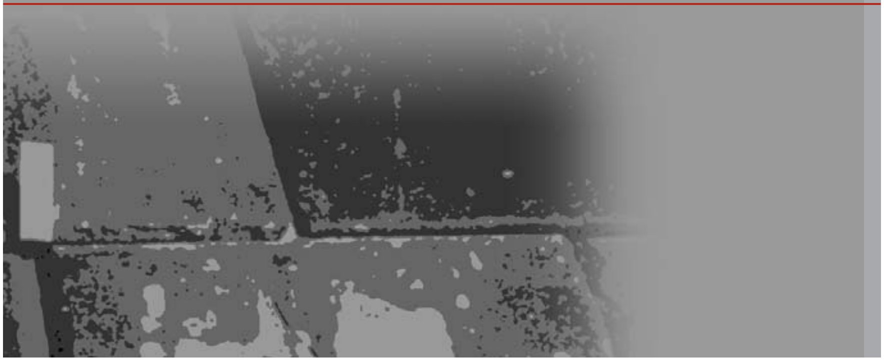
The maintenance series



Information sheet

4.2

NSW Heritage Office

Slating, tiling and roof plumbing

Introduction

Keeping the roof watertight is the first duty of a maintenance manager. Roof failure can have serious consequences for the rest of the building. A poorly performing roof can damage ceilings, and discharge excess water at the base of the building, leading to rising damp and settlement cracking.

This sheet deals with roofing made up of small units, as distinct from sheeting which is covered in the information sheet on *Corrugated Roofing*. Refer also to *Metalwork* for further information on roof plumbing.

The main parts of a roof

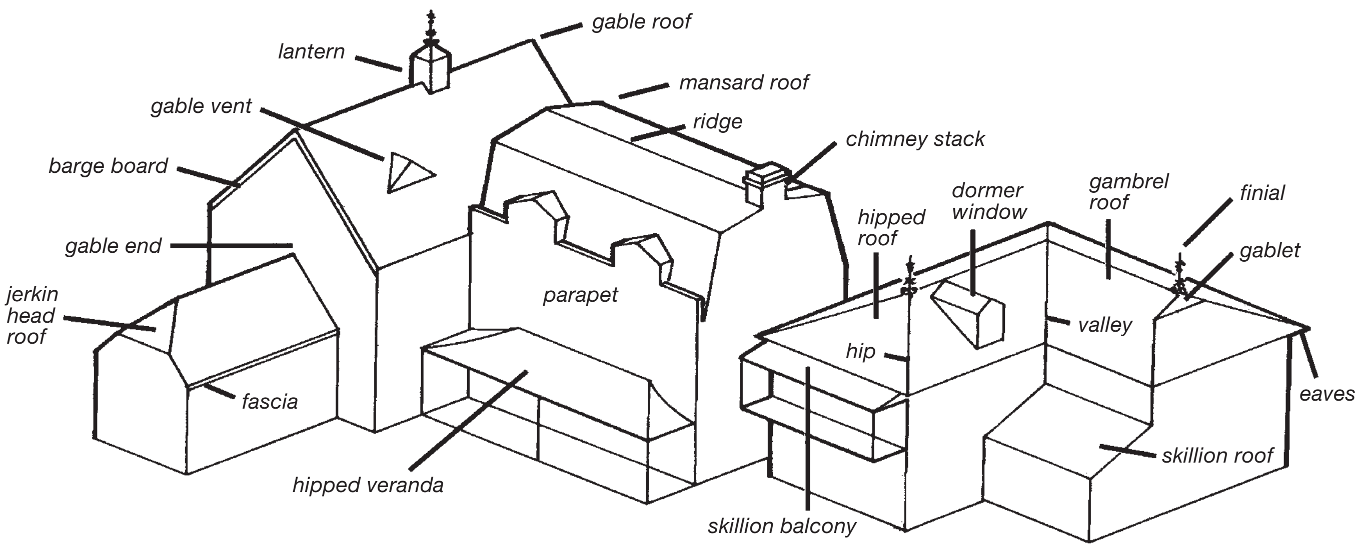
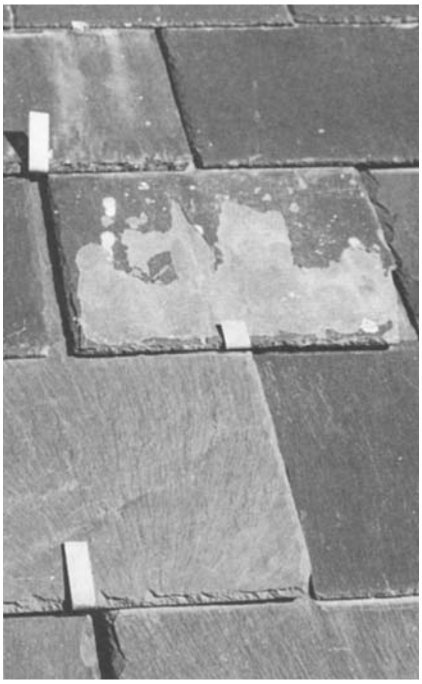


Illustration from Ian Stapleton, How to Restore the Old Aussie House, *Flannel Flower Press, 1991.*

These slates have begun to delaminate and may need replacing in the future.



