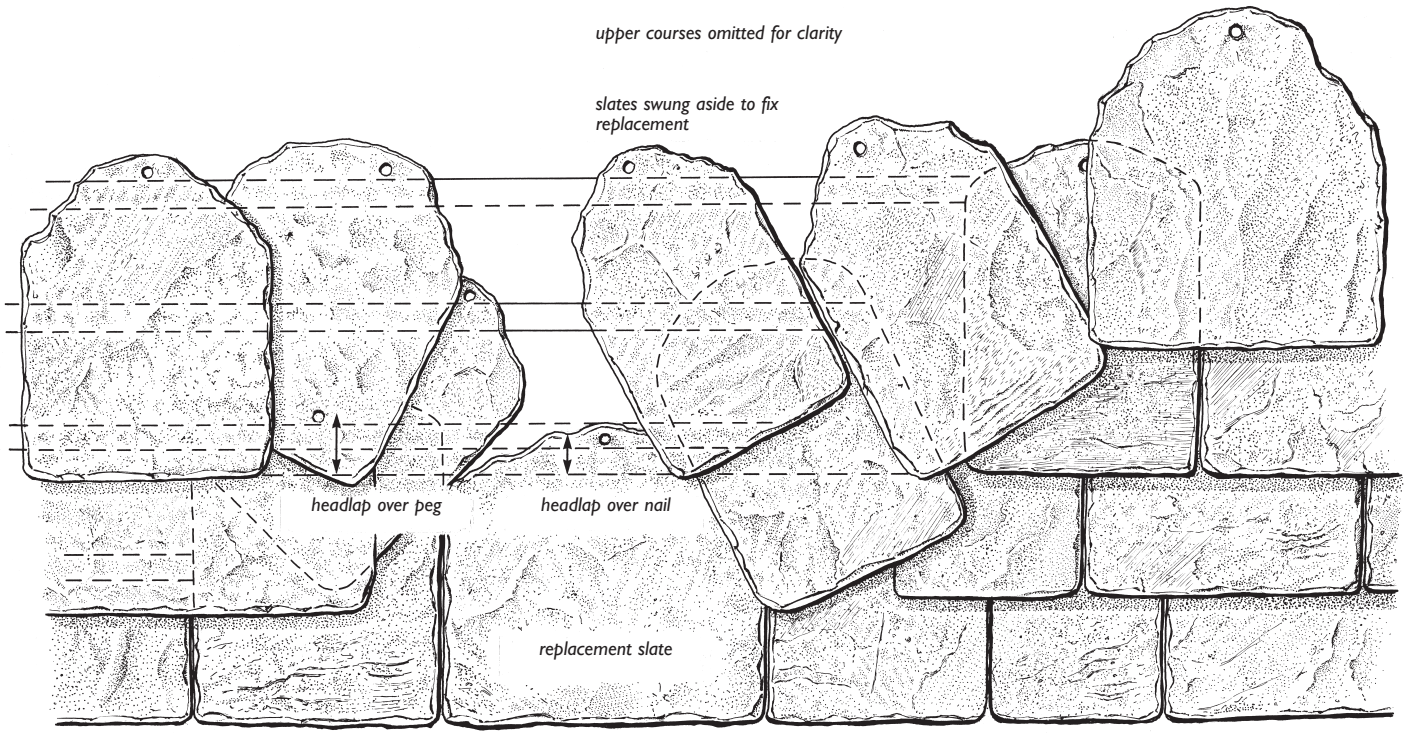


Figure 14 Fixings for replacement slates as part of a localised repair must be aligned with the adjacent slates. If the original slates are pegged but the replacement slate is nailed, care must be taken not to compromise the minimum head lap by placing the nail too far below the pegs.

there is a change in the roof line, Listed Building Consent may be required. In most cases when insulation is introduced into the roof space, it will be necessary to introduce a vapour barrier. It must be complete, continuous, and sealed at the joints. This may be difficult or impossible to achieve in practice and this fact should be taken into account when the ventilation system is being designed. BS 5250 provides design guidance.

7.2.5.3 Where proprietary ventilation products are introduced, it is important to check with the manufacturer that they are suitable for the specific situation. Particular attention should be paid to ensure that adequate laps are achieved. Individually designed solutions should be carefully considered to ensure that adequate ventilation is provided. If torching or bedding is employed on a roof, care must be taken not to block the vents or the flow of air under the eaves.

