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SLATING IN SOUTH-WEST ENGLAND



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This advice note describes the production and use of slates in the counties of Cornwall, Devon and Somerset, and deals with the maintenance and repair of slate roofs and wall cladding. It considers regional details specific to the traditions of roofing and cladding in south-west England and explains, where appropriate, adaptations to incorporate modern requirements such as improved thermal performance.

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1 Introduction

Vernacular slate roofs are important elements in the character of historic buildings and settlements in south-west England, and help give individual buildings, towns and villages their sense of place. This is in part due to the materials themselves, with their different colours, textures and sizes, but also to the way in which they are laid and detailed.

The massive rag slates of north Cornwall are seen in impressively large numbers on roofs in Launceston, for instance, where the hilly topography makes them more prominent. The small scantle slates by contrast give a completely different character to the mining settlements and historic landscapes of west Cornwall. Slate-hanging on walls is common in both Devon and Cornwall, but less so in other south-west counties. The use of large rag slates at the roof verges and eaves and, in the South Hams district of Devon, coloured slates for decorative cladding are important local features. The loss of these distinctive local slating traditions would result in blandness and uniformity.

This advice note explains the basics of south-west slating practices, including many of the local variations.

It is important that the details of roofs are recorded before the slating is stripped and that the information obtained is used to derive appropriate specifications for re-slating. Each surviving example is likely to contain valuable information about traditional craft techniques and local variations.

In general, the existing form and details of each historic building should be respected and retained during any campaign of repair. This extends not only to the overall appearance of the building but also to the construction methods employed.

The broad principle of retaining existing details does not mean that they should simply be replicated without thought. There are situations where details may need to be sensitively adapted to improve performance but if so, this should follow careful analysis in such a way that the traditional local form and appearance is maintained and with appropriate statutory consents.

West Country slate roofs use a variety of slating systems: common; rag; scantle and sized (Table 1). Their geographical extent is generally unrecorded and their boundaries may be blurred. Some of the techniques are not unknown from other parts of the United Kingdom – most notably along the west coast – but they are less prominent in those regions. Today the most frequently used type of slate roofing for new building is sized slates laid to a constant head lap to the detriment of the regional roofscape. This type is not included in this advice¹.

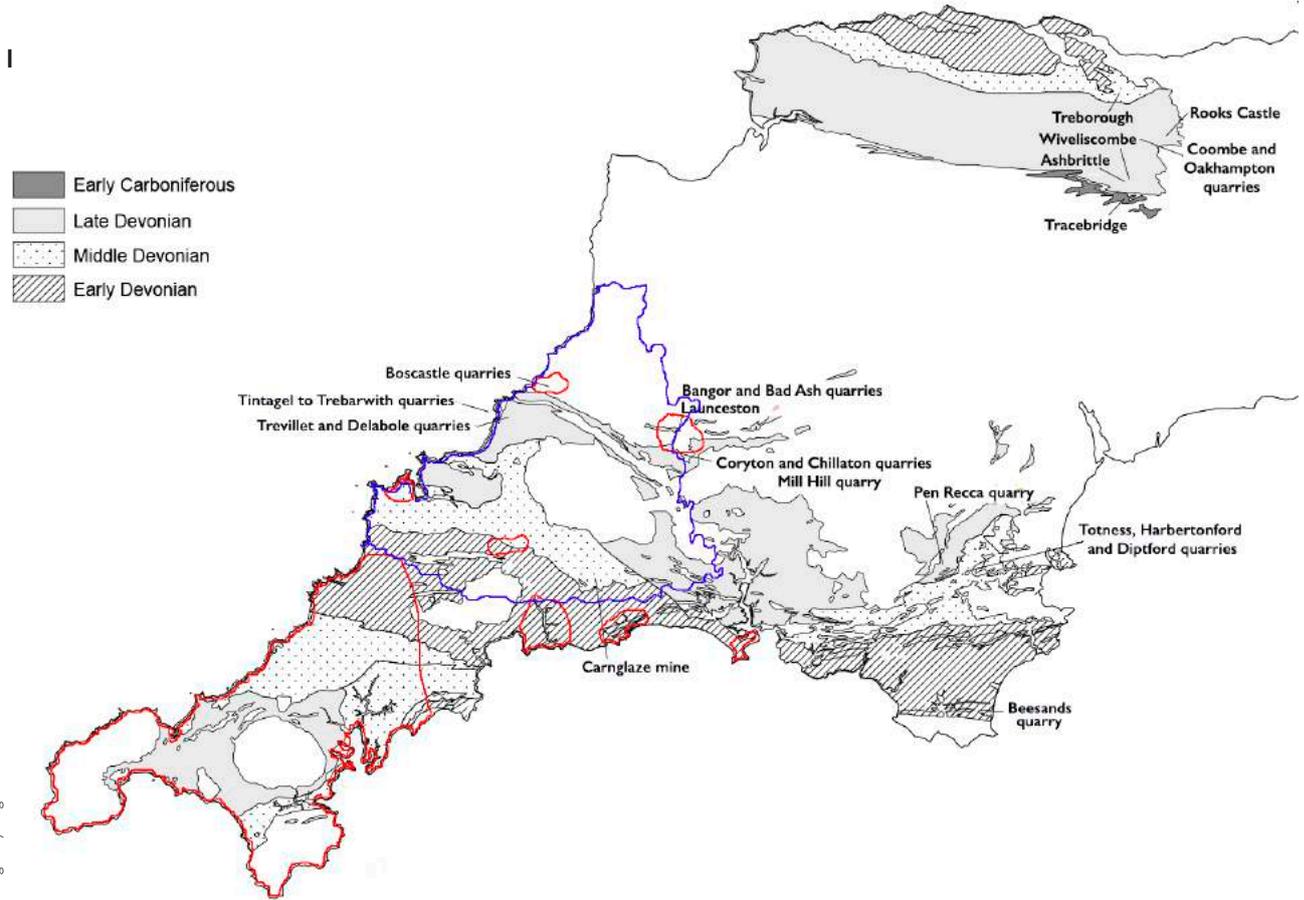
Common slating - large (mounter) slates at the eaves with small slates laid in thirds over the rest of the slope - was a medieval style and such roofs are now uncommon². Its decline began when, in the late 17th century, quarries began supplying slates as finished products and selling them in specific size ranges, such as rags and scantles. Previously they had been supplied as rough blocks or rivings to be finished by the roofer³. The visually similar and distinctive roofs seen in the South Hams district of Devon may be derived from this system.

Rag roofs and scantle roofs remain very common within their regions but are in decline due to difficulties of supply in the case of rags, lack of knowledge or skill or ill-judged attempts to improve. Rag roofs are most common in east Cornwall and into west Devon. Scantle slating is either dry-laid or wet-laid - tail bedded in mortar. Wet laying is employed in the more exposed areas of west Cornwall and dry in the more sheltered Devon and at sheltered locations within the predominately wet-laid areas.

Slating in thirds appears to be rare (or perhaps under-recognised) in Cornwall and the extent of its use in other counties still needs to be established.

Historically, all the systems used slates from the nearest sources within their own counties (Figure 1). As transport systems improved and the quarries closed, slates were used from more distant sources.

In recent years there have been misunderstandings of the traditional systems and confusion about their details leading to roof failures. In part this is because of attempts to apply British Standard recommendations and detailing.



1 The slate geology of south-west England with the more prominent roofing slate sources and the primary locations of wet-laid scantle (red) and rag (blue) slating

Historically, there were many roofing slates quarries in the region and their slates would be primarily used close by. It was only when transport systems improved that the area of use became extended and a few quarries came to dominate the market

The primary locations of wet-laid scantle (red) and rag slating (blue) are shown for Cornwall. In sheltered locations within the wet-laid scantle areas dry laying is common. (Based on research by Stratton)

2 Triple-lap scantle slating is known as both three-and-a-half pin and four-and-a-half pin. They produce the same gauging. The different names arise because in the latter the first count is taken on the stick but in former it is on the slate.

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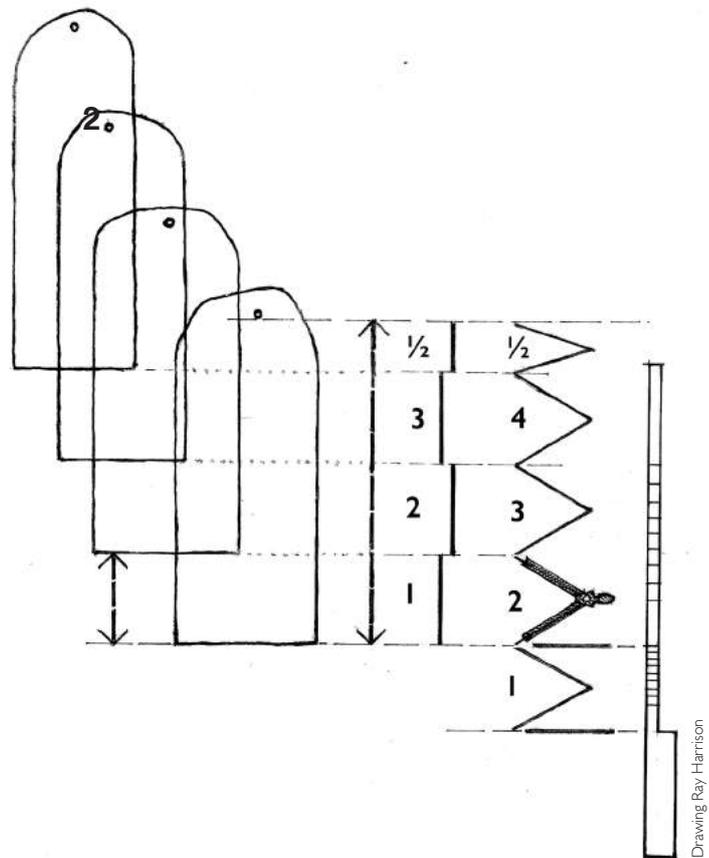


Table 1 West country slating techniques.

Slating name	Lapping system	Characteristic features	Notes
Common	Double	18 to 8 inch long slates x random width. Large slates at the eaves with small slates over the rest of the roof laid in thirds	A medieval system now uncommon in the region
Rag	Double	Large format random sized slates nailed directly to rafters	The slates are often laid with the grain horizontal
Scantle	Double	Small random sized slates head-fixed to laths (or battens) at a specified (variable) head lap	
	Thirds	Slating in thirds at a gauge of one third the slate length	Slating in thirds is common in Devon and Somerset but apparently less so in Cornwall
	Triple	Small random sized slates head-fixed to laths at a gauge of two sevenths of their length	Dry-laid in Devon and sheltered areas
Wet-laid, that is, bedded in mortar in Cornwall and exposed areas			
Sized	Double	Single size or tally slates ranging from 24 x 12 to 12 x 6 inches centre-nailed to battens at a gauge of length minus the head lap divided by two	Used throughout the region

These are not always appropriate for conservation because they do not cover vernacular techniques comprehensively. The issue of differences between modern and historic slating should be dealt with at the design stage of a project.

Terminology

Technical terms used in this advice note and not explained in the text are defined in section 15 and a fuller glossary of slate and stone roofing is referenced in 14.2. The more common terms are used with local variations bracketed. The meanings of some words are variable and need to be understood before reading on:

- **Slate length.** The length of slates sold by quarries is the overall dimension from the tail to the head (bottom edge to top edge), But for top-fixed slates the effective length is the dimension from the tail to the bottom of the fixing hole and this is typically 25 mm or one inch less than the overall length. This is important because it is the length to the fixing hole which is used to establish the gauging of the roof and hence the area which can be covered with a given quantity of slates.

Failure to appreciate this can result in expensive under-estimates of the cost of a roof. When carrying out roof surveys or recording, it is the length to the fixing hole which should be measured.

- **Pin slating.** Triple-lap slating is known as either Three-and-a-half-pin or four-and-a-half-pin (Figure 2). In the former the first count is taken on the slate and in the latter it is on the scantle stick but they both mean the same thing and in this advice note the term three-and-a-half pin is used.
- **Scantle.** In slating the term scantle has several meanings and this leads to confusion in specifications. It can mean small slates typically 12 to 6 inches long⁴ (305 to 152 mm). But it is also used to mean their use when triple-lapped (Figure 2). In this advice note any reference to scantle slates means small slates laid in this way. A scantle is also the name of the gauging stick used to sort slates into length sets and to set out the slating. This meaning is derived from the more general term for any small timber.
- **Dimensions.** Although metric dimensions were adopted long ago

many slaters still work in inches and the slate manufacturers still make imperial size slates and quote approximate metric equivalents. In this guide where past practices are described and where direct quotations are provided from historic documents the inch dimensions are used. Otherwise and for descriptions of modern practice approximate metric equivalents are given with the imperial dimensions in brackets.

2 History

Slate has been exploited to provide effective and long-lasting roof coverings for buildings in south–west England for many centuries. There is archaeological evidence throughout England of roofing slates from excavations of Romano-British sites but the earliest post-Roman records of slate quarrying date from the beginning of the 12th century. At this time roofing slate use was restricted to important buildings, including some as far away as Kent and Essex, but it was not until the 15th century that slate began to generally replace thatch on ordinary buildings. In more inaccessible areas, such as the Scilly Isles, the change did not take place until the early 18th century.

Whilst the slate itself is durable and may last hundreds of years, slate roofs have a finite life determined by the fixings used to support them. Pegs and laths rot and nails rust. Roofs are known that may be between 150 and 200 years old, but there will be very few *in situ* any older than this. Older buildings may well have had their roofs renewed two, three or more times during their existence, and whilst the original slates may be salvaged and reused once or twice, the act of stripping and relaying a roof destroys most of the evidence of the earlier roofing techniques.

The development of quarrying techniques and the methods used to convert the rock into roofing slates has changed their size and shape over the centuries, and consequently the techniques used to lay them have changed to exploit their practical and economic advantages. These changes

have been reflected in a change in the roofs' appearance. This is not a new phenomenon. In north Cornwall, from the late 17th century large rag slates were used to roof older buildings previously covered with much smaller slates.

By the mid-19th century, the Welsh slate quarries had grown large enough to be able to segregate slates into single sizes known as tally slates to distinguish them from random slates sold by weight. It was cheaper to construct roofs with these and the larger Cornish quarries were forced to respond by introducing similar products, initially alongside the rags and peggies. Gradually, however, single-sized slating displaced the older styles and those quarries which were too small to compete closed down. In spite of attempts by the Arts and Crafts movement to encourage the use of Cornish slates and vernacular techniques, the industry continued to decline throughout the 19th and 20th centuries. The last slate quarries in Devon ceased trading in the early 20th century and Treborough quarry in Somerset closed in 1938. Today, only the Cornish quarries Delabole and Trevillet (Mill Hill) still produce roofing slates.

Alongside the introduction of tally slates, sawn battens became available and these allowed slates to be centre-nailed rather than top-hung. Slates fixed in this way do not need to be bedded in mortar because they are inherently resistant to wind uplift. Bedding therefore ceased for all but the smaller slates which continued to be top-hung. Torching persisted as a means of draughtproofing and to prevent snow penetration until the advent of roofing underlay from the mid-20th century. Today, for new buildings, the old styles of slating have been almost entirely supplanted by single size slates, centre-nailed to sawn battens over underlay. Happily, many of the old roofs still survive to add variety to an increasingly bland roofscape.

3 Characteristics

3.1 Slating styles

West country roofs are distinctive because of their materials, the slating

techniques, their detailing and the repair methods used to prolong their life. These are often a reflection of proximity to the quarries and the type of slates they produced - rag slating in north Cornwall, for example - or, in the case of wet-laid scantles, the severity of wind exposure. The detailing at hips, valleys, verges and abutments is distinctive and varies within the region. Early valley types would not have used lead soakers and the collar and tie valley for example, is only known in the south-west and Pembrokeshire.

Only randomly-sized slates produced within the three counties can provide an authentic appearance because of their colour, texture and the way they weather. The decorative use of mixed slate colours and shapes is not extensive in the region, mainly because grey coloured slates predominate, but where it is used, especially as cladding in, for example South Hams - where there are purple and green slates - it can be elaborate and beautiful. It expresses the highest degree of the slater's skill.

Slate cladding to protect south and west facing walls from the prevailing driving rain is also a distinctive feature of the region. A wide range of sizes are used although the largest less so because of the weight they impose on the fixing. They are laid either with the bevelled edge facing inwards to improve the key for bedding mortar or facing outwards as for roofing.

3.2 Slating techniques

Slates are set out to achieve head and side laps of sufficient size to resist driving rain penetration over the their heads or sides or through the fixing hole (Figure 3). Head lap can be specified either as a dimension – typically 75 or 100 mm (3 or 4 inches) – or, as in scantle slating, by setting it as a proportion of the slates' lengths. The latter is economical because it automatically reduces as the slate lengths reduce. This is satisfactory because the smaller slates with smaller laps laid near the ridge carry less water. A smaller head lap is used for vertical cladding – typically about 2 inches (51 mm).

Scantle slates and rag slates are randomly sized but scantles are generally small, 12 to 8 or 6 inches long (305

to 203 or 152 mm) and rags can be very large (Figure 4). They are all laid in courses of equal slate length but diminishing in length from eaves to ridge and there may be one or several courses of a given slate length depending on the mix of slates and the roof's dimensions.

For large slates, such as rags, a proportional head lap would be very large and wasteful – 200 mm (8 inches) for a 600 mm (24 inch) slate for example. None-the-less proportional laps are known for slates up to 457 mm (18 inches) long but for slates longer than about 405 mm (16 inches) it is common for the head lap to be specified and the gauging calculated from that.

Slating in thirds (Figure 5) and rag slating are double-lapped – each course is overlapped by the next but one course above. Three-and-a-half-pin scantle slating is triple-lapped – courses are lapped by both the next course but one and the next course but two above. This means there is an extra layer of slates throughout the roof compared with double-lapped slating, making the roof more resistant to driving rain and wind and able to use narrower slates and side laps without leaking.

The gauging of all random slating has to be adjusted at the first course of shorter slates known locally as the twist. This ensures that the head lap is always adequate and that the margins diminish regularly.

3.3 Rag slating

Rag slating (Figure 4) is nailed directly to rafters set at comparatively close centres and is not bedded but often torched. The slates can be nailed anywhere above the slate in the course below but always outside the area of water spread. Rag slate roofs are gauged by using the equation:

$$\text{Gauge} = (\text{length} - \text{head lap})/2$$

3.4 Scantle slating

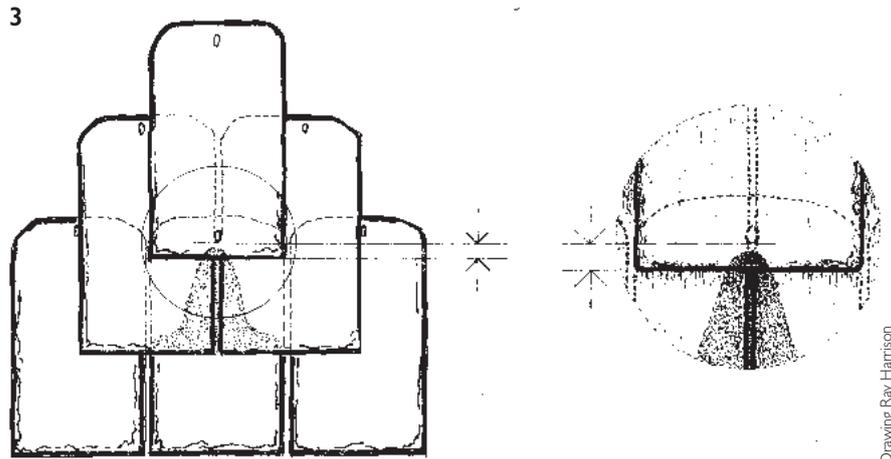
Scantle roofs are set out with a gauge of two-sevenths of the slates' lengths obtained by using a scantle stick but equivalent to dividing the length by 3.5 (Figure 6). They are peg-hung or nailed on riven laths or battens, and dry-laid in

3 All forms of slating are set out to achieve head and side laps large enough to resist driving rain passing over the slate's head or sides or through the fixing hole. The area of water spread between the slates is shown shaded.