Photograph by Warwick Connor.

About roofs

Traditional roofs are nearly always pitched (sloping) at angles of 26.5 degrees or more. Roof slopes were set out using simple proportions of height to span. For example, a 26.5 degrees slope is also known as quarter-pitch, the span being four times the height of the roof.

The sloping surfaces of a roof direct rainwater to the ground, usually first collecting it in gutters which convey the water to downpipes and thence away from the building. Some early buildings never had gutters, and require special care to paving and site drainage to keep water out of the building.

Traditional roofs achieve their weather-tightness mostly by overlapping elements. The laps need to be long enough to cope with water being driven up the roof by the wind. The steeper the roof pitch, the less the length of overlapping needed to keep water out.

Where roof slopes meet other slopes or vertical elements (such as parapets and chimneys) flashings, gutters and cappings are required. In many cases (for example, at the back of chimneys or in valleys) these meeting places coincide with concentrations of water, and must be well protected. The most critical areas of a roof are box gutters, because their failure will allow large volumes of water inside the building.

Assessing the roof

A maintenance assessment of a roof needs to consider:

- the heritage significance of the roof and its parts
- the condition of all roof elements
- any design deficiencies which may cause the roof to fail, even if it is in good condition. Examples include inadequate size of box gutters or lack of leaf guards at gutter outlets.

Roof inspection

The assistance of an experienced slater or tiler is invaluable. Only trained people should venture out over a brittle roof surface. Access ladders and a set of ladders for use on the roof should be made to facilitate regular inspection and repair. These should be kept on site for emergencies such as storm damage.

On all roofs, look for evidence of physical damage to slates or tiles, and make sure that all gutters, rainwater heads and downpipes are clear of leaves or other debris. Check that flashings and cappings are firmly in position and are not cracked, corroded or perished. Also look for slates or tiles ‘cocking’, or standing up out of the roof slope, which may indicate a defect in the battens or the roof structure underneath.

Apart from these items, slate roofs may be defective due to delamination of the slates caused by weathering, or slipping of slates caused by nails rusting out. Delaminated slates have a dull sound when struck, quite different from the clear ring of a sound slate. Slates in the gutter are often a sign of rusted nails. Water stains appearing as thin streaks down the slates may be an early indication of nail failure.

Traditional roofs achieve their weather-tightness mostly by overlapping elements. The laps need to be long enough to cope with water being driven up the roof by the wind.

Where the roof structures are old and crooked but otherwise sound, they should not be renewed or straightened beyond what is essential for safety and water tightness.

For terracotta-tiled roofs, the main problem is usually the decay of the tiles. This often shows up as a deposit of red dust on the top of the ceiling. Early tiles were unglazed and sometimes underburnt, making them sufficiently porous to be susceptible to salt attack like sandstone or brick.

Roof renewal

An old roof should be kept going as long as possible through regular maintenance. Once the main roofing material or its fixings have deteriorated beyond repair, however, stripping and refixing the roofing will be necessary. At the same time, the opportunity should be taken to repair the roof structure and other elements, such as vent pipes.

Where the roof structures are old and crooked but otherwise sound, they should not be renewed or straightened beyond what is essential for safety and watertightness. Much of the character of an old roof derives from its irregularities, and these will be lost if the roof is made too symmetrical and straight.

Stripping

An old roof should be removed with great care, keeping sound elements in good condition for reuse. This applies particularly to slates, which should be stacked vertically on timber pallets. Where possible, slates should be kept on the roof to reduce breakages in handling. Lead elements should also be carefully recovered for later use.

Preparation

Removal of part of the roof on the keeper's cottage at the South Solitary Island Light Station has revealed the sarking beneath. The roof was formerly slate, and was replaced with corrugated asbestos.

Photograph by Carol Edds.

Sarking (a waterproof underlay to the roofing) did not come into general use until recently. However, many early slate roofs had timber boarding over the roof structure to act as a secondary barrier to water entry, as well as cross-bracing for the roof. Provided the slope of the roof is adequate for the weather, sarking is still not essential for watertightness, but is a sensible second line of defence against roof leaks. It should be placed between the battens and the rafters. Sarking should only be used where there is no boarding, and where all the battens need replacement and have therefore been removed.