7.3 Minor and localised repairs

7.3.1 It is preferable to repair small areas of deteriorated stone slate roofing rather than to strip the whole roof. It may be possible to reinstate missing or loose slates and refix them by swinging the adjacent stone slates aside if they are pegged: nailed slates will break. Before a stone slate is reused, it should be examined to ensure that it is suitable for refixing. If the stone slates are pegged and torched and the underside of the roof is accessible, missing torching should also be replaced to help hold the peg in place. If the underside is not accessible and the laths or battens are in reasonable condition, it is preferable to nail fix the replacement slates. Replacement slates should be the same length as the originals and aligned with the adjacent slates so as to retain the head lap and ensure that the repair is watertight (Fig 14). If the new fixing hole would be lower than originally it should be drilled away from the perpendicular joint of the overlying slates so as to increase the effective head lap.

7.3.2 Where supplies of replacement slates of the same size and thickness are unavailable, it may be impossible to carry out patch repairs. In this case, consolidating the salvageable stone slates on one part of the building may be a solution.

7.3.3 Where the number of slates to be replaced is extensive, consideration should be given to renewing whole areas or to complete stripping and reslating. Large numbers, typically five per cent, of displaced or damaged slates probably indicate that the roof is nearing the end of its life. If large areas are to be patched, the coursing must match the remainder of the roof, and the head and side laps must be the same or larger.

7.3.4 Bitumen-coated fabric applied over roof coverings, or spray-on coatings to their undersides, should be avoided as they prevent the salvage of stone slates or reuse and make it difficult to locate defects. These treatments also serve to seal roof voids, preventing ventilation and leading to fungal attack and infestation of roof timbers.

7.4 Choosing a slater

7.4.1 Stone slating is a specialist activity and not all roofing contractors are either familiar with the particular methods involved or skilled in the local roofing traditions. An assessment and registration scheme for stone slaters is under development by the National Federation of Roofing Contractors. It is not always safe practice to import a slate from outside the region, and equally it may not be wise to import a contractor who is not experienced in the local stone slate roofing techniques. In many areas of the country, the scarcity of stone slates and the decline in their use has resulted in a loss of traditional skills, and care should be exercised when selecting suitable contractors. They should be familiar with stone slate roofing in the region and be prepared to supply photographs of work they have carried out. Better still, they should provide the opportunity to visit previous work, in order to demonstrate their competence. Inspection of a roofer's work should include a check that the stone slates are laid evenly and sit well across the roof, and that the sizes of the

Figure 15 'Pigs' (where a long margin is visible above a short one) indicate a failure to maintain adequate head lap and are evidence of poor workmanship, as this roof in West Yorkshire shows.

slates diminish regularly from the eaves to the ridge: successive margins should be either the same size or smaller than those below – there should not be equal numbers of courses of each margin size (Fig 9). Long courses above short courses, known as pigs, indicate that the gauge and head lap have not been properly adjusted at changes of slate length (Fig 15). It is sometimes possible to check the head lap at the verges, provided that the slates are not shouldered. A competent stone slating contractor should be able to provide a detailed method statement that demonstrates understanding and competence in the historical and technical methods of the area. This is a useful means of assessing tender submissions.

7.4.2 The local authority's conservation officer may be able to provide a list of specialist roofing contractors in the area. It is essential to remember that it is the individuals involved in a job, not necessarily the firm, who are important, so a check should be made to ensure that it is the team whose work has been examined (and has proved its competence) which undertakes the new contract. Roofing contractors who do not have their own retained slaters but subcontract work are at risk of having to use unsuitable or inexperienced roofers. It is equally crucial not to be swayed by price; to be wary of significantly lower tenders; to check that nothing has been missed; to ensure that all the quotations are based on the same specification; and to feel confident that the job will be undertaken to a high standard.

8 Costs

8.1 Life-cycle costs

8.1.1 Stone slates form a high quality, very durable and beautiful roof covering. They satisfy the aims of sustainability better than any other roof although, in the short term, they are also the most expensive to purchase and install. However, stone slates can prove an economic choice when account is taken of the long life cycle of the roof, and the even longer life cycle of the slates (a high proportion of which will be capable of reuse when next reslating). Where stone roofs are properly maintained, total reroofing will rarely be required.

8.1.2 Stone slates are essentially hand-crafted materials and it is difficult to reduce production costs significantly. Reusing the salvageable material from the same roof will reduce the material costs of the roof. However, new slates should be used to make up shortfalls, to help encourage the market for new stone slates and secure the future for stone slate supplies.

8.2 Grants

8.2.1 Grants for repairs to stone slate roofs of Grade I and II* listed buildings and scheduled monuments are available from English Heritage. Many local authorities also operate grant schemes which include Grade II listed buildings and occasionally unlisted buildings in conservation areas. The Heritage Lottery Fund and English Heritage offer grants for ecclesiastical buildings through the Joint Grant Scheme for Churches and other Places of Worship which is administered by English Heritage. The Heritage Lottery Fund also provides grants to registered charities, voluntary and public organisations, and to some private building owners.

8.2.2 In some areas, the Environmentally Sensitive Areas Scheme offers grants to farmers and land managers for the repair of traditional buildings, including stone slate roofing.