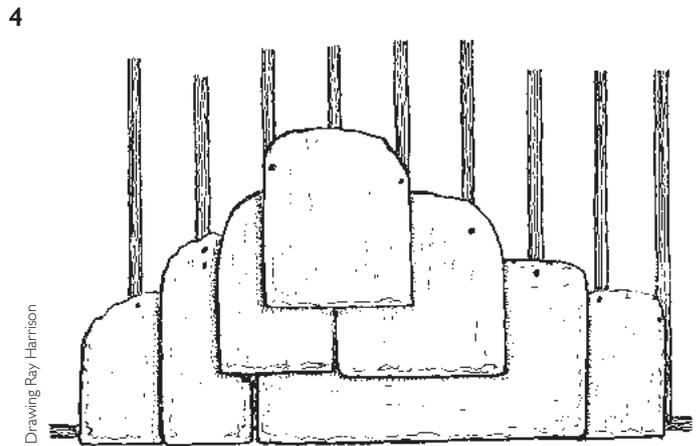
4 Rag slates are nailed directly to rafters set at comparatively close centres. They can be nailed anywhere above the slate in the course below but always outside the area of water spread. If the slate sits on a single rafter they are fixed with two nails above each other.

5 In the double-lap proportionating system, slating in thirds the head lap is one-third of the slate's length so that the tail just reaches the fixing peg of the slate next but two below. It is only applicable to smaller slates - an extreme of 18 inches (457 mm) long is known but unusual. For longer slates the head lap would be excessive.

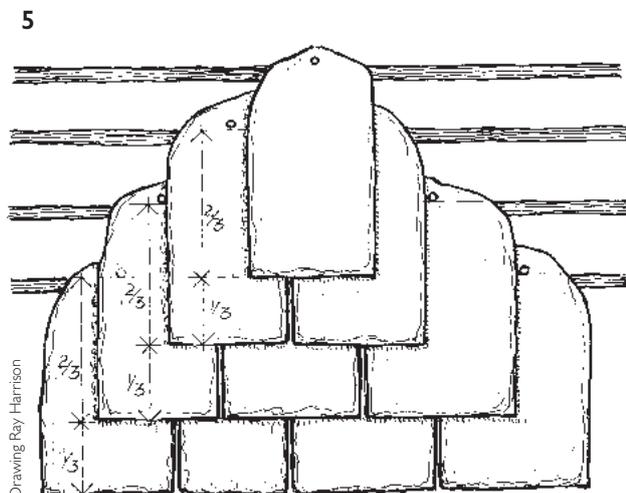
6 In triple-lap scantle slating the gauge is two-sevenths of the slate length obtained by dividing it by 3.5. The slates' tails overlap the slates next but two below by one-seventh of their length. Each slate is peg-hung and the width is chosen and laid so that the perpendicular joints are as central as possible over the slates below.



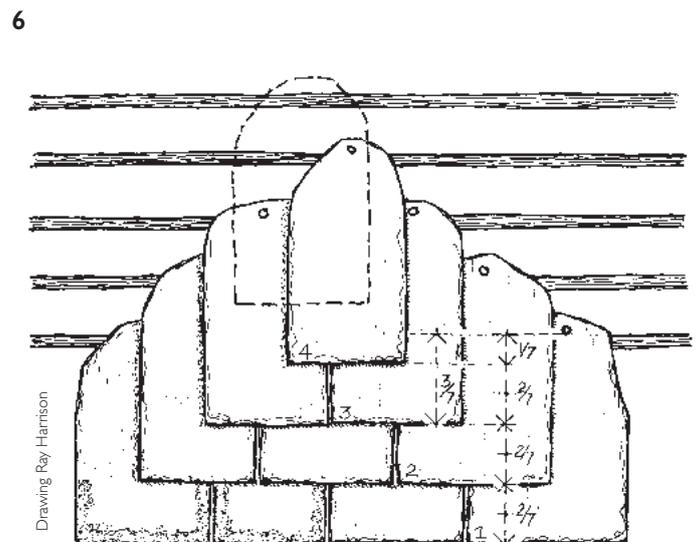
Drawing Ray Harrison



Drawing Ray Harrison



Drawing Ray Harrison



Drawing Ray Harrison

sheltered areas throughout the region or bedded in mortar in exposed locations. Torching is sometimes also applied.

For cladding a smaller divisor is used – 2.5 which produces a double-lap of one-fifth of the slate length. It is common for cladding slates to be all one length.

3.5 Slating in thirds

This is a particular form of proportional gauging using one-third of the slates' lengths. The same gauge is often used for cladding. In west Cornwall, it is less common than three-and-a-half-pin slating.

3.6 Patent slating

Patent slating is a single-lap system which has a particular connection to Cornwall. Although it has parallels in other parts of Britain, Ireland and Scandinavia, it was developed and patented by Charles Rawlinson of Lostwithiel in 1772.

It is likely that it was inspired by rag slating and differs from that system by using slates all the same width laid so that they only overlap by one course and the resulting open perpendicular joints are covered with narrow slates or, in the earlier version, by wooden strips. Within the region it appears to be most common as cladding.

It was taken up by the architect James Wyatt and used on many buildings especially as a modular system for iron-frame structures such as the church of St Michael in the Hamlet, Liverpool (see the Historic Roofs website in 14.2).

4 Winning and Production

Historical sources of slates^{5,6} are shown in Figure 1 with the more well known quarries indicated.

4.1 Somerset and North Devon

In north Devon and Somerset roofing slates were produced in the Middle Devonian Ilfracombe Slates Formation, the Kentisbury Slate Member and the Late Devonian Morte Slates Formation.

The variable grey, greenish grey and purple Kentisbury Slates, because of their friable nature, had limited use as a roofing slate. They were used, instead, for rubble walling and cladding. The Ilfracombe and Morte slates were locally important from at least medieval times and were shipped as far afield as south Wales in the 15th century⁷. Later, as demand outstripped production, slates were imported into the region from Cornwall and north Wales.

Within the Ilfracombe Slates Formation, Combe Martin slates (Combe Martin Slates Member) are grey-green but weather to yellow-brown. The Morte Slates have a similar green-grey colour with a lustrous sheen on cleavage surfaces and weather to a distinctive silver-grey.

There were a great many quarries working the slate but records specifically mentioning roofing slate production are few. Trying to identify roofing slate quarries can be difficult because they are known locally as shillet which means any fissile rock regardless of whether it was slate or another stone or if it produced roofing slates or not. (Geologically, the term shillet is usually applied just to the mainly Carboniferous, Culm Measures.)

Middle Devonian

In the Ilfracombe Slates Formation the quarries at Treborough (Treborough slates) were a well known source. Howe commented on their quality in 1910⁸.

Late Devonian

In the Morte Slates Formation there were roofing slate quarries near Wiveliscombe (Oakhampton Quarry - Oakhampton slates) and Huish Champflower (Combe quarry); and at Rook's Castle Quarry at Broomfield north of Taunton. The roofing slate quarry at Ashbrittle worked the Late Devonian, Teign Valley Group (Ashbrittle slates).

Early Carboniferous

At Tracebridge near Ashbrittle roofing slates were produced from the Doddiscombe Formation.

4.2 South Devon

To the north and east of Plymouth, roofing slates were produced from

the Early Devonian Meadfoot Group (Meadfoot Slates); the Middle Devonian (Norden Slates); and the Late Devonian, Tavy Formation (Kate Brook Slate), Gurrington Slate Formation (Gurrington Slates) and Lydbrook Slates. Kate Brook Slate is a minor resource. Roofing slate quarries include:

Early Devonian

In the Meadfoot Sandstones, Beesands quarry produced grey or green-grey slates which weathered to silver. It was also known as the Start Bay Slate Quarry.

Middle Devonian

Slates produced at Harbertonford (Harberton slates) and Diptford are dark and were produced in very small random sizes.

Around Totnes the Nordon Formation worked slates which were grey when fresh but weathering to orange-brown.

Late Devonian

Notable quarries working slate of this age include:

Cann. Worked since 1683, it produced grey slates in parts hardened by the intrusion of an elvan (granite) dyke. Despite its hardness it had a good reputation⁹.

Mill Hill (Tavy Formation - Kate Brook Slates). In the west the Tavy Formation consists mainly of smooth slates with a greenish chloritic sheen to cleavage surfaces. To the east around Buckfastleigh the upper part is a green-grey slate but the lower part contains purple and green mottled slates. Kate Brook was a minor source but the slates' smooth grey-green lustrous cleavage surface makes them quite distinctive. They weather to yellow-grey.

Pen Recca (Gurrington Slate Formation). Gurrington Slates occur in the Ashburton and Buckfastleigh area. They are bright green and purple when fresh and can be mottled.

Woodland quarry, Newton Abbott (Gurrington Slate Formation) produced green and purple slates weathering black and brown.

Coryton and Chillaton (Lydford Slates). The Lydford slates were used south-east of Launceston around North Brentor, Lydford, Bridestow, and

Chillaton. They are micaceous and dark grey weathering to brown-grey.

4.3 Cornwall

The most famous Cornish roofing slate quarries are those near Tintagel and Camelford working the Late Devonian slate and the only remaining production in the county is at the Trevillet and Delabole quarries. Roofing slate quarries, some of significant size were also formerly worked in the Early and Late Devonian and the Early Carboniferous Trambley Cove and Crackington formations. Other minor slate sources include the Early Devonian Bovisand Formation around St Austel and New Quay and the Trevoise Slate near Wadebridge (Camel Slab and Slate Quarry, St Breock). Quarries included -

Early Devonian

Carnglaze Mine (Saltash Formation). These blue slates were used on roofs from Plymouth to Penzance.

Late Devonian

Quarries in the Tredorn Slate Formation include:

Trevillet near Tintagel (Tintagel Slate). Blue-grey slates with dark metallic mineral flecks which are important for an authentic appearance.

Delabole Slates from the old workings weathered to a silver colour. Present day production is blue-grey.

Cliffside quarries from Tintagel to Trebarwith - Gillow, Long Grass, Lambshouse, Gull Point, Dria, Bagalow, Lanterdan, and West. No longer in production.

West of Boscastle where grey-green slates were produced at Trevalga quarry and others.

Early to Late Carboniferous

There were operations in the Trambley Cove Formation near Boscastle which are dark blackish.

The Crackington Formation was worked at Bangor Slate Quarry and at Bad Ash near Launceston.

4.4 Production

There are four steps in modern roofing slate production: quarrying block by

Slate durability

There have been problems with imported slates in recent years. These are caused by inclusions - carbonates (calcite etc) or metallic minerals, collectively known as pyrite or pyrites. They can be present in the slate as distinct crystals or veins, or be dispersed within the slate's structure. When exposed on a roof expansive reactions take place converting pyrite to iron oxide and carbonate to bicarbonate or sulphate. These can result in staining, cracking, flaking or blistering of the roofing slate. Some forms of pyrite can be stable so its susceptibility cannot be decided visually. Other failures have been the result of mudstones and siltstones being sold as slates. These disintegrate very quickly on the roof.

Slates should conform to BS EN 12326-1 Product Specification and should be tested by the quarry once a year or for every 25 000 tonnes of finished slates they produce. It is particularly important that they conform to the scope of the standard which defines a slate geologically. Quarries must provide certificates of conformity to the standard.

Specifiers should be aware that it is not safe to simply specify slates conforming to BS EN 12326-1. This is because the durability tests in the standard have more than one level of conformity and such a specification allows slate any of the conformity levels to be supplied. The range of conformity levels were necessary to accommodate all the slates produced throughout Europe some of which are less durable than is acceptable in the UK market. A specification should state the conformity level for three of the tests: water absorption – less than 0.6% or more than 0.6%; thermal cycling - T1, T2 or T3; and sulphur dioxide exposure - S1, S2 or S3. (The lower categories and the lower the water absorption - lower than 0.3%, are the most durable). There are other tests which need to be considered as well. Further explanation is available¹².

Rust staining indicates the presence of oxidising metallic minerals and a general whitening of the slates will usually be the result of a high carbonate content although this can also be caused by carbonates leaching out of mortar or by lead staining. A specialist report will be needed to determine whether the slates already on a roof should be replaced. It is important to understand that although oxidisation of pyrite can be a serious problem (which in recent times has been mainly associated with imported slates) not all pyrite oxidises and some will do so without causing problems. The latter two types were formally commonly used in the region and are still produced. The appearance they impart to slates and roofs is an important regional feature.

Slate breakage can be due to wind forces, roof settlement or imposed loads, such as people walking on the roof or, more importantly, because the slates are inherently weak. Wind damage is usually localised on the lee side of hips, ridges or other changes in the roof shape. Broken slates can be replaced individually but if the cause is wind damage a review of the fixing method or slating technique is advisable. Failure due to inherent weakness is usually a symptom of imported slates which are too thin. A roofing slate's strength is a function of its thickness and the inherent strength of the rock, known as its modulus of rupture (MoR). Hence an inherently weak rock will only be satisfactory if it is made thicker than one with a higher MoR. BS EN 12326-1 specifies the minimum thickness for slates in relation to their MoR and size. The minimum thickness for specific slates should be declared by the manufacturer.

The roofing slate standard is revised from time to time. BSI and the NFRC can advise on the latest version.

drilling and blasting or increasingly today by diamond wire sawing; reduction of the blocks to roofing slate sizes by circular saws; splitting them to thickness with broad chisels (riving); and dressing to size with a guillotine or similar machine.

The earliest quarrying accounts indicate that medieval quarries supplied slate rivings by the wagon-load for the slater to convert to roofing slates³ by dressing the tail and two sides roughly straight and square using a sax and break iron or slater's dog (Figures 7 and 8). At the same time scantle slates would have a peg hole inserted about one inch (25 mm) from the head using the spike on the sax or a slater's hammer. Rag slates could not be pre-holed because the nail's position is unknown until the slates are placed on the rafters (Figure 4). Progressively, the quarries came to supply the slates riven and dressed leaving only the length sorting and holing for the slater to do. Alongside this change in production system the slates came to be segregated into the different sizes – rags, sized, scantles or peggies – and sold as such. It also became common for the smaller sizes to be made by apprentices as they developed their skills.

Today quarries will supply slates in various formats: sized; randoms; and peggies or scantles but rags can only be supplied when suitable block is available. The lengths of sized and random slates are supplied in 50.8 mm (two-inch steps) and scantles or peggies in 25.4 mm (one inch). This is convenient for making up shortfalls when re-slating but for scantle slating, because it encourages the selection of equal numbers of courses of each length, it risks losing the distinctiveness of roofs which traditionally would not have had such a

regular appearance.

Stock sizes currently available from the Delabole and Trevillet quarries are shown in Table 2. The lengths given in the table are as sold by the quarries but for top-fixed slates the effective length is reduced by the distance from the fixing hole to the top of the slate – usually about 25 mm (one inch). When working out the gauging and coverage the effective length must be used. Slaters used numbers rather than lengths to identify slates. In Cornwall they ranged from number 1 for 6 inch below the hole to number 8 for 13 inch. In Devon the numbering was opposite, number 1 or firsts was the longest and might be as large as 18 inches.

Following the introduction of the British Standard for roofing slates, BS 680, in 1942 (now replaced by BS EN 12326-1 Product Specification and BS EN 12326-2 Test methods) quarries limited the width of slates to not less than half their length. This was useful for centre-nailed, single size (tally) slating which relies on a defined minimum width for 'normal' head laps to be effective, but it is not appropriate for head-fixed slating which can safely accommodate narrower slates without leaking (Figure 9). Therefore, it is acceptable and preferable in head-fixed systems to include a proportion of narrower slates in an order.

5 Work in general

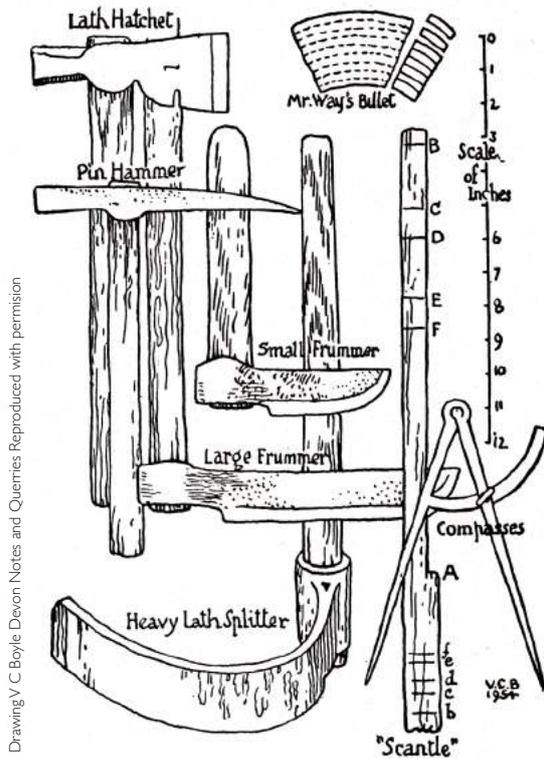
5.1 Conservation approach

Conservation imposes additional requirements on building work over and above those required for new

Table 2 Stock sizes in inches and millimetres currently available from Cornish quarries.

	Random	Scantle & peggies	Sized	Rags
Delabole	24 – 10 x R 610 - 254	11 – 6 x R 279 - 152	24 x 12 to 12 x 6 610 x 305 to 305 x 152	Up to 30 (762 mm) long or 36 (914 mm) long to order
Trevillet	24 – 12 x R 610 - 305	12 – 8 x R 305 - 203	24 x 12 to 12 x 6 610 x 305 to 305 x 152	

R = random widths

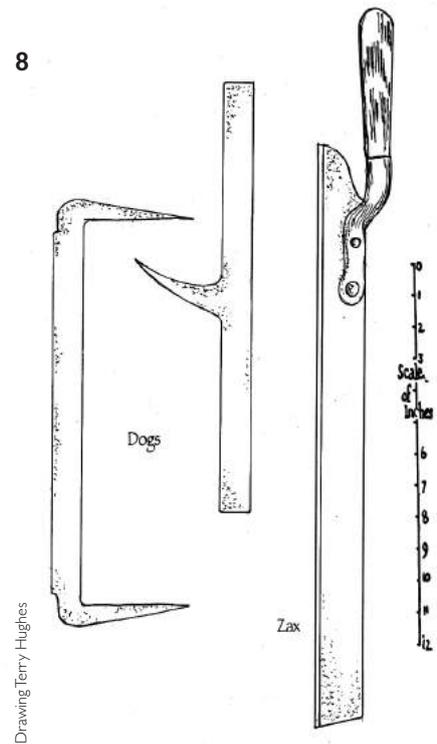


Drawing V.C. Boyle Devon Notes and Queries Reproduced with permission

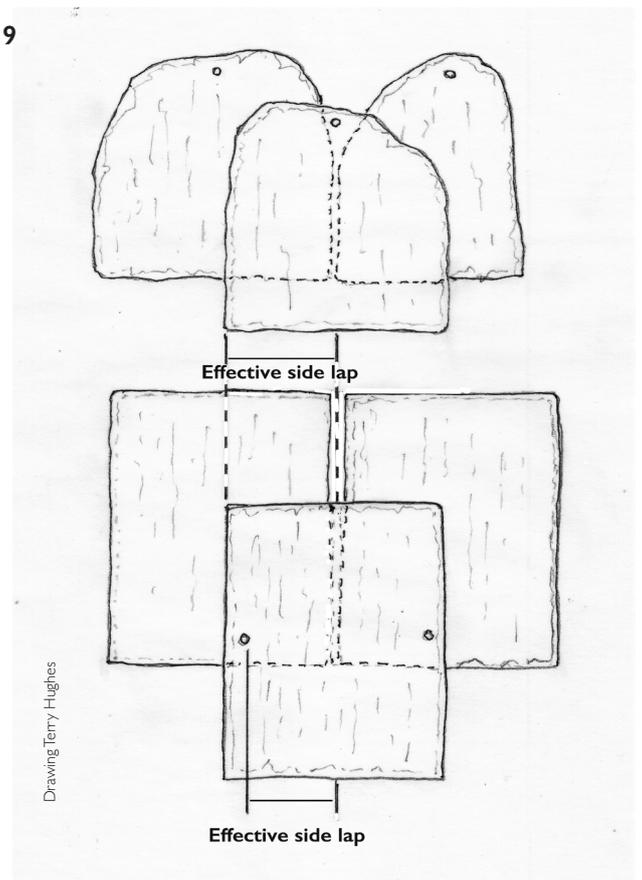
7 In the past a slater's kit included frumers for riving laths and pegs, and a break iron, sax and hammer for dressing and holing slates. This was usually wet weather work. Once the slates have been sorted into lengths (to the peg hole) the scantle stick and compass are used to mark up a gauging rod and the gauges transferred to the rafters using a string line. Laths are then trimmed to length where necessary with the hatchet and nailed.