Early sarking was made of a bituminous material which is highly flammable. Unless the existing sarking is sound and of heritage significance, it may be desirable to replace it with a modern fire-resistant type.

New slates and tiles

Slates

Because slate is such a durable material, most of the slates stripped from a roof are likely to be reusable. However, it is common for at least 10% of the slates to require replacement. To maintain the appearance of the roof, the salvaged slates should be used on external roof slopes visible from the ground, with new slates confined to unseen slopes if possible. Each roof slope should have either all old slates or all new, as a mixture of old and new on one slope rarely looks good.

Slate quarries which supplied slates to historic buildings in Australia

Country	***Quarries***	***Colour and Appearance***
Wales	Carnarvonshire Quarries: Penrhyn, Bangor, Bethesda, Dionorwic, Llamberis	Purplish blue
	Merionethshire Quarries: Oakley, Bettws-y-Coed, Blaenau-Festiniog	Bluer than Carnarvonshire slates. Also produce a grey slate
England	The Old Quarries: Delabole (Cornwall)	Grey-blue generally
	Westmoreland (Lake District)	A variety of green colours depending on proportions of iron oxide and magnesium. Generally thicker and coarser than Welsh slate

New slates should be exactly the same size as the old slates, especially in length and thickness. They should have a guillotined-edge finish, not sawn. As far as possible, the new slates should match the old, with due allowance for weathering. The table on this page shows the origin of slates likely to be found on historic buildings. Slates from other quarries in Wales, England, Spain and Australia are now available, but may not match the appearance of the original.

Replacement slates are frequently selected on the basis of the past performance of specific quarries and on visual inspection. For example, certain Welsh slates have generally performed well in the past. However, it does not necessarily follow that past performance is always a reliable indicator of the future serviceability of new materials. As with most natural stone, performance can vary with time, even when the slates come from the same quarry. If current test data is unavailable, the conservator should request that testing be carried out before making a final selection for large jobs.

There are no Australian Standards for the testing of roof slates, but there are ASTM and British Standards which can be used (see Further Information).

Slates were produced in a variety of thicknesses, ranging from 4-4.5mm for best slates to 6-7.5mm for third quality. So-called ‘extra-heavies’ should not be used in roof replacement.

Terracotta tiles

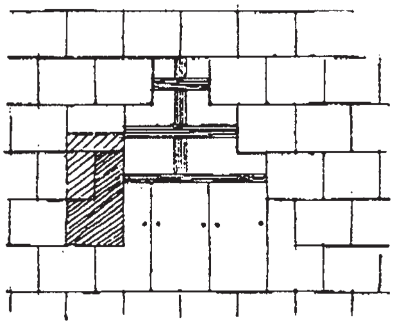
Old terracotta tiles were made in stack kilns in a similar way to bricks. The process resulted in different degrees of firing, those tiles closest to the fire being overburnt and those furthest underburnt. When glazed tiles appeared, there were more variations in the thickness of salt glazing, which was applied by hand. The manufacturing process thus resulted in natural variations in the colour of the tiles, and accounts for the motley colours of a traditional terracotta roof. Modern terracotta tiles are made in a tunnel kiln using highly controlled composition and temperature, and emerge very uniform in colour. They may therefore not be suitable for re-roofing an old building.

Tiles are still made by traditional methods in some parts of the world, and can be obtained with an appropriate mix of colours. Alternatively, matt glazes have been used with some success to produce slight colour variations simulating the traditional appearance.

Traditional colour variations in terracotta tiles.

Photograph by Peter Phillips.

Centre nailing of slates



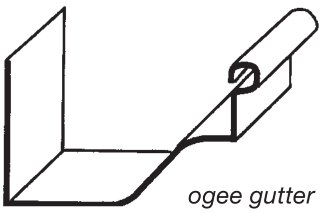
Fixing slates and tiles

Slates should be centre nailed rather than head nailed. The advantages of centre nailing are that it is cheaper, and the slates are less likely to move in the wind, and can be replaced more easily if they break. Non-ferrous nails should be used. Slates are laid with the thickest ones at the bottom of the roof and the thinnest at the top. From the diagram at left, you can see that the slates are lapped, so that at any point on the roof there are at least two thicknesses of slate.

On the best slate roofs, lead was traditionally used for ridge and hip cappings, laid over a timber roll. Other capping materials were galvanised iron, copper and later terracotta. The original material, if known, should be reinstated. If capping is missing, it may be the original design. Well-built slate roofs were mitred at the hips to avoid using capping.

Terracotta tiles were usually shaped to hook over battens and interlock with one another, so that less overlapping was required. The exception was terracotta shingles, used in the early decades of the 20th century, which were laid much like slates. Terracotta cappings were made to match the tiles. They were pointed-up in mortar, which tends to crack over time as the roof moves. Tiles were secured to the roof at intervals by nails or wire to prevent wind movement. Replacement wire should be copper.