8.2.3 For a comprehensive guide to Government, private sector organisations and charitable trusts which offer grant aid towards the repair of historic buildings, see *Funds for historic buildings in England and Wales*: this guide is available on the Architectural Heritage Fund (AHF) website, free and regularly updated, at www.ffhb.org.uk

Appendix 1 Stone slate roofs: checklist for recording construction details

Ridges	Fixing: bedded or nailed, etc	
Pitch		
Slating	Head lap	
	Number of courses	
	Margin for each course	
	Batten/lath gauges	
	Side lap: minimum and range	
	Gallets	
	Single lap	
	Shadow slates	
Dormers	Pitched: mono or duo	
	Hipped	
	Cheeks: slated or other	
	Junction weathering	
Abutments	Weathering: mortar or metal	
Gables	Plain or coping	
	Fixing for coping	
	Flush, overhang or oversail	
Hips	Mitred	
	Covered: stone, tile, lead, etc	
	Detail: roll top, etc	
Valleys	Open	
	Mitred	
	Chevron	
	Swept	
	Laced	
	Other	
Eaves	Plain or sprocket	
	Slating detail	
Rafter centres	Range or average	
Fixing system	Battens or laths	
	Slates fixed to rafters	
	Pegs or nails	
Torching	Full, partial or none	
Slating felt	Laps: head (up slope)	
	Laps: side (across slope)	

Appendix 2 Stone slate roofs: checklist for recording materials

Ridge	Material	
	Dimensions	
	Shape	
Copings	Material	
	Dimensions	
	Shape	
Slates	Limestone	
	Sandstone/Gritstone	
	Other	
	Composition	
	Dimensions: length range x random	
	Thickness: average or range	
	Gallet or shadow and material	
Battens/laths	Split	
	Sawn	
	Species	
	Dimensions	
	Fixings	
Slate fixings	Pegs: sawn or split	
	wood: species	
	other: bone, etc	
	dimensions	
	Nails: hand made	
	machine made	
	wire	
	dimensions	
	material and composition	
Mortar	Bedding	
	Pointing	
Flashings and soakers	Material	
	Dimensions	
Torching	Composition	
Slating felt	Composition	

Glossary

Backer narrow slates laid centrally over a wide slate to accommodate the diminishing size and therefore increasing number of slates in subsequent courses as work progresses up the roof (Fig 9)

Batten sawn wooden support for hanging or nailing stone slates. Synonym: *lath*. NB: in this *technical advice note*, the word *lath* is reserved for cleft supports (Fig 7).

Bedding use of mortar in spots or fillets to prevent stone slates from rocking. In some areas, it is used to improve weather tightness.

Cussome see *Eaves*

Defrassing the removal of insect attacked sapwood from timber. The material subjected to insect attack is termed *frass*.

Delamination splitting of stone slates along the bedding planes, most often seen at the heads of slates. Delamination should not be confused with surface flaking.

Diminishing the system whereby slates are sorted by length and laid with the longest at the eaves diminishing to the smallest at the ridge. It is essential that the minimum *head lap* is maintained when there is a change of slate length between two courses. This also ensures that each successive *margin* is the same size as or smaller than those below (Fig 9).

Double lap stone slates laid so that each course overlaps the course next but one below (Fig 9)

Dressing the process of shaping the stone slate and producing the edge detail using either a chisel edged hammer or a bladed tool. Regional differences exist for the edge detail which may be square or bevelled. Synonyms: *trimming*, *fettling* (Yorks, Lancs)

Eaves *of stone slates*: the short course laid at the eaves under the first full course. The method of placing and supporting the eaves stone slates varies regionally. Synonyms: *under eave(s)*, *cussome* (Cotswolds)

Fixings nails or pegs

Gallet a small piece of stone slate or metamorphic slate bedded in lime mortar at the head of a slate to support the slate above. Synonym: *shale*

Gauge the spacing of laths or battens up the roof slope measured from the top edges of successive laths or battens. In stone slating, the gauge is always variable (Fig 9).

Head the top edge of a stone slate as laid (Fig 9)

Head lap the amount by which a stone slate vertically overlaps the stone slate in the course next but one below (Fig 9)

Lath cleft wooden support for hanging stone slates (Fig 7). Synonym: *batten*. In this *technical advice note*, the word *batten* is reserved for sawn supports.

Margin strictly the area, but more commonly the length, of the exposed part of the slate

Mossing use of moss or other vegetable material to windproof the joints and gaps between stone slates

Overburden in quarrying: useless material which overlies a bed of useful material

Perp joint Perpendicular joint: the vertical joint between adjacent slates in a course

Pig a course with a larger margin than the course(s) below resulting from poor setting out and a failure to maintain adequate head lap (Fig 15)

Pitch the angle of the rafters to the horizontal. The pitch of the stone slates will be significantly less because they are resting on each other, but this is taken into account by the traditional rafter pitch and lap relationship for the slate and the locality.