8 As the slates are fixed they can be redressed if needs be with the sax and a dog or cutting iron driven into a rafter. The slater's pin hammer has a sharp spike for occasional reholing and a nail puller.

9 The effective width of head-fixed slates is greater than if they are centre-nailed. Following the introduction of BS 680 Roofing Slates in 1944 quarries adopted the 'slate width not less than half the length' limitation for all slates but this was in fact only necessary for centre-fixing. The consequent elimination of the narrower slates traditionally used in scantle slating has changed the appearance of roofs. For the conservation of old roofs the existing range of lengths and widths should be recorded and the narrow examples included in the specification and order to the quarry.



Drawing Terry Hughes



Drawing Terry Hughes

construction. Whilst the specific ways in which these requirements can be met will vary greatly from case to case, as will the reason for undertaking the work, the underlying principles advocated by the SPAB remain the same.

The Society believes above all that it is vital to maximise the retention of a building's authentic fabric and minimise the disturbance to this to keep its integrity. This is achieved by carrying out essential work coupled with using compatible methods and materials.

Obtaining sound information about a building's history, construction and condition before embarking on any major work is an important prerequisite. The level of recording entailed should be proportional to the significance of the building.

5.2 Selecting an architect or surveyor

An architect or building surveyor may be employed on larger, more complex projects, or projects where the re-slating is only part of the work. This should give the client protection if things go wrong, and a competitive tendering procedure should ensure that value for money is obtained. Professional advisors should be selected who have the right knowledge and experience to specify and inspect the work. For sources of names see Section 15.1.

5.3 Selecting a slater or slating company

It is most important to ask skilled and knowledgeable slaters to tender for the work. The key is to ensure parity of tendering. Then the lower price can be chosen. It is usually unwise to make

a selection based on cost alone as an inexperienced slater may simply have underestimated the cost because they left out a step in the slating process. Problems can also arise if the main contractor is allowed to choose the slater because they too may be primarily concerned with cost.

The National Federation of Roofing Contractors operates an accreditation scheme for heritage roofing companies which includes Patent, scantle and rag roofs.

There are national vocational qualifications (NVQ) for roof slating and tiling and construction site management (conservation) (Table 3)¹⁰. Older but highly skilled slaters may not have such qualifications but this should not disqualify them from consideration. These qualifications may be required by clients or be included in grant conditions.

A slater should be able to show roofs which they have successfully worked on and provide references. It is wise to view roofs which a company has repaired or reslated, preferably recently. Although an external view cannot reveal all the mistakes which may have been made, examples of good workmanship to look out for include:

- Evenly diminishing margins – no margins taller (longer) than ones lower in the slope
- Perpendicular joints roughly central on the slate below – any joints lying closely above each other are a serious fault
- Tidy mortar – neatly finished at the slates' tails, verges and abutments
- Ridge tiles fitting closely onto the slating without large mortar beds
- In the roof space there should be

Table 3 National Vocational Qualifications in roofing.

NVQ title	S/NVQ level	CSCS card
Roof slating & tiling including random slating	3	Gold
Diploma in Heritage Skills Roof Slating & Tiling	3	Gold + Heritage Skills
Construction Site Supervisor Conservation	3	Gold
Construction Site Management Conservation	6	Platinum
Conservation Consultancy	7	Black

no sign of leaks or dampness but these would only be visible if there is no underlay

- Similarly bedding mortar should not be visible from the underside of the roof but do not confuse this with torching.

The slater should be asked to provide a statement covering all the steps in reslating the roof including:

- Survey and recording – how the roof will be inspected before and during stripping to ensure historical details will be conserved and technical detailing will be replicated or if necessary improved. This may be subcontracted to a specialist surveyor and may have been carried out prior to tendering
- Specification review – advising on unsuitable or impractical aspects of the specification
- Method statement – a description of the process of organising the work
- The re-slating process - a description of the process of carrying out the work. This aspect is important because comparison between tenderers will highlight any step which has been omitted
- How they will deal with any faults or damage caused, for example, when dismantling scaffolding.

Quotations should state the total area of the slating work to be done so that differences can be checked and any aspects which are unknown until the roof is stripped should be clearly explained. It is also very important that all quotes are based on the correct gauging system. A price based mistakenly on slating at double-lap when three-and-a-half-pin is specified is going to seriously underestimate labour and materials.

5.4 Specifications

Any work on historic roofs should always be based on an understanding of the existing roof and how well it has performed. Ideally, a survey to record and photograph the constructional details should be carried out prior to writing the specification. This will involve some opening up of the roof. The survey

should cover the general slating and eaves, valley, verge, abutment, hip, ridge and dormer details and the slate sizes, their condition and gauging . It should also assess whether the roof has performed satisfactorily or if it has deteriorated prematurely because of some inherent defect. Care and experience are needed to differentiate between cause and effect. The survey could be carried out by a slating consultant, an experienced contractor, architect or surveyor.

Based on the survey findings the specification can be prepared. Where modifications are required to fulfil other objectives such as environmental performance, they should be based on sound information. In particular, care should be taken where insulation is introduced, especially on wet-laid scantle slating where a method for venting any moisture from the batten space must be provided.

This advice note includes roof details which vary across the region and should be replicated during repairs or re-slating. However, the location and geographical extent of their use is not necessarily known, so their application on a particular roof should be based on research, survey or other reliable information.

A written specification will allow the work to be detailed and the standards of materials and workmanship to be set out so that all slaters who are pricing the work can do so against the same document, and the prices can be judged on an equal basis. If the work includes more than slating, and is to be managed by a main contractor, a good specification will ensure that the method and standard of slating can be understood by all who tender and can be met by the main or slating sub-contractor. Under certain contracts a particular slating firm can be nominated. The specification should cover the following issues:

- Survey and recording if required
- Policy on retention of historic details and materials
- Slate source, sizes range, thickness
- Gauging
 - for scantle this can be described as either three-and-a-half or four-and-a-half for roofing and two and half for cladding. To avoid confusion, the slate length

- divisor should be stated: 3.5 for roofing and 2.5 for cladding are typical
- for slating in thirds the gauge divisor is 3
 - for rag slating the head lap should be specified
- Side lap – for scantle the requirement is to set perpendicular joints approximately central over the slate below; for rags and slating in thirds a minimum side lap can be stated
 - Battens or laths and fixings – sizes and materials
 - Slate fixing method – nailed or peg-hung
 - Slate fixings – nails or pegs, sizes and materials
 - Mortar, if required, including any preparation procedures and precautions to ensure satisfactory curing
 - Underlay
 - Insulation and means of ventilation
 - Details for eaves, verges, hips, valleys, dormers and ridges.

5.5 Listed building consent

For listed buildings, most changes to the construction details will require listed building consent from the local authority. Relevant changes will include the:

- Reslating of a roof at the end of its life, where renewal would affect the building's character
- Removal and alteration of material and/or detail of archaeological or historic importance
- Alteration of a detail such as ridges, valleys, hips, abutments verges or the style or size of dormer windows
- Change from one slate type to any other slate or to clay or concrete tiles, imitation slates or sheet products
- Use of slate of a different geological type, including another source quarry within a particular geological type
- Change from riven laths to sawn battens or the reverse
- Introduction of underlay with counter-battens which significantly raise the roof line
- Change of slate fixing method, for example top-hung to centre-nailed
- Change in the overall range of slate lengths which would significantly affect the roof's character
- Use of new slates that have been

prepared using nontraditional methods, such as sawn edges which have not been dressed to give a bevelled edge

- Change of ridge or hip material, such as from one stone type to another or to reconstituted stone, concrete or clay ridges
- Introduction of building service or ventilation details that would significantly alter the character of the building.

Local policy on these issues should be checked before making proposals for alterations. The policy is likely to cover three main options:

Completely authentic reslating – an exact replication of the existing style and techniques;

External appearance authentic but modern methods adopted, for example nailing rather than peg hanging; or

Either of the other two but including modern innovations like insulation.

The third option is most likely to be driven by the building regulations.

5.6 Building regulations and other controls on roofing work

In addition to listed building consent, building regulation or, for many places of worship, faculty approval will be required for any increase or decrease to the weight of the roof covering. This will include a change from a slurried to a normal roof.

Where more than 25% of the roof area is to be replaced, the person intending to do the work has a legal obligation to contact the local authority building control department in relation to the upgrading of insulation to comply with the Part L of the building regulations - see Section 7.6. Places of worship are exempt. Historic England has published guidance on compliance with Part L - *Building Regulations and Historic Buildings*¹¹.

All bats and some birds and plants which live on or in roofs are protected. This will often limit the time of year when work can be done. The county wildlife trusts will be able to advise and other sources of information are given in Section 15.

6 Recording and assessment

6.1 Recording and condition surveys

Any work on historic roofs should always be based on an understanding of the existing roof and how well it has performed. Each surviving example is likely to contain valuable information about historic craft techniques. It is important that the recording of such information is undertaken before the slating is stripped and the results used to develop a specification for the re-slating. This will minimise the possibility of delays and errors in the ordering of any new slates, and importantly will give the owner of the building more certainty over the final cost. If no survey is done, assumptions about the quantities of slates needed will have to be made at the time of specifying the work in order to obtain prices. For scantle slating where there is flexibility on lengths, potential shortages of smaller sizes can be overcome by ordering extra longer slates which can be used on shorter courses. For rags, however, small quantities of specific lengths and widths will often be needed and will not be known until either a survey has been carried out or the roof has been stripped. The potential delay in obtaining them should be built into the contract programme.

Where defects occur, they are frequently down to poor maintenance, unsuitable alterations or inadequately sized members, and result in decay or distortion of the roof.

6.2 Structural deterioration, rafter settlement and deflection

Most historic roofs will have moved during their life. Commonly, because of inadequate restraint by couples etc, the eaves will have spread, pushing out the walls, and the ridge will have settled. Rafters may also have settled along their length or adjacent to walls. These features give roofs much of their character and should not be rectified unless there is a clear structural reason to do so.

Every effort should be made to

conserve the structure that supports the roof covering. It is frequently one of the least altered parts of an old building and may provide valuable clues about its history. These range from smoke-blackened timbers where a medieval open hall preceded a chimney, to remnants of early decoration and evidence of smoke bays or louvres. Many old roof structures also constitute fine examples of craftsmanship, jointing is often exemplary and features such as crown posts, moulded beams and traceried early spandrels may be found.

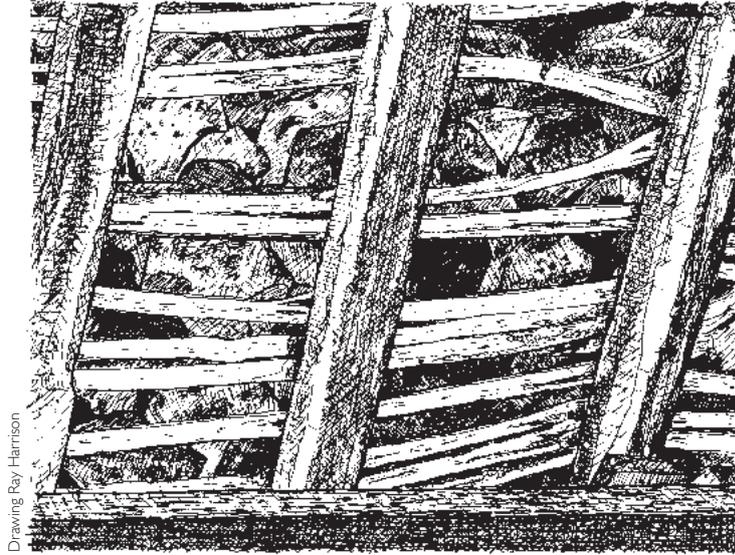
A technical assessment will often indicate that stabilisation of the structure is all that is necessary. However, deflection or settlement of the structure may have created undulations in the roof slope which are impossible to slate without gaps, especially for larger slates such as rags. In this case it is acceptable (and essential) to ease the undulations by packing the rafters or similar. Where settlement is less severe, gaps under the slates can be reduced by using narrow slates which will fit more tightly across the undulations.

6.3 Nail failure

Rusting of iron nails used to fix laths or slates is the main cause of slates becoming detached from the roof. Loss of slates individually indicates that it is the slate nails which are failing. This will be a gradual process and they can be refixed for a time. If lath nails fail several slates in a course will slip (Figure 10).

6.4 Lath failure

Lath failure is indicated by courses of dropped slates or undulations in the roof plane. If the failure is extensive then the roof will need to be reslated. Laths may be unable to carry the slates' weight if they have been weakened by rot or insect attack, or if the slating has been grouted and slurried. Repeated slurrying increases the load on the laths and when it becomes too heavy for the lath nails large cracks called ruffles form (Figure 11). To overcome the slippage barbed wire was laid over the ridge and turned under the eaves slates or nailed into the rafters and covered with a mortar fillet. This is only a temporary solution. Slurrying



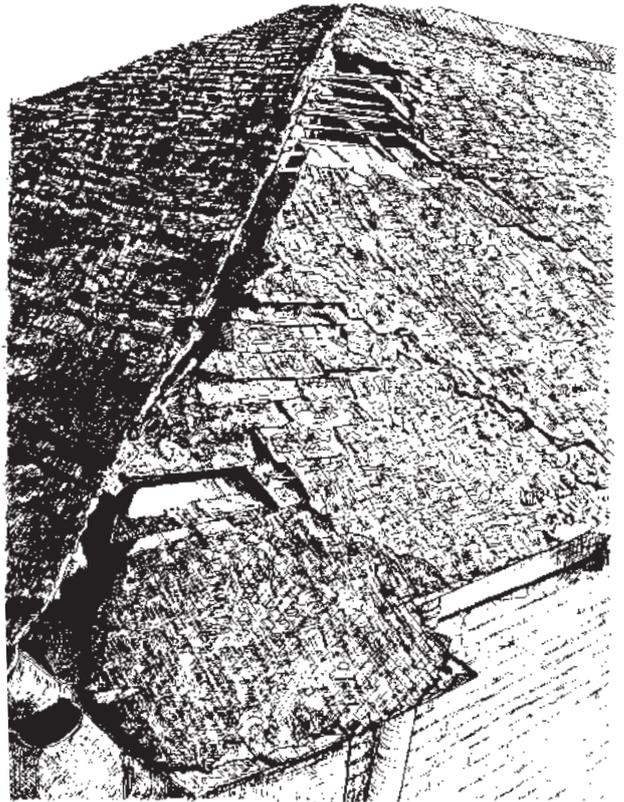
Drawing Ray Harrison

10 Where whole courses of slates are seen to have slipped the cause is usually failed lath nails (Godolphin).

11 Grouting and slurring roofs substantially increases the loading on the lath nails. When they fail and large areas of slates slip, cracks known as riffles appear across the roof (Penzance).

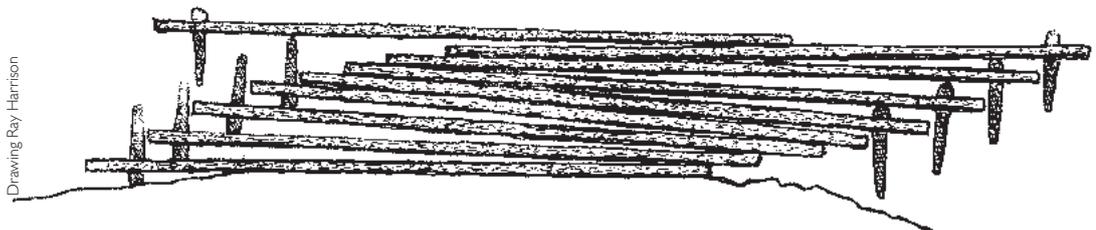
12 'Now the pins are put firmly into the holes and the slates piled so that they will stand without toppling: so many with pins lapping one end and so many the other, and still in sets of equal lengths.' Boyle, V C, Scantle Roofs, in Devon and Cornwall Notes and Queries 26, pp 10-15

11



Drawing Ray Harrison

12



Drawing Ray Harrison

and grouting reduce the roofs ability to breath resulting in rotting of the laths and structural timber.

6.5 Slate failure

Slates currently sourced from Cornwall and Devon are durable and will only reach the end of their lives after many, commonly hundreds, of years. Typically, the process of slate ageing is a general softening in the overlapping parts of the slates. Less durable slates may fail for three main reasons: the presence of deleterious minerals; inherent weakness or because of mechanical stress (see box page 11).

7 Repairs and re-slating

7.1 Alteration of details

It is normally assumed that a like-for-like repair or re-slating – same slates, same gauging, same bedding, if originally used, etc – will perform satisfactorily in the future. However, the implications of the increasing incidence of deluge rain and more severe storm force winds consequent on climate change should be considered in deciding on the gauging and the fixing method. An improved specification can usually be adopted without impact on the appearance of the roof but specialist advice may be needed so that all the implications of changes are taken into account and an integrated solution achieved. Simply applying the recommendations for each element in isolation is unlikely to be successful.

7.2 Structural repairs

All roof work should be carried out from a safe means of access that does not damage the roof. Scaffolds should be designed to carry the weight of stacked slates and to be wide enough to allow sorting and redressing. The NFRC provides guidance publications - Sheet A: Fall Protection and Prevention for Working on Roofs, Sheet E: Slater's Heel and Sheet M: Working at Height.

It is better to repair rather than replace roof timbers. Consult a structural engineer where necessary and leave

only minor repairs to roofers. Whilst conventional carpentry techniques alone will frequently be suitable, strengthening using steel may be justified where it allows more timber to be retained than would otherwise be possible. Use resins and consolidants only with great care.

Where active decay exists, the first priority is to eliminate causes of dampness and promote drying. Chemical treatments are frequently unnecessary and should only be used judiciously where justified as a secondary measure, for example, when it is difficult to reduce moisture levels sufficiently. Degraded surface material should not be removed (defrassed) without good reason. Serious mutilation can result.

Keeping roof spaces clear of rubbish and debris discourages decay. Timbers may be vacuumed or brushed down – though take care not to remove any medieval smoke blackening or evidence of early decoration that is of archaeological value.

For further advice on work to roof structures see the SPAB Technical Pamphlet 12.

7.3 Slates

Although slate roofs which are reaching the end of their life can be kept weather-tight for many years by regular maintenance, eventually they will have to be stripped and reslated, typically when 5-10% of the slates have slipped or been lost. The decision to reslate is often precipitated by the repeated cost of scaffolding for repairs.

When carrying out repairs the primary aim should be to retain the maximum amount of historic fabric without compromising the effectiveness of the roof. The existing slates should be reused if they are still sound or if they are damaged or softened, they can be dressed down to remove any defective areas.

Only slates from the local sources can produce an authentic appearance. Slates from other locations should not be used unless there is no local source. For extensive re-slating, new slates should be used to make up any shortfall. This may be local authority policy and a condition for any grant supported works. Claims of unavailability or long delivery times should always be checked with

the quarries. It may be worth delaying the project for a few months until the right slates can be produced, since the life of a well-slatted roof is likely to be in excess of 100 years. Only where it is impossible to obtain suitable new slates should the use of reclaimed slates be considered. These will not last as long as new and their use inevitably means some other building will have lost its historic roof. Often they are sourced from several other roofs so their remaining life will be mixed. They should be checked for softening and damage especially around the fixing hole. Affected areas can be dressed off but this may result in a shortage of the longer sizes with a consequent change in the roof's appearance. It is better for appearance and durability reasons to consolidate old slates on to one or more slopes and to use the new ones on others.

When stripping and reslating scantle roofs any shortfall should be made up with new slates supplied in a mix as they arise in the quarry but with appropriate scantle widths. Normally the new and old slates should be fixed on separate slopes. When the existing slates are consolidated and sorted into lengths the number of courses of each length can be calculated.

Rag slates are not always immediately available and have to be specially ordered. Suitable block for such large slates may not be readily available so the order should be discussed with the quarry as early as possible.

The quarries are always willing to make special slates but they will need a detailed specification of what is required and almost always time to organise production of any special slates. An order might include sizes, quantities, colour, texture, and most importantly the date work is to commence and, for large projects. The scheduling for each stage. It is always wise to discuss the order and work programme well in advance. If a roof is to be stripped and re-slatted, there will inevitably be uncertainty about the quantities of slates needed until the numbers of reusable slates are known. Experienced slaters or independent consultants can advise on this before stripping commences.