Traditional ogee and half-round gutters



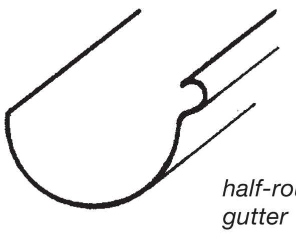


Illustration from BHP Building Products National Products Catalogue, 1997.

Roof plumbing

Lead was traditionally used for flashings to both slate and tiled roofs. Copperised and correctly fixed lead is still the best flashing material for slates and tiles.

Valley gutters, which drain quickly, can be made of galvanised steel, although the preferred material is copper. The use of copper is even more desirable for box gutters, where water may lie. Note, however, that copper and galvanised steel should not be used together, especially with copper above.

Profiles and size

When replacing gutters and downpipes, the original profiles and shapes should be reinstated. Evidence from early photographs or original specifications, or from remnants such as brackets lying around the site, should enable the correct profiles to be determined. Often a paint shadow of the original profile can be found hidden behind existing guttering where it abuts a fascia.

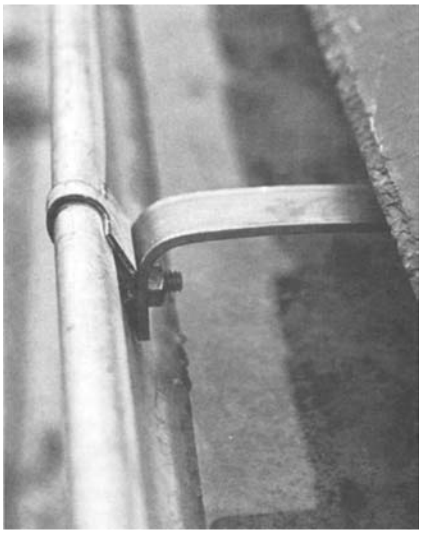
The gutters and downpipes of many stormwater disposal systems are too small to carry the volume of water commonly shed in heavy rain. Modern 'ogee' guttering is slightly wider than the traditional profile, allowing greater carrying capacity. Its use will be acceptable in most cases. Judicious insertion of new downpipes and rainwater heads can help improve the capacity of the system, but their design and siting must be carefully considered.

When box gutters are replaced, they will frequently need to be increased in size. This can readily be done without altering the original visible profile.

Traditional rainwater head, Gloucester Street, Sydney.

Photograph by Lianne Hall.

Overstrap provides additional support for a copper gutter.



Photograph by Warwick Connor

Any new downpipe should be located to minimise visual disruption of the façade, while providing a good spread of outlets around the roof. The profile should be similar to the original, but with some way of distinguishing between the new and the old on close inspection. If anything, simplify an existing design; do not make it more complex. A date stamp recording when the work was done, is a good way to identify new work.

Rainwater heads and internal downpipes

Those elegant boxes at the top of downpipes are not just pretty decoration. The purpose of the rainwater head is to provide a large catchment area to slow and dissipate the energy of the horizontally moving water from the gutters. Gravity then takes over and the mass of water in the head drives the water down the downpipe much more effectively than without a head. Repair and maintenance of rainwater heads is therefore good building management practice as well as good conservation.

Rainwater heads should always have an overflow spout, so that in the event of blockages excess water is directed away from the walls below. They should also have wire mesh covers or baskets in a design that will not encourage bird nesting.

Many box gutters directed water to internal downpipes. These may cause damage to wall fabrics and finishes due to internal blockages or insufficient capacity.

Maintenance

Gutters are particularly susceptible to corrosion due to build-up of leaves, bird droppings and air pollutants. These contribute weak organic acids and salts, which promote corrosion in an environment already at risk due to water lying for long periods in shallow-draining guttering. The regular cleaning of gutters and stormwater disposal systems is an essential maintenance strategy. Old copper gutters may require support, such as by overstrapping. This also enables the fall to be maintained.

Occasional checking to ensure that gutters fall (slope) the right way is also important. The slope in a gutter can change with time due to distortion of the roof framing and to reactive soils causing heave beneath parts of a building. In turn, the resulting build-up of water and debris may weaken gutter supports and so compound the problem.

FURTHER READING

American Society for Testing and Materials, C121: *Standard Test Method for Water Absorption of Slate* [R 1994].

ASTM C120: *Standard Test Method of Flexure Testing of Slate* [Modulus of Rupture, Modulus of Elasticity [R 1994].

ASTM C127: *Standard Test Method for Weather Resistance of Slate*, Document Type S.

ASTM C406: *Standard Specification for Slate Dimension Stone*, Document Type S.

British Standard 680: Part 2 1971 *Specification for Roofing Slates.*

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