Pointing use of mortar to fill the vertical joints and to seal the tail gap of stone slating. Pointing may show (undesirable) or be raked or held back. Often associated with bedding.

Random
of stone slate: variable length and width
of roofing: slates laid with reducing length up the roof slope and the widths selected and placed so that they provide at least the minimum *side lap* over the slates in the course below (Fig 9)

Regularly *of diminishing slating*: the system whereby each successive margin is the same size or smaller than those below. It does not mean that there is an equal number of courses of each *margin* size (Fig 9).

Shadow a thin piece of slate used in the Horsham district to improve the weather resistance of a roof when, because of a shortage of stone slate, the head lap is reduced to less than the normal minimum. Originally the shadow was a thin piece of Horsham stone but it is now normally a metamorphic slate. It was always used in conjunction with mortar bedding and pointing. Technically this is an undesirable method; however, it has been in use for about 100 years and appears to work in many cases.

Shale see *Gallet*

Shoulder (verb) to remove the top corners of a stone slate; (noun) the top corners of stone slates. Excessive shouldering can result in a leaking roof.

Side lap the amount by which a stone slate laterally overlaps the stone slate in the course below (Fig 9)

Tail the bottom edge of a stone slate as laid (Fig 9)

Tiering see *torching*

Tilt the lift provided to the eaves course to ensure that successive courses lie correctly without gaps at the *tail*. On the main areas of the roof slope, the tail of each stone slate rests on two thicknesses of stone slate. At the eaves, the first full course rests on only one thickness - the eaves slate. Essentially, the tilt replaces the missing thickness.

Torching lime and hair mortar applied to the undersides of stone slates to render them windproof. Synonym: *tiering*

half torching/single torching: application of lime and hair mortar between the top edge of the lath or batten and the undersides of the slates (Fig 7i)

full torching: application of lime and hair mortar between the top and bottom edges

of the laths or battens and the undersides of the slates (Fig 7ii)

Unweathered *of stone roofing*: rock which is too deep to have been subjected to weathering and consequently has to be split by mechanical action or frosting after extraction

Weathering the process by which rocks are broken down and decomposed by the action of external agencies such as wind, rain, temperature changes, plants and bacteria. In the development of weathered stone slates, it is often very thin clay or mica beds which are weathered out.

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Figure 16 Langley Chapel, Shropshire. This Harnage stone slate roof includes both sandstone and calcareous sandstone, which overlie each other in the same quarry. The calcareous sandstone is identifiable by the presence of white lichen.

Further information

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Exhibition: English Heritage's exhibition *The Roofs of England: A celebration of England's stone slate roofing traditions* is available for loan free of charge. The exhibition provides information on stone slate roofing including production, traditional techniques, conservation, and practical issues. For enquiries regarding the exhibition or to comment on this *Technical advice note*: contact

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Environmentally Sensitive Areas Scheme: for information contact
The Department for Environment, Food and Rural Affairs
Nobel House
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Regional stone slate types, areas of use, sources and manufacturers: contact
Stone Roofing Association
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01286 650402
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Figure 17 The misinterpretation of historic details and their modification with modern materials can cause difficulties. The cement pointing to this Purbeck stone slate roof is unsightly and technically problematic.

Figure 18 The hip of the roof at Stokesay Castle, Shropshire has been formed with lime mortar, which disguises the introduction of a lead soaker beneath to ensure that the roof is weather-tight.

Figure 19 These small Cotswold stone slates have been laid at a steep pitch to form the huge roof of Great Coxwell Barn, Oxfordshire.

Sourcing stone slates

- New stone slates rather than second-hand should be used.
- Reclaimed slates should be used only on the building or group of buildings from which they were removed.
- Substitute materials, such as artificial slates made of fibre resin, concrete tiles, 'reconstituted stone' and so on, are inappropriate alternatives to real stone slates and are not suitable for use on historic buildings.
- New stone slates should match the existing ones as closely as possible in terms of geological type, colour, texture, size, and thickness. It is important to recognise the slates particular to your area. Sandstone and limestone slates should never be substituted for each other, nor should they be used together.
- Stone slates which have been sawn to thickness, rather than split, can be technically and aesthetically unacceptable and, if they fail to meet these criteria, should not be used on historic buildings.

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Editing: Margaret Wood, English Heritage Publishing
Design: Michael McMann
Production: Elaine Pooke, English Heritage Creative Services
Printer: Hawthornes

English Heritage Product Code 51024

Front cover Stone slate roofs are laid to diminishing courses, with the longest slates used at the eaves, diminishing to the ridge. This maximises the use of the available rock from the quarry or local delph.

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