The individuality of rag and scantle roofs derives from the mix of slate sizes. Historically, no attempt was made to

supply a specific mix of sizes and this policy should be respected for most re-roofing work. How the slates were fixed and the detailing was mainly a response to the weather. In sheltered areas, especially in Devon, scantles are laid without mortar bedding (dry-laid) whereas in exposed parts of Cornwall tail-bedding with mortar (wet laying) is used. The use of large (rag) slates at the eaves or verges of scantle roofs is also a precaution against wind damage. Similarly large slates at the eaves (mounters) span the space between a rafter footed onto the inside face of a wall without the need for a sprocket.

Roofing slates produced today may be thicker than formerly. This can cause them to lie on the roof at a lower angle than thinner ones and the shortest slates near the ridge might become unacceptably flat. This problem can be alleviated by using a range of sizes slightly larger than traditional - say one size larger for the first course(s) and two sizes larger at the top of the roof. This should be discussed with the conservation officer.

7.4 Slate repairs

The thickness and size of missing or damaged slates must be determined and matched and this will probably involve opening up the slating.

If the slates are pegged it may be possible to swing adjacent slates aside and hang the new slate. If the slates are nailed or if the slating has to be opened for another reason then a triangle of slates should be removed so that each one can be accessed for refixing and the last one can be slid up and pegged by moving adjacent slates. Inevitably any bedding or torching will be damaged and this should be renewed.

Refixing slates by simply bedding them in mortar should be avoided but is sometimes necessary as an emergency and purely temporary measure. Cement mortar should not be used as any water getting behind it cannot evaporate through it and more damage will ensue. Lime mortar of the torching type placed high on the underlying slates is preferable. However, slates fixed in this way will not be fully secure but a small dab of bedding mortar under the tail will

prevent them lifting in the wind.

Roofs in the south-west are often inadvisably repaired by grouting and slurring with mortar; covering the slates with hessian and bitumen (Turnerising); or spraying foam on the slates' undersides. These techniques make it expensive or impossible to re-use the slates and reduce the ventilation through the roof, increasing the risk of rot or insect attack. This will be aggravated where insulation is installed in the roof. Grouting or slurring leads to structural deterioration and will eventually cost far more than if the roof had been re-slatted instead. Although slurried roofs are a distinctive feature of the region they are no more than a temporary repair – a last resort for a roof which has failed - and should not be replicated when the roof is re-slatted.

7.5 Fixings

Lath nails should be no less durable than galvanised or sheradised and sized to suit the laths or battens. Stainless steel nails are sometimes specified for lath or batten fixing especially in marine situations but not all types are equally durable. There have been failures associated with AISI grade 304 slate hooks in coastal areas and current advice is to avoid this grade for roofs and only use 316. However, standards and grades of stainless steel are changing and the NFRC technical bulletin 11 should be consulted for full details¹³.

For 50 x 25 mm softwood battens a 3.35 mm shank diameter is recommended in BS 5534. Shank length and diameter should be chosen to provide adequate pull-out resistance for the building's situation, height etc. BS 5534 provides further guidance. Smaller nails will be needed for fixing thin riven laths to avoid splitting them or the laths can be pre-drilled. Alternatively cleats (cooper's hooks) can be used.

The traditional fixings for wet or dry scantle or rag slates were soft or hardwood pegs. They were a roughly square section and whittled to a slight taper and forced into the hole until almost flush with the slate's surface. The slates were then stacked before carrying up to the roof¹⁴ (Figure 12).

On a pegged roof where the

underside of the roof is to be visible, wooden pegs should be used and will be prevented from twisting or falling out by the addition of a small dab of mortar (pin pointing) or by torching. Otherwise, nails can be used in the same way as pegs.

Where wood or metal pegs are used over underlay they must not be so long as to risk puncturing it especially close to the rafters. Counter battens may be necessary to ensure they are well away from the underlay but these can create other problems at abutments etc.

For slate nailing, copper or, in salt water exposed situations bronze nails are the most durable option. Aluminium nails are also suitable but should be avoided where they might be in contact with lime mortar. Ring-shanked nails should not be used as it will be impossible to remove the slates in the future for reuse without breaking them. Stainless steel nails are too smooth to provide adequate pull-out resistance in most situations. Small nails - 2.65 mm shank diameter - are satisfactory for scantle slates but for larger sizes such as rags the BS 5534 recommended 3.35 mm shank diameter is appropriate. Nailing rag slates into old hardwood rafters may require pre-drilling to avoid breaking the slates.

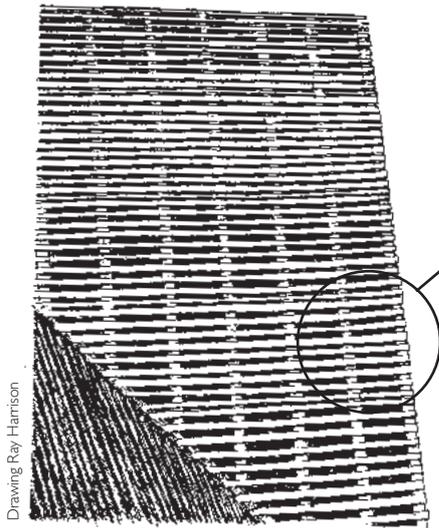
Hook fixing is not traditional and should not be used on old roofs.

7.6 Laths, battens and sarking boards

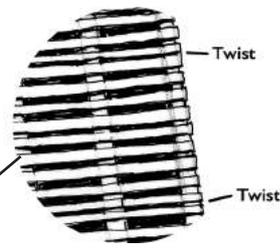
Historically, riven laths were used for all types of slating except rag slating and are satisfactory for peg hanging all the slating types in this Advice Note (Figure 13(a)). Made from a variety of woods including oak and sweet chestnut they are typically 25 mm by at least 6 mm thick and in length 900 to 1800 mm. They are available from specialist suppliers. Being riven they are not straight and impart undulations to the slating which gives a more lively and less mechanical appearance to the roof. Also they are less prone to beetle attack than sawn battens. For small peg-fixed slates, battens need to be narrower near the ridge to allow space to insert the pegs between them as the gauge reduces (Figure 13(c)).

Formal guidance for slating, such as BS 5534 recommends thicker battens of 50 x 25 mm, which are regarded as providing a safe platform for slaters to

13(a)



13(b)



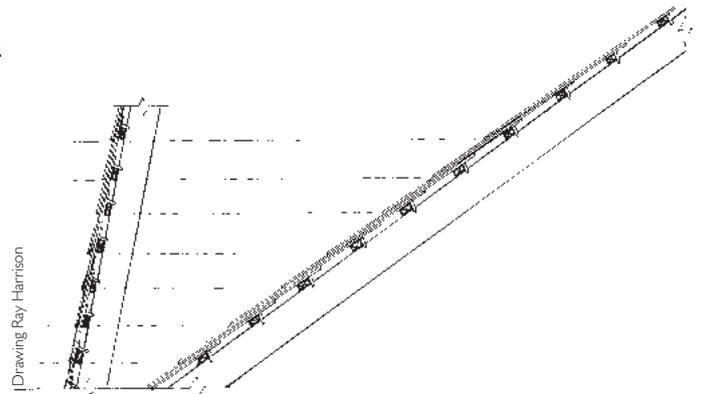
13(c)



13 Lath gauging

- (a) For a given slate length the lath gauging is consistent for each course (Addislide).
- (b) When a shorter length is introduced the gauge is reduced. This is known as the twist. Failure to do so means the head lap will be too small and the margin too long.
- (c) Narrower laths may be needed for the smaller slates in the upper courses to provide space for the pegs.

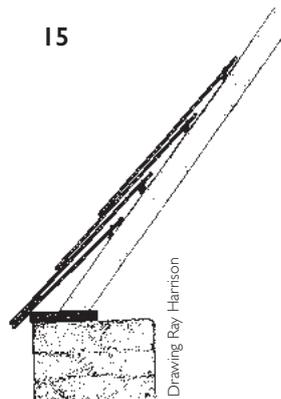
14



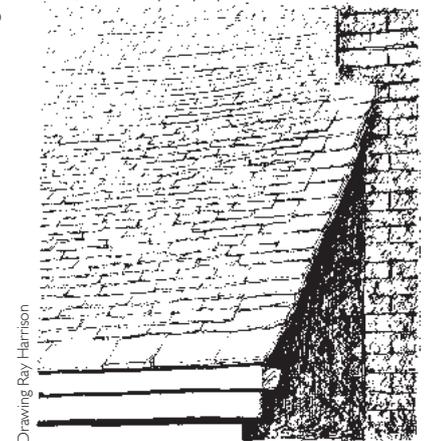
14 If a hip has unequal pitches on either side and the slating is mitred the lath gauging must be carefully worked out so that the margins match without compromising the head laps.

15 The eaves slating must be tilted to ensure the slates lie tight onto each other without gaps where the wind could lift them. This was often done by setting the rafter foot back from the wall face or by extending the wallplate. If the rafters oversail the wall a tilting fillet is placed on the rafter foot or, if there is a fascia, by raising it to lift the eaves slates.

15



16



16 Large munter slates are often used at the eaves to resist the wind and to throw water away from the wall where there is no gutter (St Erth).

17



17 If the slating is wet-laid, the mortar bedding is either reduced in width or omitted between the under eaves and the eaves course to allow any condensation in the slating to drain away (St Ives).

work on. If riven laths are used a risk assessment may be needed to justify their use. A slater's heels are a suitable option. Changing from riven laths to thicker sawn battens will raise the roof level and may lead to problems at abutments and verges. Listed building consent will be required.

Slating was commonly laid over sarking boards and these should be retained wherever possible. They fulfil most of the functions of underlay in keeping out draughts, powdery snow and dust, reducing the wind uplift force acting on slates and acting as a moisture buffer. Under correctly laid slating there is no need to include an underlay over boarding and its addition will reduce the ventilation of moisture from the roof space. Even the addition of a vapour permeable membrane will have a lower rate of ventilation of moisture than no membrane at all. To ensure ventilation through the boarding they can be laid with penny gaps.

If an underlay is needed to provide temporary weather protection it can be removed as slating progresses.

7.7 Insulation and ventilation

Part L of the building regulations requires the addition of roof insulation for most substantial repairs, including partial re-slating. This can increase the condensation risk in the roof structure unless precautions are taken. BS 5250 The Control of Condensation in Buildings provides advice on how to minimise the risk. Vernacular roofs were built with inherently good ventilation which prevented moisture build-up and condensation in all but the most adverse conditions. This is one of the main reasons they survive for so long. Underlays were not included in old roofs and draught-proofing was provided by lime mortar torching. This would temporarily absorb moisture and release it when the weather was more favourable.

It will be difficult for many older buildings to achieve statutory target U-values without compromising their appearance and it may be impossible. Part L allows for exemptions and special consideration for historic buildings to enable building control officers to take a sensible view in order to conserve the

appearance and character of the building and not introduce technical risks. Historic England has published guidance on complying with Part L¹⁵.

To prevent condensation problems, the first step should always be to reduce the amount of moisture reaching the roof. This has two aspects: elimination at source, especially for bathrooms and kitchens, and the installation of a vapour control layer at the top floor ceiling or at the rafters. To be effective a vapour control layer must be sealed at all joints, perimeters and penetrations but this can be very difficult as a retro fit.

Having minimised the moisture reaching the roof space it is important to ventilate any which does. This can be done with eaves, high-level or ridge ventilators or with vapour permeable membranes. Ventilation product manufacturers provide guidance on the amount of ventilation required and the levels their products achieve under ideal conditions. Where Agreement Certificates are available they should always be checked for the limitations applying to products. For example, many vapour permeable membranes will only achieve adequate performance provided a vapour control layer is installed below the roof. It is preferable to place insulation at ceiling level rather than in the rafter depth because it is easier to provide ventilation through the roof space via eaves to eaves, eaves to ridge or through gable walls. However, this may be undesirable where there is an historic ceiling or lining.

Providing ventilation for insulation placed in or above the rafters can involve raising the slating on counter-battens leading to problems of detailing and changes to the building's appearance at eaves, abutments, below copings and at verges. Secret gutters at abutments can be used to avoid the need to cut into the wall to reposition flashings or a string course. But they will need regular maintenance to avoid blocking by leaves or other debris.

Where there is natural ventilation, at the eaves, for example, it is important that it should not be impaired by the insulation. Roofing specialists are the best sources of advice on this rather than insulation installers who probably know little about roof construction.

Wet-laid scantle slating is a

sealed system so if there is any sort of membrane or underlay installed or a ceiling is fixed to the rafters it is vital that the batten space is ventilated. This will usually necessitate eaves ventilators and high level vent(s) in the roof slope or at the ridge.

7.8 Mortar

The use of mortar has a long history in roofing. It has been applied to improve the wind resistance of slates and prevent draughts, as well as for bedding slates, ridges and hips, pointing verges and forming abutment fillets. Mortar is

Table 4 Selection of mortar

	Roofing application	Mortar mix (ratio by volume)	Comments	
↑ Increasing strength ↓	Torching, except on exposed roof slopes or where the lap is not ideal	1:3 non-hydraulic lime:soft sand plus hair	The bedding mix immediately below is likely to be more suitable for torching on exposed roof slopes, especially where not heated from the underside. This also applies where slates are being reused or an ideal lap cannot be achieved for various reasons	↑ Increasing permeability and flexibility
	Bedding for wet-laid scantle, ridge or hip bedding, forming fillets, and pointing verges and flashings	1:2 NHL 3.5:aggregate	For use in sheltered and moderately exposed locations in reasonable weather	
		1:2 NHL 5:aggregate	For use in very exposed locations or cold weather	

Notes

(i) NHL denotes a natural hydraulic lime. Natural hydraulic limes are classified under BS EN 459: Part 1: 2015 Building Lime¹⁷ as NHL 2, NHL 3.5 and NHL 5 in order of increasing strength. The classes refer to the compressive strength in megapascals of a 1:3 lime:sand mix by mass (approximately 1:1 by volume) after 28 days. Users should be aware, however, that the strength continues to grow considerably over the first couple of years so the final result may be a much stronger mortar. It is also important to note that the NHL classification accommodates a wide range of strength within each class.

(ii) Cement:lime:aggregate mortars are often used for work on the roofs of old buildings but great care must be taken to control the mix proportions on site to avoid the problems associated with excessive strength.

(iii) Pre-mixed lime mortars are available that minimize material handling and quality control problems on site. It is advisable to clarify with the manufacturer, though, whether any additives are present, as some will be unsuitable for conservation work.

(iv) The inclusion of well graded crushed limestone for, or as part, of the aggregate will aid moisture entrainment and carbonation, and enhance frost resistance.

(v) Where lime mortar is applied in thicknesses greater than 15 mm, the same principles should be followed as with external lime render, ie use more than one coat, incorporate hair in the first of these and ensure the aggregate is sufficiently coarse.

important in scantle slating because the slates are short and the gauging small, so their heads tend to be lifted away from the laths, especially in the upper courses. This makes them susceptible to wind-lift and this is overcome by bedding the tails of the slates, tipping the heads onto the lath.

Lime rather than cement was the binder for most roofing mortars before the early 20th century and is being used increasingly for this purpose again today. Roofs move under the influence of wind and temperature so it is essential to use a flexible bedding mortar to avoid cracking. Strong cement mortars (1:3 or 1:4 cement:aggregate) should be avoided because of their inherent rigidity and impermeability. They result in cracking and loss of adhesion. Old roofing slates (sometimes irreplaceable) are likely to be damaged beyond repair when later rebedding or relaying is necessary if they have previously been laid in cement mortar.

The recent resurgence of hydraulic limes in Britain, and their development and increased use in both conservation and new-build work, now makes it possible to use lime mortars which are durable in exposed conditions. Although historically mortars for bedding scantle slates may have been non-hydraulic or only weakly hydraulic, hydraulic lime mortars are more commonly specified today to give a speedier set and greater durability.

There is a wide variation of mixes using different strengths of hydraulic lime and varying proportions of aggregate. These need to be selected to suit local weather and building exposure conditions.

Due to the level of exposure to wind, rain and sun to which roofs are naturally subject, various levels of movement of slates are inevitable. The softer, richer and more flexible mortars (possibly also containing hair) are likely to cope best with movement, but the tougher and harder mortars with extreme exposure conditions. The type of lime and form in which it is used will also affect adhesion. Hydraulic lime is less 'sticky' than non-hydraulic lime. Lime may be included in the form of quicklime, lime putty or bagged dry hydrate. Generally, working from the

former to the latter of the three, the extent of adhesion and workability will be in descending order. Sources of information on mortar are given in Section 14.

Table 4 indicates typical lime-based mixes that can be used for work on old slate roofs in south-west England. It is not exhaustive. For example, hot lime is being increasingly used for roofing and should be considered where investigation of the roof indicates it was originally used successfully.

The aggregate should be a clean and well graded sharp sand with angular particles, which will bind well with the lime and leave minimal voids. The thickness of mortar beds for slating should be no more than 5 mm but may be due to the unevenness of some slate surfaces. Where thicker beds are unavoidable, it is important to keep the aggregate size sufficiently large to prevent cracking. The size of the largest aggregate particles should normally be about one-third of the mortar bed thickness.

The mortar should be mixed in a pan or drum mixer for a minimum of 30 minutes. Only mix sufficient quantities for immediate use unless trials have been carried out to show that they may safely be knocked up without the need to add further water. Non-hydraulic lime that is kept damp can usually be left overnight, as sometimes can certain weaker hydraulic limes. This is inadvisable, however, with NHL 5 and some NHL 3.5 limes.

The principle of mixing is to achieve a good dispersion of lime and other constituents with the dry sand before any water is added. Once the dry mix is fully dispersed water should be added slowly, allowing time for this to become fully mixed before deciding on the amount needed to achieve good workability. Bear in mind that too much water will decrease the mortar strength by holding the grains apart thus leaving an open structure when dry.

Protection of all new lime-work against the weather is almost always required. If possible, avoid working in the winter months when there is a risk of frost, because freezing and expansion of water can damage uncarbonated areas. To prevent this, layers of hessian or another insulating material must cover

the roof (leaving air gaps). The use of anti-freezing agents in mortars is not recommended.

Rapid drying of the mortar by the wind or sun will produce a light-coloured surface with an increase in the deposition of lime binder and risk of cracking and powdering; when this occurs the work will have to be redone. All lime mortars must harden in the presence of moisture. Covering with polythene over damp hessian will provide a microclimate that encourages carbonation. A fine mist spray applied daily for a minimum of four weeks where this is practical is also beneficial.

8 Specifications and detailing

8.1 Slating specifications

Specifications should include the materials to be used, methods to be applied and the detailing of local areas such as eaves hips and valleys etc.

All slating should be specified and constructed to provide adequate head, side and shoulder laps to resist driving rain and be fixed to resist wind uplift. The different slating systems achieve these objectives in different ways. These are explained below.

Slates should be laid without gaps underneath them. For single sized (tally) slates this is done by sorting them into sets of equal thickness and laying them with the thickest at the eaves grading down to the thinnest at the ridge. This is not possible for random sized slates because they have to be positioned on the slope where their length dictates. Therefore they must be selected as they are laid to ensure adjacent slates are equally thick. For wet-laid scantles the mortar bedding takes up any variation.

All random slating should be set out to provide the required head lap by using one of the gauging systems described in sections 3, 5.4 and 9-11.

There is little reason for variation in the general slating. The gauging rules are normally applied consistently to all slopes unless there are different pitches across an intersection such as a hip or a close mitred valley. In this case the margins are sometimes coursed across

the pitch change. To do this the gauging is worked out on the lowest pitch and then the lines of the tails are struck across to the steep side and slates long enough to provide the lap over four courses are selected for each course and the laths fixed to suit (Figure 14). This can also be worked out by calculation or with a scale drawing.

8.2 Eaves

The slating should overhang at the eaves to discharge water into the gutter where there is one or well away from the wall if not. A tilt (springing) must be provided to lift the tail of the under eaves slates to ensure the subsequent courses lie tightly onto each (Figure 15). This is done either by fixing a tilting fillet, by raising a fascia board or, if the rafter is set back on the wallhead, by packing up the masonry. Eaves slates are vulnerable to wind uplift and in exposed locations may need additional nailing near their tails. If rafters extend beyond the wall, the slating can be protected by soffit boards.

A variation seen across all three counties is to form the eaves with one or two courses of rag slates, known as mounters or prickers, nailed to rafters. These are more resistant to wind lift and, where there is no gutter, they discharge water well beyond the wall without the need to use a sprocket to carry smaller slates (Figure 16)

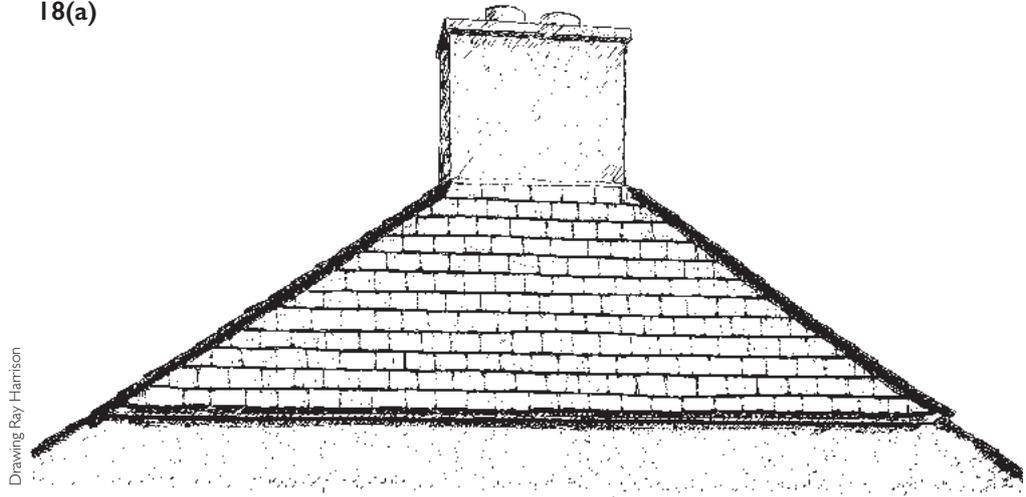
Eaves are usually formed with one course of undereaves slates but sometimes with two. If wet-laid, the mortar bedding is either reduced in width or omitted between the under eaves and the eaves course (Figure 17).

8.3 Verges

Verge (windspur) slating is finished with a slight overhang to the gable wall or slate cladding and a mortar fillet under the slates; over a barge board or an external rafter; or abutting a coping (Figures 18). The slating is often raised slightly to direct water back onto the roof slope.

Verges are very susceptible to wind damage. Localised techniques to overcome this include using large (rag) slates spanning two or three courses of scantle slates (Figure 17), bedding bricks

18(a)

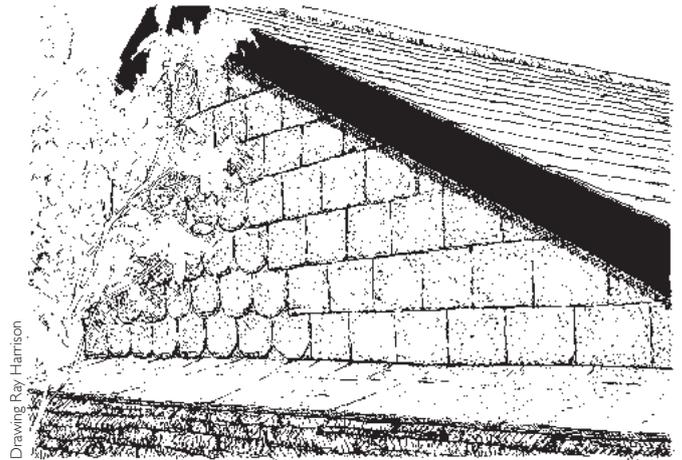


Drawing Ray Harrison

18 Verge or windspur slating can be finished in a variety of ways:
 (a) with a slight overhang to the gable wall or cladding and a mortar fillet under the slates (Marazion);
 (b and c) over a barge board or an external rafter (Carnglaze & Dunster) or
 (d) abutting a coping (Gwithian).

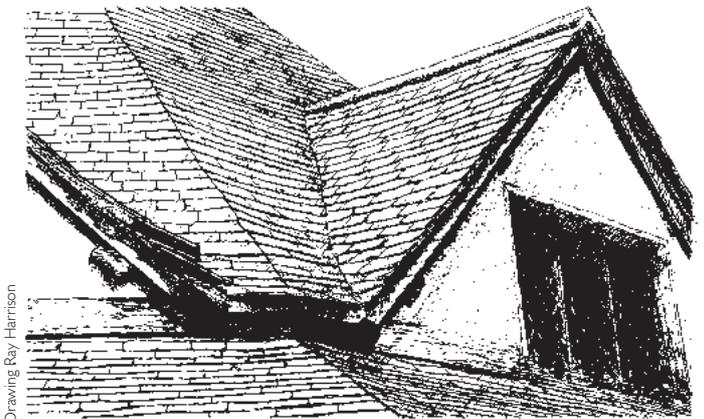
19 In wind-exposed areas verge slates are often held down with coping stones or bricks bedded in mortar (St Ives).

18(b)



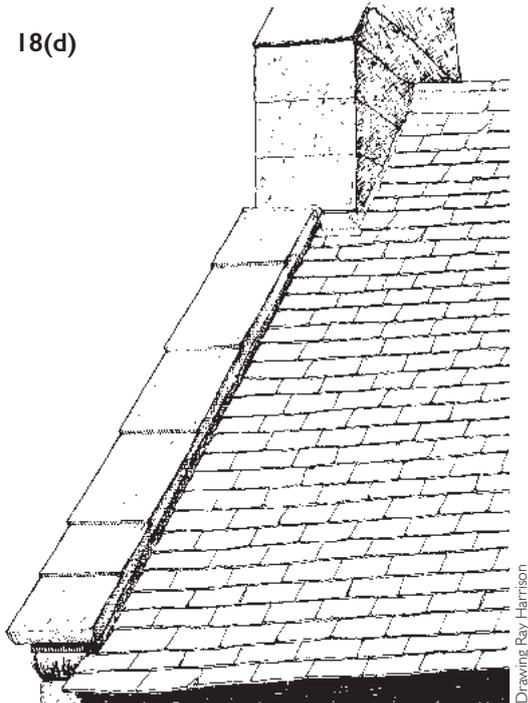
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18(c)



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18(d)



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19

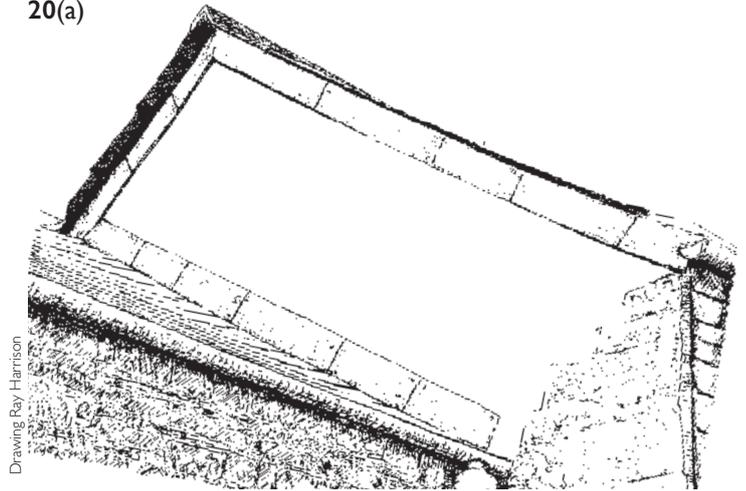


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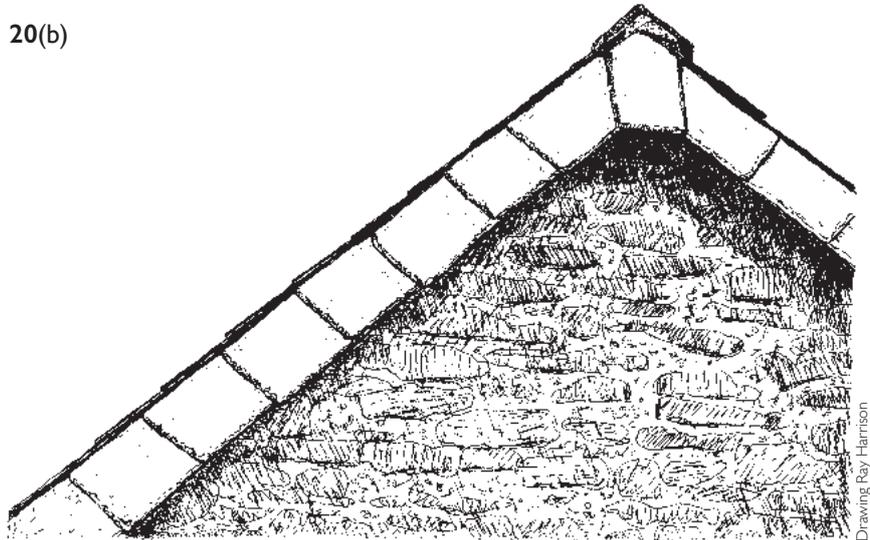
20 Where there are external rafters they, and any exposed purlin ends, are often protected with slates known as scrips. These are either:

- (a) butted up with the nails exposed (Bridestow) and Figure 23 or
- (b) overlapped to cover them (near Dartmouth).
- (c) Scrips are often used as a decorative detail (Near Marazion).

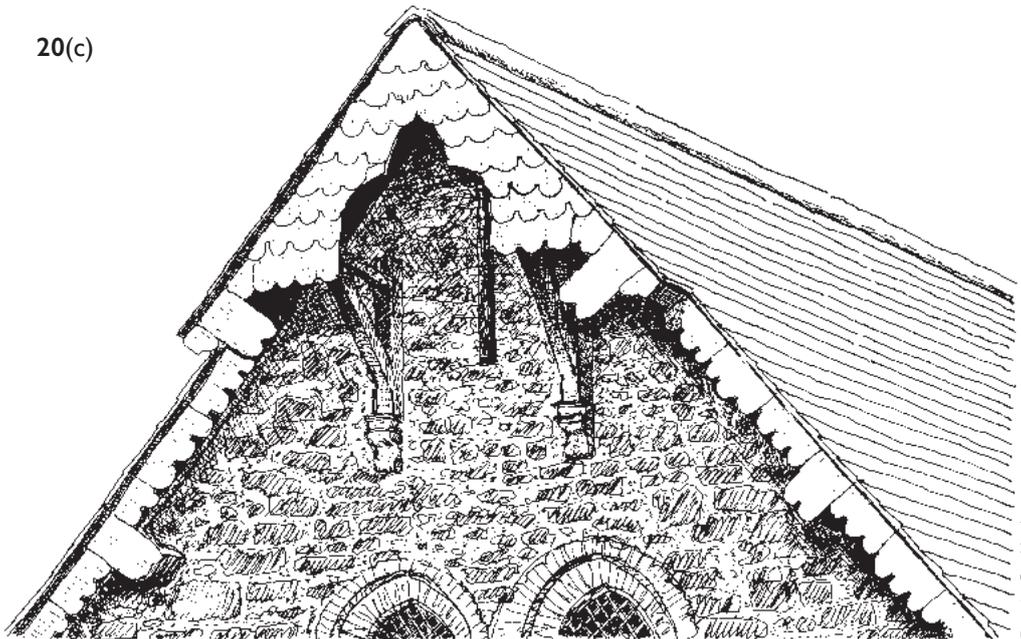
20(a)



20(b)



20(c)



or stones onto the slates (Figure 19) or fixing a verge board over the slates¹⁸.

Where there are external rafters they, and any exposed purlin ends, are often protected with slates known in some areas as scrips (Figure 20) and are sometimes decoratively shaped (Figure 20). They are either butted end to end with the nails exposed or covered with a mortar fillet, or they are overlapped by about one-third to protect the nails.

Where two or three courses of scantle slates are laid up to a rag slate verge, they are selected to have a combined thickness equal to the rag slate.

8.4 Abutments

The junction between the slating and abutting walls and chimneys can be difficult to make water tight. Historically, they did not include soakers and relied on mortar fillets (flaunches) (Figure 21(a)) or slates bedded in mortar and nailed onto the wall to prevent water penetration (Figure 21(b)). These were often protected by droppers (feathers) (Figures 21(c)) and the slating might be tilted slightly by raising the last rafter or packing the laths to direct water away from the junction (Figure 21(d)). It is possible to conserve the appearance of abutments but to include concealed lead soakers. These and cover flashings became common once lead became economical, but the latter can be visually intrusive and mortar flaunchings are preferred. Nonetheless the flaunchings can be problematical as they often crack and leak. To reduce this pieces of slate were bedded into the mortar. When renewing fillets the risk of cracking can be reduced by avoiding hard mortar, separating it from the slating and incorporating stainless steel mesh screwed to the masonry joints (Figure 22).

8.5 Ridges

The earliest ridges were finished by carrying the windward side slates above the opposite slope or with wrestlers (Figure 23(a)). During the 19th century Patent slate ridges and hips were made at Delabole quarry and these are occasionally still in place (Figure 23(b)). New pieces to replace any broken parts

can be manufactured to order. More commonly ridges are covered with clay ridge tiles or crests (creces) which are sometimes decorative (Figure 23(c)). They should be back-bedded in mortar which should not show at the long edges as far as possible and not be pointed.

Where dormer ridges run into the main slating they are either swept up into the main slope or the junction is weathered with a lead saddle (Figure 24).

8.6 Hips

Before lead and ridge tiles became commonly available hip slates were mitred and bedded with clay or mortar, sometimes with a mortar roll (Figure 25(a)). Some unusual techniques have been used to try to protect the open joint, for example, by extending the slates beyond the arris on one side and butting the opposite slate tight up under it. Elsewhere hips were in effect swept so that the joint was covered and lapped (Figure 25(b)). Today the mitre is normally weathered with lead soakers and if the adjacent slopes have unequal pitches it is good practice to adjust the gauging and hence the margins so that they course across the hip (Figure 14). Cut slates on mitred hips are vulnerable to wind damage so to reduce this risk wider slates are selected for the raking cut (Figure 25(c)). An alternative wind-resistant option is to use clay or slate ridge tiles or cast *in situ* concrete but this can spoil the slates for re-use in the future (Figure 25(d)).

8.7 Valleys

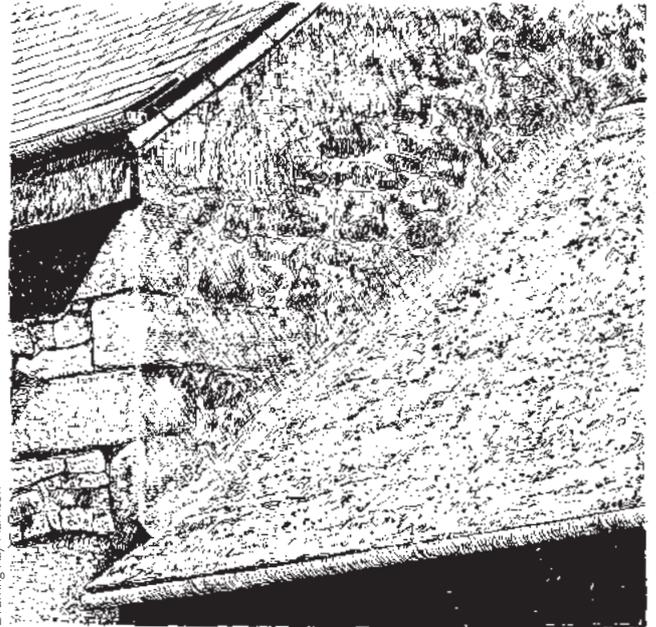
The difficulty of making a watertight valley has been tackled with ingenuity, especially before the ready availability of lead for soakers. Various methods relying on slates laid up the centre of the valley, sometimes bedded in clay or mortar, have been used in the past and these add to the character of the building. There is no reason why they cannot be replicated and if their effectiveness is in doubt lead soakers can be unobtrusively interleaved in each course. On an old roof this is far preferable to an open lead valley. Examples include swept, sometimes with a very wide sweep, and collar and tie (Figure 26(a-c)).

21 Historically, abutments did not include soakers and relied on a variety of techniques to prevent leaks. The junction with a wall or coping could be protected with:

- (a) a mortar fillet but these are prone to crack (St Erth)
- (b) sealing slates to the wall with mortar and nailing in place (Bridestow)
- (c) slates laid in the wall (crow steps) to provide an overhang to throw water away from the abutment (Marazion)
- (d) tilting the slating away from the junction by raising the last rafter (St Erth).

22 To help prevent fillets cracking slates, known as listings in some regions, were bedded into the mortar. A modern alternative is to reinforce the mortar with stainless steel expanded metal and to separate it from the slating with a temporary board. This allows the wall and roof to move independently without stressing the flaunch.

21(a)



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21(c)



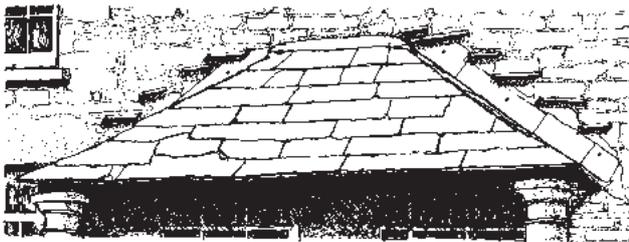
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21(d)



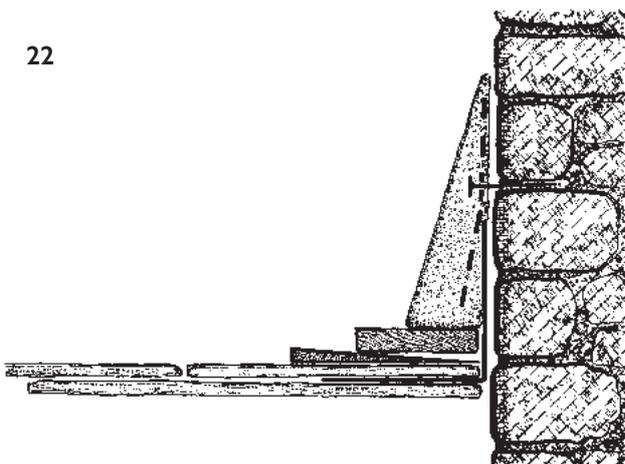
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21(b)



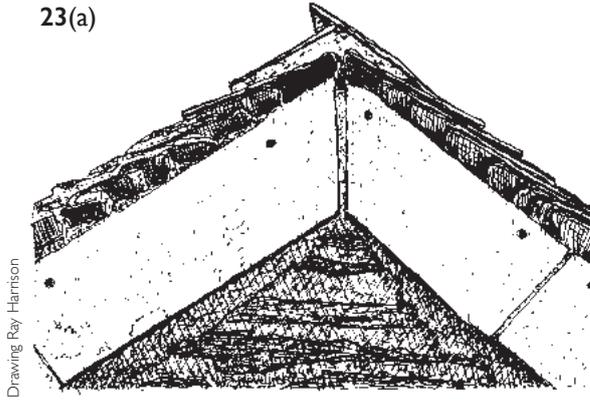
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22

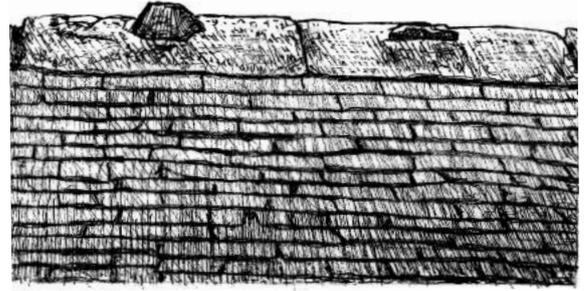


Drawing Ray Harrison

23(a)



Drawing Ray Harrison



23 Ridges

(a) Before the use of clay ridge tiles became common the ridge slating was usually closed with overlapping or interlocked slates. (wrestlers). The overlap would face away from the prevailing wind (Tintagel).

(b) Ridges could also be formed with patented wing and roll slates screwed to the rafters. These were made in two or three parts: A combined wing and roll or two wings and a separate roll.

(c) Eventually clay ridge tiles became almost ubiquitous. Often with a decorative crest (Trevarno).

24 The ridge of a dormer can be formed with a lead saddle or swept up into the main slating.

Davey's Patent Slate Ridges and Hips.

Manufactured and sold by Mr J Carter Agent to the Patentee.

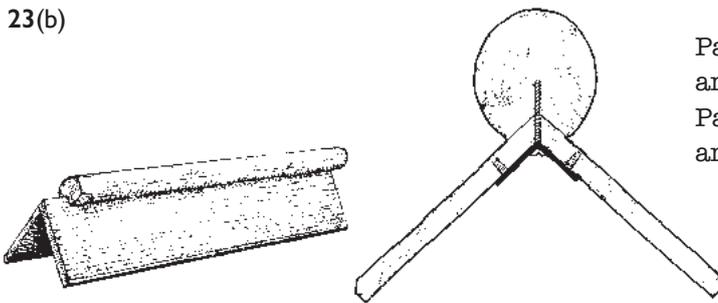
Old Delabole Slate Quarries, Near Camelford, Cornwall.

The ridges consist of three pieces of slate, viz. two sides and a roll as shown. The roll is perfectly round, presenting a bold appearance, and being made in the strongest way of the slate, is reckoned superior to any other. They may be had in separate pieces, or united in one solid piece, in length from 4 to 6 feet, the roll of each length projecting 1 1/4 inch over the sides of the adjoining length, and to any given angle.

When placed on the roof in separate pieces, the sides can be nailed or screwed to the batten, and the roll bedded upon them in blue putty, and if found necessary a screw put through the ridge piece. When united they need only to be placed on the roof like a common tile.

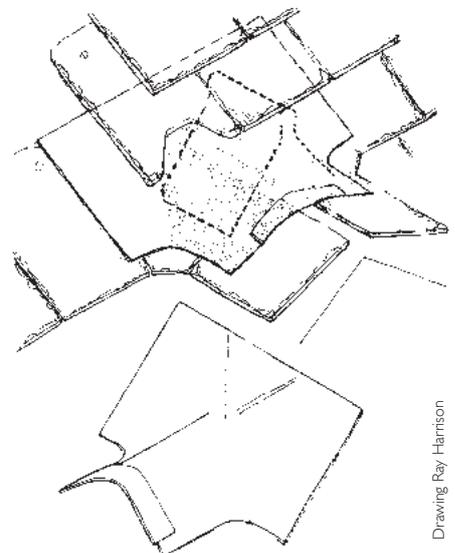
Parties if they wish it, may buy them in separate pieces and unite them themselves after the manner of the Patentee, with metal angular plates screwed to the roll and the sides underneath as shown.

23(b)



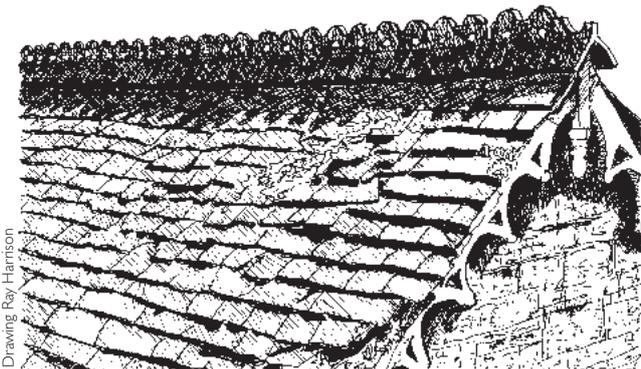
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24



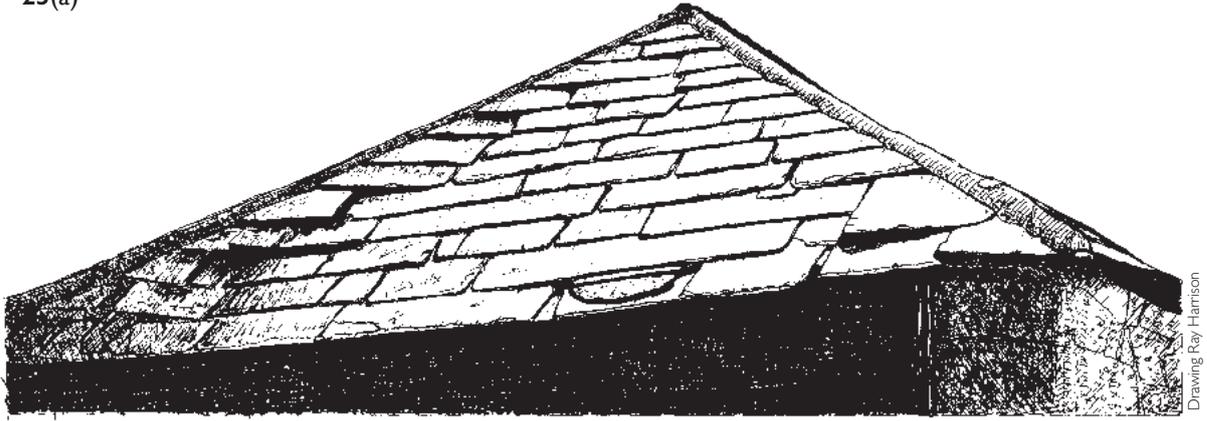
Drawing Ray Harrison

23(c)



Drawing Ray Harrison

25(a)



Drawing Ray Harrison

25 Like ridges, hips only carry a modest amount of rain which naturally drains away from them so sealing the junction is less onerous than for valleys. They are, however, very susceptible to wind and need to be securely fixed:

(a) Although today they would normally be soaked, historically the slates were simply bedded in clay, mortar or a mastic or putty (St Maby)

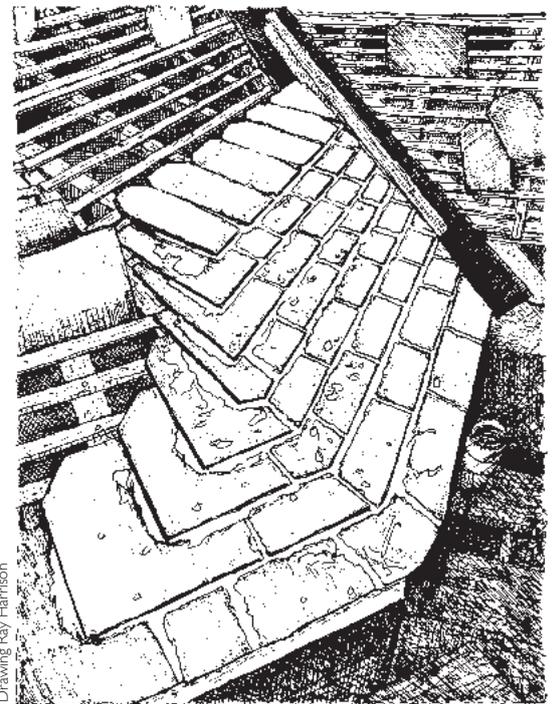
(b) The vulnerable hip junction was sometimes protected by forming a sort of roll hip with slates in alternate courses laid across the joint and cut to align with the slate courses

(c) To improve the wind resistance the hip was often made with larger slates selected from the stock (Tintagel)

Covering the hip with a tile or with slates like Davey's Patent ridge allows smaller slates to be used

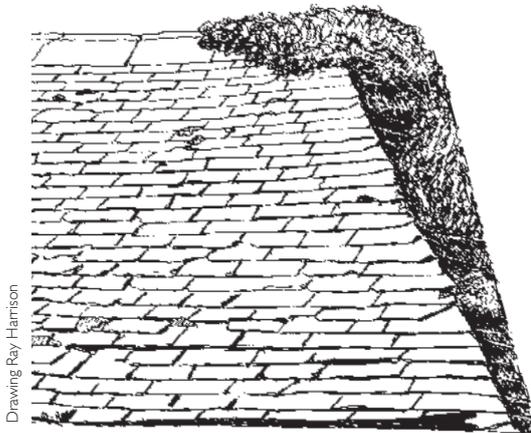
(d) In many areas the most commonly seen hip is concrete cast *in situ* but these have only come into use since cement became generally available (St Ives).

25(b)



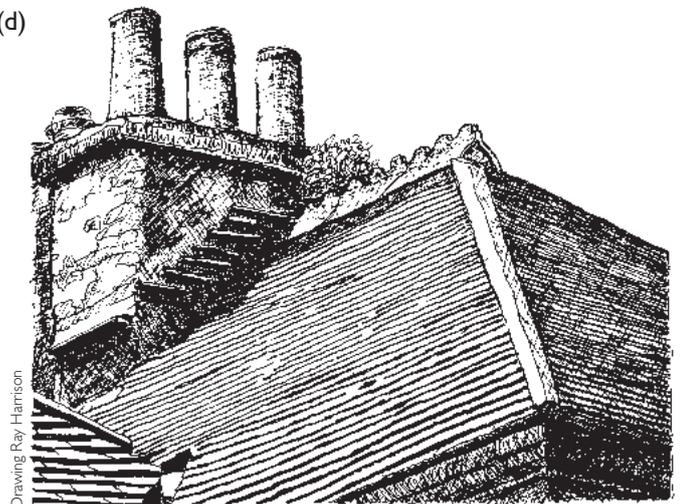
Drawing Ray Harrison

25(c)



Drawing Ray Harrison

25(d)



Drawing Ray Harrison

There are many subtleties in the way valleys are constructed. Some, for example, slightly raise the slating at the valley to turn water away from the junction. Information and videos of valley construction can be seen at www.stoneroof.org.uk/historic/Historic_Roofs/Introduction.html

8.8 Dormers and rooflights

Within the region the position of dormer windows can be below, through or above the eaves or wholly within the roof slope (Figures 27(a-c)). Most commonly the cheeks are slate clad or covered with single slate panels with soakers at the junction with the roof slope (Figure 27(b)). It is not uncommon for them to be glazed (Figure 27(c)). Before the general adoption of lead saddles, ridges were swept up into the main slating.

Rooflights are an alternative to dormers and being much cheaper to install are common on industrial, farm and similar buildings. They are an important feature of many farm buildings but are usually quite small. In their simplest forms a sheet of glass is substituted for a slate or is inserted into the slope and the slating overlaid (Figure 28(a)). Where the extra cost was acceptable cast iron lights are used (Figure 28(b)). The scale of the rooflights in relation to the roof slope is an important consideration in roof renewal.

8.9 Torching

Torching stabilises the slate heads and pegs; closes the roof against draughts and powdery snow blowing into the roof, and conserves the historic appearance of the roof from the inside. It should never be omitted from any repair work unless underlay is installed.

It is applied to the underside of the slates and may be a single, thrown coat of lime mortar which has been left rough and not troweled. On small, scantle slates it may be applied just to the top of the slates or cover their backs completely between the laths and, if a second coat is applied, this may be troweled or floated as the background of laths and pegs will be sufficiently covered to allow this. It is very important that torching is not forced too far down between the slates to avoid

drawing water to the laths and rafters.

Both domestic and agricultural buildings are found with two-coat work, which indicates its importance. It became more common in houses when roof spaces were adapted for home workshops. In shippons or cow houses it was used because cattle will not tolerate drips.

8.10 Farm buildings

These tend to remain unaltered for long periods and are often the best source of information on early roof structures and slating techniques. Their detailing is less elaborate than domestic buildings and this should be respected in repairs. Verges and eaves often have little overhang and gutters are seldom included. Lighting for storage areas or livestock was not important so it was often provided by replacing a few slates with glass or by installing small cast iron rooflights rather than dormer windows (Figure 28). Good ventilation is important for livestock but this was usually provided by openings in walls rather than roofs or by raising a few ridge tiles.

9 Scantle slating

9.1 The scantle process

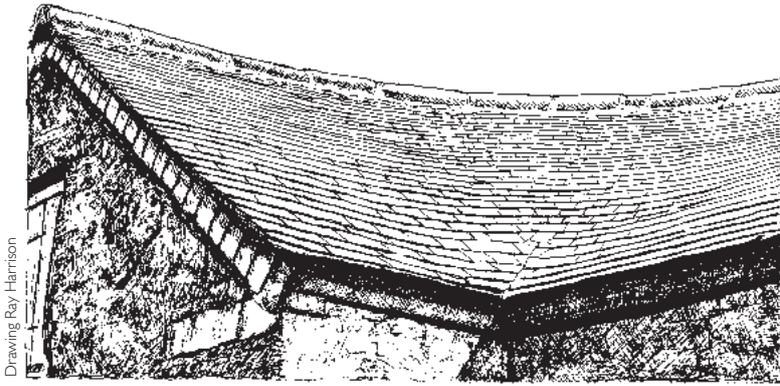
This involves four main steps: making a scantle stick; preparing the slates; setting out (gauging) the roof; and fixing the slates. If lime mortar is to be used, this is made well in advance of the slating work - historically by as much as three months - when the building foundations were being dug.

A scantle stick is prepared by marking on a set of slate lengths and then a set of lath gauges using the appropriate divisor (Figure 3). This will be three for slating in thirds; three-and-a-half for wet or dry-laid scantle roofs and usually two-and-a-half for cladding. It is possible, although not necessarily any more convenient, to work out the gauging by calculation.

9.2 Preparation

New, and if appropriate reclaimed,

26(a)



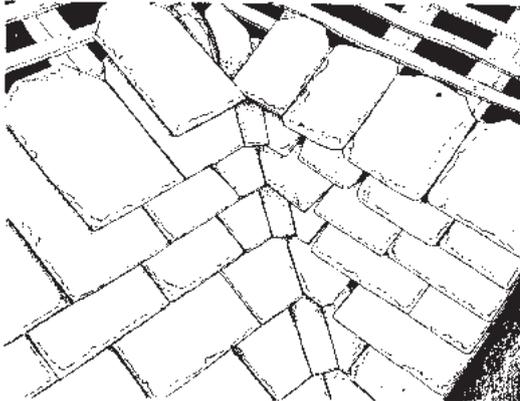
Drawing Ray Harrison



Drawing Ray Harrison

26(c)

26(b)



Drawing Ray Harrison

26 The difficulty of making a watertight valley has been tackled with ingenuity, especially before the ready availability of lead for soakers. Various methods relying on slates laid up the centre of the valley sometimes bedded in clay or mortar have been used in the past and these add to the character of the building.

Examples of traditional valleys include:

- (a) swept, sometimes with a very wide sweep, and
- (b) collar and tie in Devon and
- (c) in Cornwall.

27(a)



Drawing Ray Harrison

27 Dormers make a strong statement in the roof and can be placed through or immediately above the eaves or entirely within the roof slope.

Variations include their own roof type:

- (a) gabled
- (b and c) hipped
- or monopitched.

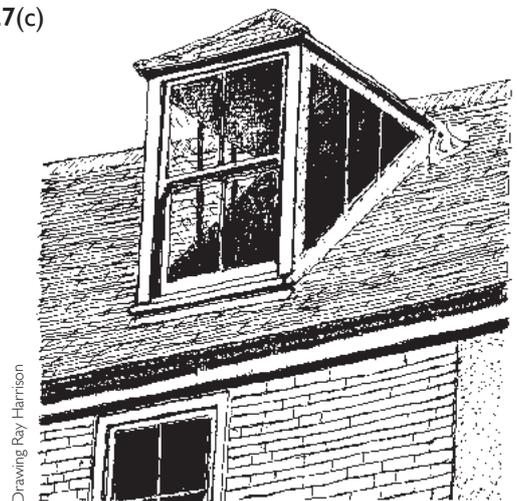
The cheeks may be boarded, clad with roofing slates (b), single slate panels or glazed (c).

27(b)



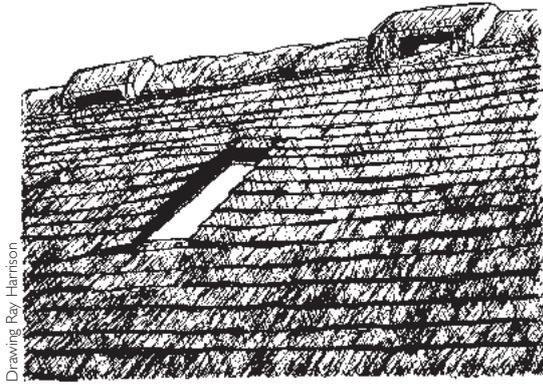
Drawing Ray Harrison

27(c)

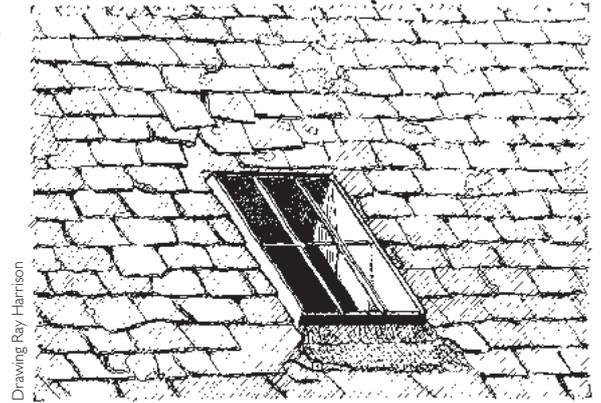


Drawing Ray Harrison

28(a)



28(b)



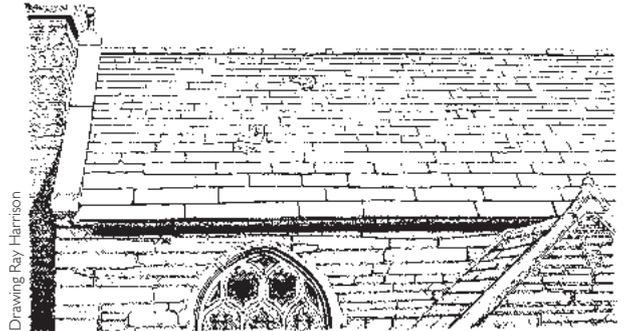
28 Rooflights are a cheap alternative to dormers. They are commonly seen on outbuildings and are important features of farm buildings. They are formed most simply by:

- (a) inserting a sheet of glass in the slope and laying the slates onto it or by replacing individual slates with glass.
- (b) On better quality work a cast iron light is installed.

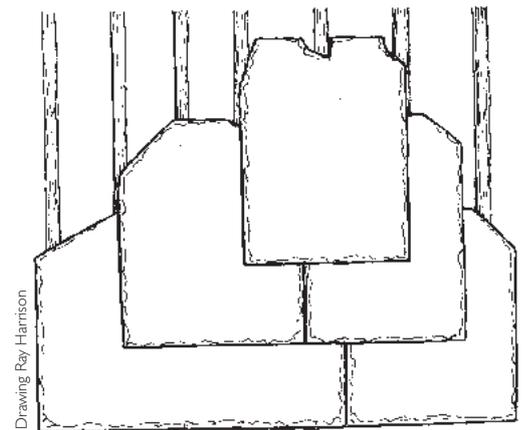
29 Rag slating

- (a) Rag lates are very wide partly because they the are laid at with what would normally be the length laid horizontally (St Maben)
- (b) The system is different from all other slate systems except Patent slating because the slates are fixed directly to the rafters. Consequently, they cannot be holed for fixing until they are offered up to the roof.
- (c) Also, they may need to be notched or shouldered to allow them to lie flat to the rafters.
- (d & e) They are not mortared expect for torching and this is usually applied only along the tops of the slates (Bodmin).

29(a)



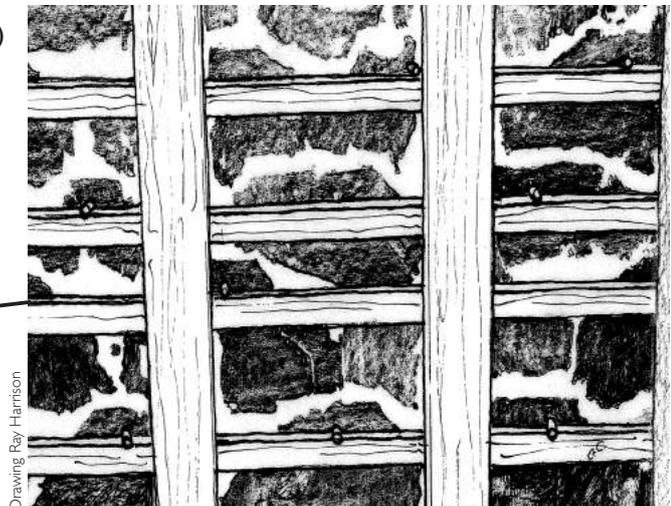
29(c)



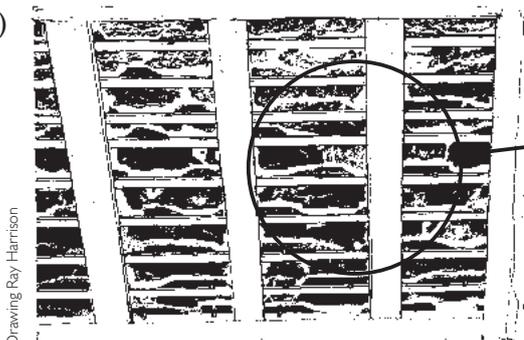
29(b)



29(e)



29(d)



slates are first holed about 25 mm (one inch) from the top and sorted into sets of equal length measured from the hole to the tail. The slates were traditionally numbered rather than using their lengths in inches for example, 1 equals 152 mm (six inches) long; 2 equals 178 mm (seven inches) etc, up to 9 equals 356 mm (fourteen inches). But there are other systems and some are numbered in reverse, that is, the lowest number is the longest slate. The total width is then measured or estimated for each length and these values are divided by the roof's width to give the number of courses available for each slate length. Left-over slates are added to the next shorter length. To cover slopes on both sides of a roof the slates might be sorted into odd and even number lengths or simply half the total applied to each side. If the slates are to be fixed with wooden pegs these are inserted before taking them up to the roof.

9.3 Gauging

The position for the first slate course is marked on a rafter at each side of the roof - at the verge, hips or any intervening valleys - and allowing the required eaves overhang. A similar mark is made for the appropriate length under-eaves slate. Then if a scantle stick is being used, the gauge for the longest slate is taken off the stick with a compass and the next course marked above the first. Each of the subsequent gauges are marked on the rafter. However, at each twist - the first course of shorter slates - the next gauging mark using the same compass setting is lowered by the difference in the slate lengths - usually but not always about 25 mm (one inch) - and marked with a letter T. This ensures that the tails of the shorter slates overlap the next but two slates below by the correct amount.

These two steps, marking the courses and then the twist course, are repeated for all the slates up to the ridge. A chalk line is then snapped across the rafters at each mark and the T of the twist courses written on each rafter. The laths or battens are then nailed below the lines and, if necessary, at the twist or near the ridge where the lath gauge is tight their width is reduced to make room for the pegs (Figure 13). An alternative method

involves marking the gauges onto two laths which are placed against the rafters on either side of the roof and the lath marks snapped onto the rafters.

9.4 Fixing the slates

The roof is first stacked out with the slates by their appropriate laths. They are then hung on the laths or nailed working one or several courses progressively across the roof and, if wet-laid, bedding them with the minimum of mortar - typically a 25 mm (one inch) bead. Each slate is selected and laid so that the perpendicular joints are approximately central over the slates below (Figure 6).

Sometimes the decision is taken to re-use top-fixed slates by centre nailing. In this case the slates' tops must be dressed off to avoid the risk of leaks through the old holes and the head lap and minimum width specified to take into account that the centre nailing renders the slates effectively 50 mm narrower.

10 Rag slating

10.1 The rag slating process

Slating with rags is different from almost all other slating systems in that the slates are nailed directly to the rafters and consequently there are no laths to use to gauge the roof or to work off. Sometimes rag slates are encountered fixed to battens but this is thought to not be original and will certainly be the case if there is underlay installed as well. The slating process involves three steps: sorting the slates by length; determining the number of courses of each length and fixing them on the roof.

The rafters on rag roofs are small - about 50 mm square - but set closer together than battened roofs, at about 300 mm (12 inch) centres. Rag slating is a double-lap system and although historically roofs would be gauged without calculations the normal method using $\text{gauge} = (\text{length} - \text{lap})/2$ applies. A head lap of 108 mm (four inches) is most common and given the width of the slates appears to be generous but it was probably adopted to be certain that there was enough lap (shoulder lap) at the

slates' ragged top corners.

10.2 Preparation

Rags slates are usually described as large but really their distinguishing feature is that they are very wide (Figure 29(a)). This is because they are generally laid with the longest dimension horizontal unlike normal slating. As a consequence their grain does not always run north-south in the slates. Slates are usually made with grain in this orientation in order to best resist the stresses they experience on the roof but rags do not break because their thickness combined with the inherent strength of the slate rock is adequate.

Rags are not holed before stacking the roof because it is not known where they will overlie the rafters and hence where they will be nailed. So they are only sorted into length sets and the number of courses for each determined before taking them to the roof. Typically they are sorted into seven sets from 610 to 305 mm (24 to 12 inches) long in about 50 mm (two inch) steps.

10.3 Gauging

This is done as work progresses. The eaves are set out as described below and then a line marking the tail of the next course is struck across each preceding course at a point giving the required head lap over the second course below (Figure 29(b)). At the first course of shorter slates the gauge is adjusted as normal to ensure evenly diminishing margins.

10.4 Fixing the slates

The slates are holed for nailing by offering them up to the rafters. The holes are positioned at any convenient point well above the slate below and, because of the difficulty of manipulating large slates, holing is normally done from the back to the bed, the opposite of the normal way. They are usually nailed to two rafters but it is not essential for each slate to rest on more than one rafter because the tails rest on the slates below. If they only overlie one rafter, to make them secure, they are fixed with two nails above each other.

As for all slating, the side lap

should be kept as large as possible.

This is normally done by setting the perpendicular joints about central over the slate below but with such wide slates the side-lap would still be adequate even if they were substantially offset so the normal central placing does not apply.

In practice the slater chooses a slate and determines its position to ensure there is adequate cover over the shoulders in the slates below. If particular slates would not give a generous side lap, a minimum of three inches (76.2 mm) was adopted.

Large rag slates inevitably tend to be a bit uneven or twisted which could cause kicking in overlying courses. To overcome this the heads were thinned, shouldered or notched to allow them to set down between the rafters (Figure 29(c)).

10.5 Eaves

The under-eaves and eaves slates are positioned to give the required eaves overhang – usually 50 or 75 mm (two or three inches). Generally, rag roofs do not have fascias or gutters so the overhang needs to cast water well away from the wall. The length of the under eaves-slate is the gauge plus the head lap.

10.6 Verges (windspur)

Most commonly verges are formed with a rafter at the outside face of the wall and the roofing slates carried over about 50 mm (two inches). The rafters and purlin ends are protected by scrip slates nailed on tightly under the roof slates as described in Section 8.3 (Figures 19 (a) and (b)) either butted end-to-end or overlapped. The joints between them and under the roofing are pointed with lime mortar.

10.7 Abutments, ridges, hips and valleys

These intersections are treated in the same way as is described for scantle slating. The main difference is that large slates are not as amenable to tight curves so hips and valleys are simply mitred. For security, wider slates would be selected from the bulk for cutting on the rakes. Most examples seen today are weathered with lead soakers, sometimes

with a mortar fillet along the joint, but it is likely that the earliest roofs – 17th century – would have been bedded onto mortar or clay. This would have had a good chance of being successful on hips where water flows away from the joint but on valleys they would be likely to leak or fail completely, needing early or frequent renewal.

10.8 Mortar

Rags roofs are not usually tail-bedded but may have been torched just along the slates' top edges (Figures 29 (d) and (e)). If rags have mortar at the tails or have been slurried they are most likely repairs to try to prevent the slates slipping when the nails are failing.

11 Patent slating

11.1 History

Although this single-lap system was patented by Charles Rawlinson of Lostwithiel in 1772, it appears to be rare in the region. It is seen as cladding in some towns including St Teath, Launceston and Tavistock, and hopefully, there are more to be identified. In spite of its apparent regional rarity, it is a nationally important technique and should always be conserved.

11.2 Construction

The construction illustrated in Figure 30 is from Rawlinson's patent. The slates overlap vertically but only butt up against each other laterally. The consequent open perpendicular joints are weathered with slate cover strips and glazier's putty or similar material. It relies entirely on the headlap and the bedding material at the butt joints to be effective. Where it is used as roofing it is always the deterioration of the bedding which results in leaks but this should not be accepted as a reason to change to another slating system. Failed bedding can be satisfactorily replaced with modern seals or sealants¹⁹.

11.3 Durability

A Patent roof's durability is as long as that of the slates and normally these roofs only need repairs when the seals or bedding fail.

Roof pitches are usually low and because the slates appear to be strong there is a temptation to walk on them for inspections or to look for deteriorated bedding. But, because the spans are large - about a metre, this is the most common cause of cracked slabs. Roof ladders or similar means of spreading the load should always be used.

Provided the slates are not walked on without spreading the load they can be carefully removed and reused. Any losses can be made up with new slates and a flexible mastic with a matching expansion coefficient to slate or a sealing system should be used to reseal the joints.

Used as cladding, the bedding's deterioration is unlikely to lead to discernible leaks and seldom needs repairs until any iron fixings fail.

11.4 Preparation and gauging

The slates are all the same size and nominally the same thickness so they do not need to be sorted. Any thickness variation, and consequent gaps under the cover strips, are accommodated by the putty.

Gauging is done in the same way as rag slating - striking head lap lines on each course as work progresses - or by striking lines across the rafters for positioning the slates' top edges.

11.5 Fixing the slates

A variety of wooden pegs, nails - including lead nails, and screws have been used to fix the slates and cover strips into the supporting structure.

Once in place the slates are drilled for the fixing holes and the fixings applied. If lead nails are used they are inserted and wrapped around the rafter from below. The lateral gap between the slates is filled with glaziers putty or a modern equivalent and a bedding strip applied where the next course will overlap. This can be in short, staggered lengths to create gaps for ventilation from the rafter space.

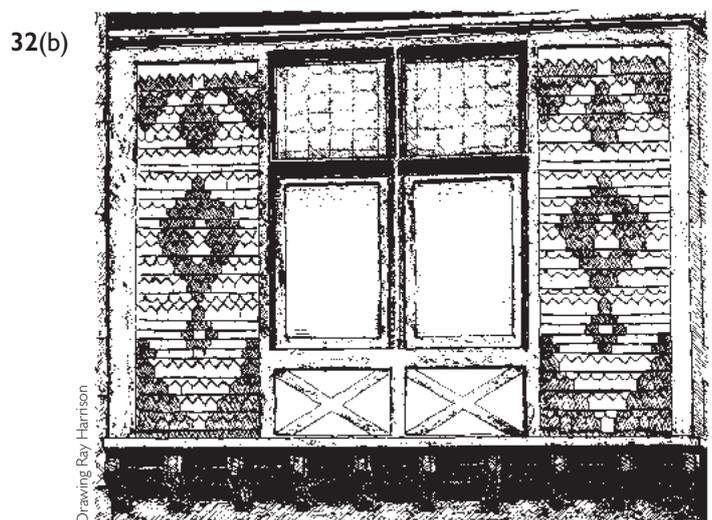
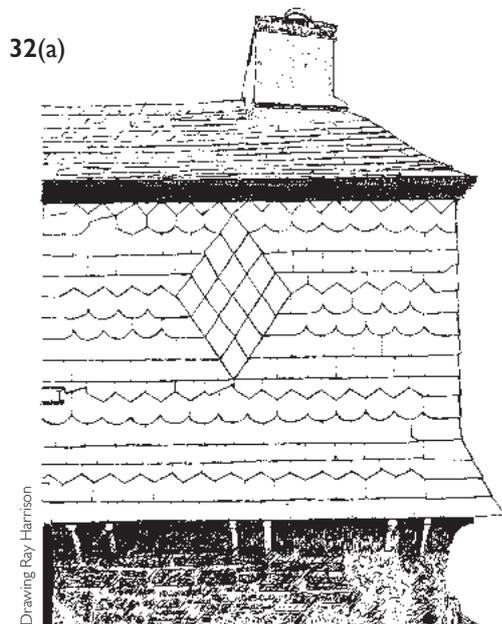
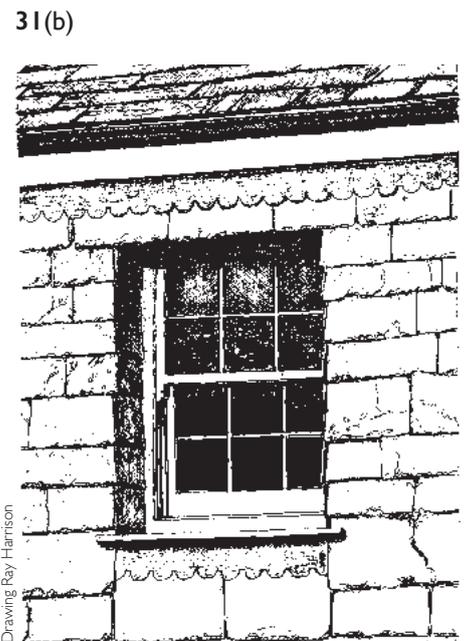
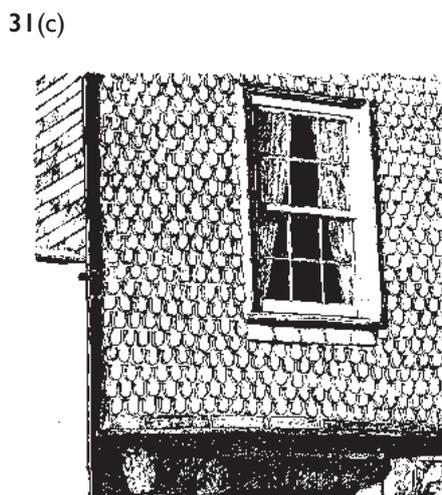
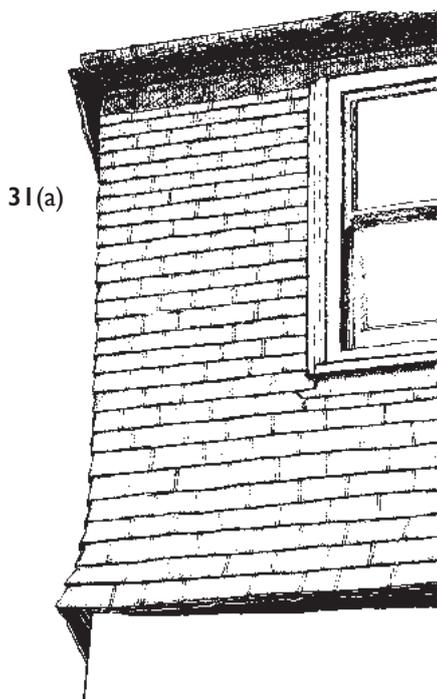
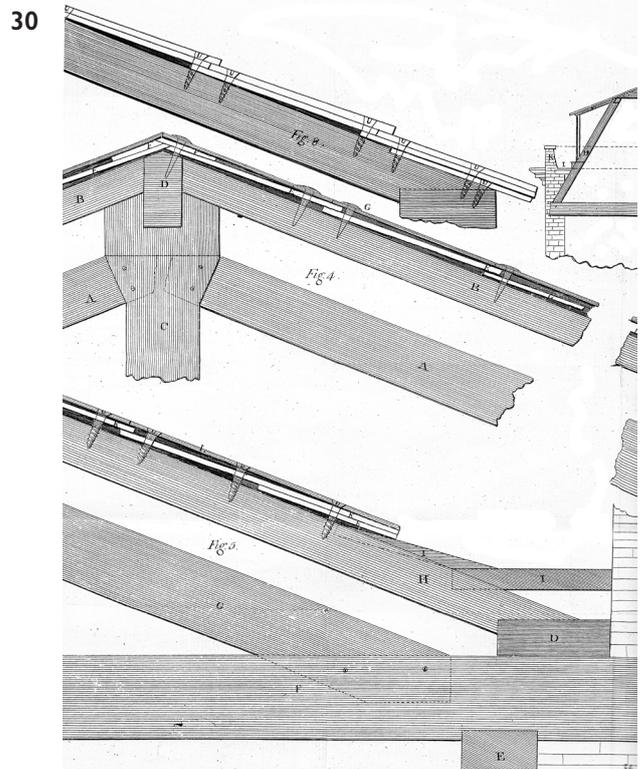
30 Rawlinson's Patent slating system seems to be rare in the region but is nationally important and should be conserved.

31 Slate-cladding is common on wind- and rain-exposed walls especially on timber-framed upper stories where the lower storey is stone:

- (a) The bottom courses are always given a good kick to throw water away from the foundations (St Ives). Various methods are used to finish the slating around windows with:
- (b) an architrave (Ashburton) or
- (c) the slating returned into the reveal (St Mabyn).

32 Cladding has often provided an opportunity for decoration:

- (a) using shaped slates (Bridestow) or
- (b) a mix of colours (Dartmouth).



Once all the slates are in place the cover strips are similarly fixed with putty or seals.

12 Wall cladding

12.1 Application

Slate cladding is common on wind- and rain-exposed walls throughout the region especially on timber-framed upper storeys where the lower storey is stone (Figure 31). Many examples were not original features of the building but were added to alleviate damp walls.

12.2 Ground work

The slates are fixed directly to mortar render or to laths or battens which in turn are nailed directly into the mortar joints, or into the masonry itself if it is soft like mudstone or shillet or to counter-battens nailed to the wall. Historically, wrought iron nails were used for batten or counter-batten fixing which held well when they rusted but eventually corroded away or failed due to rust-jacking.

12.3 Fixing

The slates are pegged or nailed directly to the mortar or to the battens and bedded in mortar. The slates are usually laid closely together laterally but are sometimes spaced out to promote air circulation behind them. They can be laid with the bevel edge inward facing to provide a better key to the mortar or as normal, bevel outwards. Mortar for direct fixing is laid in two coats. The first is allowed to set, the second is then laid and the slates pressed into and pegged or nailed into the first coat. The mortar mix is critically important to ensure good wind resistance²⁰.

12.4 Details

The eaves are given a large kick (springing) to cast water well away from the lower wall and to allow the slates in successive courses to sit tightly together (Figure 31(a)). Historically, the slates at external angles were not soaked but were carried slightly beyond the opposite

face. Soakers should be used today.

Around windows the cladding is butted up to an architrave or, if the window is deeply set into the walls, the cladding is returned on the reveal (Figures 31(a) and (b)).

Cladding has often been used as an opportunity for decoration using shaped or coloured slates (Figures 32(a) and (b)).

13 Maintenance

13.1 Deterioration

Slate roof deterioration is usually a long-term process and even though repairs can be carried out for many years routine maintenance will significantly delay the need to strip and re-slate. The key is to check often - perhaps twice a year, inside and out if at all possible - and to act quickly. An unattended leak can result in timber rotting or other fabric damage which will seriously exceed the cost of repairs. It is particularly important to keep rainwater gutters - especially horizontal lead gutters - and downpipes clear of debris.

Insulation is also a potential source of dampness because it can cause moist air to condense onto woodwork so it should not be assumed that dampness always indicates a slating problem.

13.2 Repairs

Missing slipped or broken slates should be replaced as soon as possible. If they are pegged it will probably be possible to lift or rotate adjacent slates to slide a new slate of similar thickness into place. However, this will break any torching so this should be replaced as well. If the slates are nailed then a slater's ripper should be used to cut or drag out the nail. The replacement can be fixed with a hook, copper tingle or peg. For repairs to large areas a triangle of slates should be stripped so that all except the apex can be refixed with pegs or nails and only the top one(s) will need a tingle or similar fixing. For a temporary (emergency) repair single slates can be simply bedded in lime mortar but a proper repair should be done as soon as practicable.

13.3 Mortar

Where long established mortar bedding is crumbling or falling away it can be repointed but this is usually only a temporary reprieve as the lath nails are probably failing as well and repointing places more stress on them.

Slurrying roofs is a policy of last resort. Although it is traditional in the region it is not a good technique because it can eventually cause the complete failure of the roof with collapsed battens and rotting of the structure and far more cost to repair than reslating. When the battens fail large areas of slating will slip forming riffles (Figure 11). At this point the roof will be beyond practical repair and should be stripped and reslated.

Fallen torching should be renewed because it holds pegs in place, helps prevent slates being lifted by high winds and protects laths from water damage. Ridge and hip tiles may need re-bedding and if the bed is not exposed along the edges an NHL 3.5 mortar is suitable. Where it is exposed it will need to be stronger NHL 5, for example, or the NHL 3.5 bedding mix can be pointed up.

13.4 Bi-annual checklist

- Internally check for water-staining or other signs of leaks. These may be much lower on the roof than the leak.
- Clear gutters and downpipes, pitched and horizontal valleys and secret gutters.
- Replace slipped, broken or missing slates.
- Check if ridges and hips are secure.
- Check leadwork – look for wrinkles and cracks, cuts from slipped slates and flashings coming out of chases.
- Are mortar beds, fillets or faunchings cracking or insecure?
- Are roof penetrations such as for solar panels leaking?
- Ensure insulation is not blocking ventilation routes for example at the eaves or ridge.

size (tally) slates is available in BS 5534 Code of Practice for Slating and Tiling and the Construction Industry Training Board manual CTP 036/6.

2 Common slating is distinct from the externally similar technique of Three-and-a-half-pin scantle slating with mounters at the eaves and often with large verge slates. “They were sold by the thousand with forty two small rags called pricklers for the eaves.” John Jenkins 1888 Delabole slate quarry: a sketch by a workman on the quarry.

3 Blue slates at the quarry, 3s. 6d. per thousand; for the ordinary rough undressed slates, great and small; running from 4 to 12 inches wide and 8 to 18 inches long, when dressed. The large eaves slates – provincially rags – some of them two feet square, when dressed, are sold at 2s. 6d. a dozen; rough at the quarry.

The price of dressing, or cutting slates into the required form, is 20d a thousand. The entire workmanship, of dressing, pinning, pins, laying on in mortar, is 6s. a square of 100 square feet: without pins, 5s. 6d. per square.

A square of slate roofing takes about a thousand slates.

Oak Timber – 15d. a foot

Ash timber – 1s. to 14d. a foot

Lime – 5d. a bushel

Mason’s wages – 18d. a day, and a quart of cider.

Carpenter’s wages - the same.

Marshall, W, (1796) *The rural economy of the West of England including Devonshire and parts of Somersetshire, Dorsetshire and Cornwall*, vol 1, London, Nicol.

4 Scantles. Small pieces made from the trimmings of slate, not dressed, used in Cornwall.

Richardson, C S, (1854) *The Slate Quarries of Vermont in The Mining Magazine*, New York, Vol 2, pp271-282.

5 With respect to roofing slates, there are many quarries in the district, generally supplying their immediate neighbourhood, and which are rarely exported, with the exception of the Delabole and other slates near Tintagel. In the northern grauwacke there are

14 Notes and references

1 Technical guidance on fixing single

scarcely any of importance; some slates are, indeed, raised near Treborough, but the quantity is not considerable. Slates are worked in the carbonaceous series at Ashbrittle, on the north, and in the same series near Coryton and Launceston, on the south; the chief quarries, in the vicinity of Launceston, being near Newchurch farm, Tresmarrow and on the south of Bad Ash. Slates are also raised in the range of the latter beds on the west. There is much roofing slate in the grauwauke ranging round the southern part of Dartmoor. There are quarries at Ingsdon, near Bickington; at East Down, between Ogwell and Ashburton; at Bulland, on the south of the latter place; near Wash, on the east of Buckfastleigh; at Bow, on the north of Staverton; at Tigley and Moor, near Rattery; at Porter Bridge, near Harberton Ford; at Brixham; at Wood and Ludbrooke, near Ugborough; at Cann Quarry, near Boringdon Park (to which a canal has been made up the Plym), and extensive works have been carried on; at Leigham, on the east of Egg Buckland; and at Mill Hill, near Tavistock. There are slate-quarries in Cornwall, at Hay, near Callington; at Kerney Bridge, on the south of Linkinghorne; at St. Neott's; at Newport, near Morgan; at Penquean, near Wade Bridge; and, at a few other minor places. The great Cornish quarries are at present those of Delabole, and the vicinity of Tintagel; including a large one on the sanding road between Penpethey and Pentafridle. de la Beche, H, (1839) *Report on the Geology of Devon and Cornwall and West Somerset*, London, Longman, pp 502-503.

Grauwacke is a variety of sandstone composed of poorly sorted angular mineral grains in a compact fine grained matrix.

6 An extensive list of local newspapers including articles on slate quarries can be seen at Exeter University on <http://projects.exeter.ac.uk/mhn/Newspapers2008.htm>

7 Shipments to Kidwelly in South Wales are recorded in 1478-79 and 1480-81. '... stones called slates, cost 20d. per thousand and payment for carriage of the said 10000 stones from Ilfracombe to

Kidwelly price per thousand 12d. - 26s. 8d.' and 'payment for 10000 stones called slatstone bought at Ilfracombe price per thousand 20d. - 16s. 8d.' National Archives Duchy of Lancaster accounts DL 29/584/9251 and DL 29/584/9253.

8 '... the Devonian strata in north Devon and Somerset have afforded rough slates strong and sound, but with a rather wavy cleavage surface, and not capable of being split at all thin. They have been worked in a small way about Countisbury and Treborough, in the Bredon Hills. As a rule these slaty rocks are too much crinkled and folded to make good slate.' Howe, J. A, (2001) *The Geology of Building Stones*, Shaftsbury, Donhead Publishing Ltd. First published in 1910.

The Countisbury source may be in the Lower Devonian, Lynton slates.

9 'The stone of Cann Quarry is a very firm and durable slate of a kind of greyish-blue; it does not run into such fine and even laminae as the Dedibole [sic] and Millhill quarries, as it frequently splits out wavy and irregular thick; but there is none, I believe, that can exceed it in strength and durability: and I have a great deal now on the roof of my house, which was taken down after having remained on it in seventy years, and is now replaced, being, if possible, still more firm and stronger than even what is taken fresh from the quarry: even the same pin holes served again.' Polwhele, R, (1793-1806) *The History and topography of Devonshire in three volumes*, Exeter Trewman, Vol 1, p52.

Polwhele is quoting Yonge of Puslinch House, Yealmpton.

10 The Level 3 NVQ Diploma Roof Slating and Tiling includes random slating. Successful completion entitles candidates to apply for the Construction Skills Certification Scheme (CSCS) gold card covering craft skill, job knowledge and understanding. They can extend this with the Level 3 Heritage Special Apprenticeship Programme for Roof Slating and Tiling which covers the historical, theoretical and technical knowledge and practical skills in historic building conservation, repair and

restoration which leads to the CSCS card endorsement Heritage Skills. These are the appropriate qualification for slaters who work on scantle and rag roofs. There are similar systems for construction site management of conservation work and for conservation consultancy (Table 3). These qualifications may be required by clients or be included in grant conditions.

11 Historic England: Energy Efficiency and Historic Buildings - Application of Part L of the Building Regulations to historic and traditionally constructed buildings. First published 31 March 2011.

12 Whilst the slate standard itself does not contain a classification of slate durabilities an explanation of the tests is available at See www.stoneroof.org.uk/tests2.html and two organisations have established their own requirements or guides:

National House-Buildings Council (NHBC) www.nhbc.co.uk/Builders/Technicaladviceandsupport/Slates-nomoregreyareas/

National Federation of Roofing Contractors NFRC guide TB4A Selecting Natural Slates for Roof Covering. www.nfrc.co.uk

13 National Federation of Roofing Contractors Technical Bulletin *Selecting Hooks for Slating*.

14 ‘Now the pins are put firmly into the holes and the slates piled so that they will stand without toppling: so many with pins lapping one end and so many the other, and still in sets of equal lengths.’ Boyle, V C, Scantle Roofs, in *Devon and Cornwall Notes and Queries* 26, p10-15

15 Historic England series Energy Efficiency in Historic Buildings:
- Insulating pitched roofs at rafter level - warm roofs.
- Insulating pitched roofs at ceiling level - cold roofs.
- Insulating dormer windows.

16 Viscar in Wendon 1834: ‘Roofs with best scantle slate on Norway heart laths at the four-and-a-half-pin and rag eaves double laid in lime and sand

half Aberthaw and half common lime.’ Cornwall Records Office X634/52/2.

Aberthaw was a strong hydraulic lime.

17 Further advice on selecting mortars is included in

Allen, G C, Allen, J, Elton, N J et al (2003) *Hydraulic Lime for Stone, Brick and Block Masonry*. Shaftesbury: Donhead Publishing Ltd. See particularly Tables 9 and 10 regarding mortar selection for durability giving durability classes.

Holmes, S and Wingate, M (2002) *Building with Lime: A Practical Introduction*, revised edition, London: Intermediate Technology Publications (now Practical Action). Chapter 5 is particularly relevant.

British Standards Institution (2015) *Building Lime – Part 1: Definitions, Specifications and Conformity Criteria*, BS EN 459-1, London: BSI

18 ‘At the gable ends the scantle slates may sail out over the bargeboards as in later roofs, but in windy places the barge-boards come up outside all, and a capping piece about 3 ins. wide is nailed down, covering ends of slates and top edge of barge-board.’ Boyle, V C, *idem* 26, p10-15

19 Information and pictures of Patent slating can be seen at www.stoneroof.org.uk/historic/Historic_Roofs/Patent_slating.html

20 Describing West Devonshire: ‘In situations exposed to westerly winds the walls of dwelling houses of every material are frequently guarded with slates, put on scale-wise, as upon roofs, to prevent the “sea air” from penetrating the walls, and giving dampness to the rooms. In towns, the shells of houses are not uncommonly built of wood; lathed; plastered; and slated. Houses fronted with well coloured slate, put on neatly, and with “black mortar” (namely cement, among which pounded forge cinders have been freely mixed), are not unsightly. But smeared in stripes or patches, with white mortar, oozing out of the joints, and spreading partially over the surface, the appearance is filthy.’ Marshall, W., *idem*.

21 The map showing wet-laid scantle

and rag slating in Cornwall is based on research by Viv Stratton © 2007. It is reproduced here with permission.

15 Other advice

14.1 Contacts

Where slating work is being considered, the SPAB may be able to suggest the names of suitable contractors and professionals or advise on courses that teach practical skills. Local authorities may also have lists of architects, surveyors and slaters with experience in local slating.

Architects can be chosen from the list of Architects Accredited in Building Conservation (AABC) www.aabc-register.co.uk/ and conservation accredited surveyors from the RICS www.rics.org/. The Institution of Structural engineers CARE scheme lists structural engineers www.istructe.org.

National Federation of Roofing Contractors Ltd

Roofing House
31 Worship Street
London, EC2A 2DY
Tel: 020 7638 7663
www.nfrc.co.uk

Historic England

South West region
29 Queen Square
Bristol BS1 4ND
0117 975 1308
www.historicengland.org.uk/about/contact-us/local-offices/south-west/

14.2 Advice on protection of animals and plants

DEFRA

APHA Field Services
Isca Building
Manley House
Kestrel Way
Exeter
Devon EX2 7LQ
Tel: 01392 266 375

Natural England

Bristol
1st Floor
Temple Quay House
2 The Square
Avon
Bristol BS1 6EB
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Exeter
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Truro
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The Bat Conservation Trust

5th floor
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Tel: 0845 1300 228

The Barn Owl Trust

Waterleat
Ashburton
Devon TQ13 7HU
www.barnowltrust.org.uk

14.3 Further reading

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16 Glossary

This glossary includes terms mentioned in the text many of which are specific to the region.

Back: Upper face of the slate when laid on the roof, visible from outside the building. Antonym: bed.

Backer: narrow slates laid roughly centrally over a wide slate to accommodate the increasing number of

slates in each course as work progresses up the roof. Synonym bachelor

Batten: Sawn wooden support for hanging or nailing stone slates. Synonym: lath. In slate and stone roofing guides the word lath is usually reserved for riven supports.

Bed: Lower face of the slate when laid on the roof, visible from within the roof. Antonym: back

Bedding: Layer of mortar laid over the back or face of a slate, into which the tail of the slate in the next course above is pressed.

Break iron: Long iron blade set into a wooden block over which slates are dressed to shape and size. Smaller versions are used on the roof driven into a rafter. Synonym: slater's dog.

Calcite: form of calcium carbonate which can occur in layers or veins in metamorphic slates.

Carbonate: calcium or magnesium carbonate potentially deleterious inclusion as veins or layers in metamorphic slates.

Centre-nailing: Fixing of slates to battens by a nail at each side of a slate, on a line approximately halfway up the slate.

Cleavage: Slaty cleavage is developed in fine grained rocks following metamorphism. Under the influence of pressure and heat the pre-existing minerals are partially re-crystallised and aligned perpendicular to the pressure. Slates cleave parallel to these platy minerals.

Cleat: spike bent at right angles and driven into the rafter to hold thin laths with out splitting them. Synonym, cask / barrel / cooper's hook, tenter hook.

Collar and tie valley: A valley of alternating courses of mitred slates (the collar) and a single long, narrow slate (the tie) all laid triple-lapped.

Common slating: Wet-laid small slates pegged over laths in diminishing courses at one-third lap so that each slate just laps the peg of the slate in the second course below, and using large slates at the eaves.

Course: A single row of slates across a roof or wall.

Coursing: See gauging.

Crest, crece or cresting: Ridge stones or tiles.

Crow steps: slate or stone set into a wall to throw water away from an abutment

synonym feather, dropper

Diminishing: Slating with a range of lengths on one roof. The system whereby random sized 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 or smaller than those below

Double-lap: Slates laid so that each course overlaps the course next but one below. See triple-lap and thirds.

Dressing: Trimming slates to square the edges. Traditionally done with a sax over a break iron or in the quarry with rotary guillotines.

Dressing iron: Synonym for break iron.

Dropper or feather: Flat stones or slates set into a wall or chimney to protect the vulnerable slating abutment from water penetration.

Eaves course or eaves slate: Short course laid at the eaves under the first full course. In pin slating there are sometimes two eaves slates. Synonym: under eaves.

Ellen: A roofing slate.

End lap: See head lap.

Feathers: Synonym for droppers

Full torching: application of mortar to the underside of the slates between the top and bottom edges of the laths or battens. Synonym single torching.

Gauge: The spacing between the top edge of a lath or batten and the next one on a roof or wall. Synonym: lath or batten gauge. See twist.

Gauging: Setting out the laths to provide the specified head lap or margin. Synonym: coursing. See twist.

Half-torching: Mortar applied to the underside (bed) of the slate at its head from the inside of the roof after the slating is completed.

Hammer, rag hammer, pin hammer or slater's pick: Hammer with a blunt end for nailing and a pointed end for holing.

Head: Top edge of the slate when laid on the roof.

Head bedding: setting the head of slates in a bed of mortar across part or the full slate's width.

Head-fixing: Slates hung on or nailed to laths or battens with wooden pegs or nails positioned close to the slate's head.

Head lap: The length by which the tail of

a slate overlaps a slate in a course below. In head-fixed slating it is the overlap of the peg hole or the top of the lath. In centre-fixed slating it is the overlap of the head of the slate. Synonym: end lap.

- single-lap: course two overlaps course one.

- double-lap: course three overlaps course one. Slating in thirds is double-lapped.

- triple-lap course four overlaps course one. Three- or four-pin slating is triple-lapped.

Helling, hailing or healing: Roofing stone or slate; to slate a roof

Horse: Long wooden block into which a break iron is fixed.

Lath: A strip of riven (split or cleft) timber, rectangular in cross-section, on which slates are hung. cf batten which in slate and stone roofing guides is usually reserved for sawn supports.

Lath hatchet: Hatchet with a blade for cutting laths to length and a hammer head at the back of the blade for nailing the laths to the rafters.

Lap: Amount by which the tail of a slate overlaps a slate in a course below. See head lap and side lap.

Margin: Portion of the back of the slate visible when fixed on the roof, from the tail of one slate to the tail of the slate in the next course above.

Metamorphism: The action of pressure and temperature on rocks or sediments in the earth's crust, producing mineralogical and structural changes.

Mounter or mounter slate: Large slates laid at the eaves of roofs for one or two courses and often fixed directly to rafters rather than laths or battens.

Ovvies or hovies (offies): Double course of slates at the eaves (under ovvies) or ridge (top ovvies).

Patent slating: single lap system where slates are fixed to rafters, especially on cast iron frames.

Patent ridge: ridges made from slate. They have two forms: a birdsmoth roll top which is fixed over two wings or a wing and roll mating with an opposite wing.

Peg: Small piece of wood roughly square in section and may be tapered. Used for hanging slates from laths.

Peggy: Small slate, typically, in West Country slating, slates ranging from 305 to 152 mm (twelve to six inches) long.

Pig course or gaper: A large margin

above a shorter one, the result of not applying the twist at the change course.

Pin: Synonym for peg;

Pin pointing: Mortar applied to or around slate pegs to hold them in place and to prevent them tilting.

Pin slating: System for gauging roofs by division of slate lengths into fixed proportions. The normal division is into sevenths whereby the head lap is one seventh and there are three margins of two sevenths each in a set of four successive courses. This division can be described as three-and-a-half or four-and-a-half-pin.

Prickers: Synonym for mounters

Pricking up: Setting out the laths or battens on the roof.

Pyrite, pyrites: generic name for a group of metal sulphides found in some slates often collectively known as oxidising pyrites or oxidising metallic minerals. It is also the specific name for one form of iron sulphide FeS₂.

Rag slate: Large slate squared on three sides and with a ragged top.

Rag slating: Rag slates nailed directly to rafters. There is some evidence that rag slates have been nailed or pegged to boards historically.

Random slate: Slates of varying lengths and widths. In west country slating, usually restricted to mean slates longer than 305 mm (twelve inches).

Rap: Batten or lath.

Rapping: Battening, lathing.

Riffle: A hole especially a long gap in slating where the lathing has failed and one or more courses have slipped. Usually a consequence of grouting or slurring.

Rip or ripper: Long flat tool with an offset handle for cutting or withdrawing slate nails.

Riving: Piece of slate split to thickness but not dressed to size.

Sax or zax: Bladed tool with an offset handle used for dressing slates to size and optionally with a spike to make a fixing hole.

Scantle, scantle gauge: Length of timber marked with slate lengths and their corresponding lath gauge

Scantle rod: length of timber marked up with the slate gauges. A pair of rods are placed at either side of the roof and

the gauges struck onto the rafters with a chalk line

Scantle slates: Small slates typically ranging in length from 305 to 152 mm (12 to 6 inches) long and of random widths,

Scantle slating: Systems of wet- or dry-laid slates set out (gauged) and laid in diminishing courses, so that each slate laps the head of the slate in the third course below. Also known as three-and-a-half and four-and-a-half-pin.

Scrip: Slates fixed to exposed verge rafters and purlin ends.

Shillet: building shale able to receive a nail fixing for cladding slates.

Side lap: Horizontal distance between the side edge of a slate and the side edge of the next slate in the course directly above or below.

Slate length: In top-fixed slating, the dimension from the fixing hole to the tail of the slate;

- in centre-nailing, the full length of the slate from its head to its tail.

Slater's dog: See break iron

Springing: See tilt

Square: One hundred square feet of roof area. Historically, the basis for coverage and supply of slates.

Swept valley: A valley formed with several tapered slates, with the narrow end down, laid without a break across the intersection of the two slopes

Tail: Bottom edge of the slate when laid on the roof.

Tally slates: Slates all the same size.

Thirds: Setting out slates on the roof so that the head lap and hence margin is one third of the slate length. See double-lap.

Tilt or springing: Lift provided to ensure the slates are correctly supported and/or lay closely onto their neighbours:

- on the main areas of the roof slope, the tail of each slate rests on two (in pin slating, three) thicknesses of slate in the courses below. At the eaves, the first full course rests on one thickness less - the eaves slate(s). Essentially, the tilt replaces the missing thickness but a little more is needed to allow a slate to bridge between the lath at its head and the underlying slate at its tail. The required amount of tilt can be provided by a tilting fillet, by building up the wall head underneath the eaves course or by setting the rafter back

from the outside edge of the wall. Fascia boards can also be used to provide tilt but historically they were not used on slate roofs.

- at the eaves course and at back abutments - the lift provided to ensure that successive courses lie correctly without gaps at the tail
- at verges and side abutments the lift provided by raising a rafter relevant to the roof slope or by use of a batten or tilting fillet to tilt the slating into the roof thus directing water onto the slope and away from vulnerable abutments.
- at lead valleys – use of a wooden fillet to support the edge of the valley slates and to fill the gap between the lead and the slates thus preventing water driving into the slating. The lead must be laid over the tilt.

Tingle: Metal strip used to replace a slipped slate. It is nailed to a lath or batten, the replacement slate is slid into place over it and the tingle turned up to hook the slate's tail.

Torching or tiering: Mortar applied to the underside (bed) of the slate from the inside of the roof after the slating is completed. It serves to check the entry of wind-blown snow or dust through the slating. In full torching the mortar is applied between the laths or covering the laths. In half torching the mortar is only applied at the top edge of the laths.

Triple-lap: The overlap formed by the

tail of a slate lying over the slates next but two courses below.

Triple-lapping: Slates laid so that each course overlaps the course next but two below. See double-lap.

Turnerising: The damaging and disfiguring mid-twentieth century practice of spreading a mesh and bitumen mix over the top of the slates to prolong the life of a failing roof.

Twist: Decreasing the lath gauge in random slating at the first shorter course to maintain the minimum head lap. If the twist is not applied there will be courses with larger margins than lower courses and the head lap will be smaller than intended and may leak.

Under, under eaves slate, under course: the first, short course of slates laid at the eaves.

Valley: The sides or bottoms of two adjacent or opposing roof slopes. **Vapour control layer:** A material used to limit the passage of water vapour between parts of a building.

Vapour permeable membrane: Sheet material which allows the passage of water vapour between parts of a building.

Windspur: Synonym for verge.

Worm: lead welt

Wrestlers: Vernacular ridge detail in which sets of notched slates interlock along the ridge.

Zax: See sax.



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