CORRUGATED ROOFING

ABOVE: Belay Homestead, Walkaway

INTRODUCTION

This information sheet deals with corrugated iron and steel, which have been widely used in Australia, particularly for roof sheeting. The section Further Reading lists more detailed works on this subject. For more information, refer to the information sheet on Metalwork, which covers the care and conservation of other metal elements commonly used in traditional building. These include cast and wrought iron fencing, decorative panels and steel-framed windows.

THE HISTORY OF CORRUGATED IRON

The common term 'corrugated galvanised iron' is used to describe two different materials: galvanised wrought iron and galvanised mild steel. Until very late in the 19th century all corrugated galvanised iron was made from wrought iron, but from 1890 to 1910 improved methods of steel making and processing led to the complete replacement of wrought iron by mild steel. Although wrought iron is no longer available in sheet form, examples of galvanised wrought iron roofing have survived in Australia. As well as the corrugated form, other types include the pressed metal tiles by Morewood and Rogers in the second half of the 19th century.

The strengthening effects of corrugating or crimping flat sheets have been known for centuries, but a successful technique for corrugating did not appear until the early 1840s. At first the grooves were produced by pressing and this method continued in use throughout the 19th century. Grooved rolls were in use by 1845, although the method of achieving uniformly corrugated sheets was not developed until much later.

Although iron and steel are stronger and cheaper than other common metals, they corrode readily in air and water, and their use as a durable building material became possible only with the protection provided by galvanising. In this process the metal is immersed briefly in molten zinc.

A thin protective coating of zinc is bonded to the iron base by a series of iron–zinc alloy layers. Galvanised iron sheet suitable for corrugation was first produced during the 1840s. It proved to be strong and durable, relatively light and easily transported.

Since about 1850 corrugated galvanised iron and steel have been widely used in Australia for roofs and wall cladding and have become part of the Australian vernacular. As manufacturing processes improved during the late 19th century, the production of larger sheets further reduced the amount of supporting timber framing needed.

Several small corrugating plants operated in Australia during the 1860s and a small galvanising plant was established in 1863, but production from these was very limited and based entirely on imported sheet iron. Substantial production of corrugated galvanised sheet in this country developed only after steel smelting began in Lithgow early last century.

In 1921 the English firm John Lysaght set up a large-scale corrugating and galvanising works in Newcastle. For many years production was based on a single-sheet system, until continuous rolling and galvanising lines were introduced in 1961.

Early catalogues for corrugated sheet indicate that several profiles were made. These varied in both depth (the vertical distance from top to bottom of the corrugations) and pitch (the horizontal distance from the top of one corrugation to the top of the next). Greater depth allowed the sheet to be used for wider spans.

The single-sheet system often produced uneven coatings and generally the coating was thicker on one surface than the other. The common practice of laying alternate sheets upside down (to save on overlap, if not watertightness) has left us with many old roofs with a striped appearance resulting from the more extensive rusting of the more thinly coated surface. Thicker coatings also occurred at the ends of the sheets. These problems have been largely overcome by continuous processing.

In 1976 BHP introduced a new coating alloy containing 55% aluminium, 43% zinc and 1.6% silicon which is known as ZINCALUME®. Today Zincalume-coated sheet is the most common metallic roofing material, although zinc galvanised steel is still produced. Both are available with oven-baked, pre-painted finishes such as COLORBOND®, which were introduced to Australia in the mid 1960s.

GALVANISING AND CORROSION

Iron and steel are not naturally durable. They tend to corrode in the presence of water and oxygen and revert to reddish iron oxide or rust. Rust is a porous material and provides no protection against continuing corrosion. On the other hand, the corrosion of zinc produces a relatively non-porous and stable coating which protects the metal from further attack. Moreover, if the zinc coating is scratched, the increase in volume of the corrosion product tends to seal the scratch. Although zinc is a less noble (more chemically reactive) metal than iron or steel, it is effectively more durable because of the way it corrodes.

If a galvanised sheet is scratched or cut, steel and fresh zinc are exposed. In the presence of water (a few raindrops or a thin film of condensation are enough) an electrical current flows between the two metals and through the water. This process is called galvanic action and causes the less noble metal, zinc, to corrode preferentially and in so doing protects the more noble metal, steel. (The corrosion of metals is further discussed in the information sheet on Metalwork.)

Thus, the corrosion of a galvanised sheet is a two-stage process. Firstly, provided there is a complete coverage of zinc over the steel, the zinc will slowly corrode more or less uniformly over the sheet. But, when scratched or cut, the fresh zinc will corrode by galvanic action at a much faster rate and in so doing protect the exposed base metal. Corrosion in this second stage is uneven, as most zinc is lost from the area adjacent to the exposed steel.

The width of the scratch or cut affects the manner of corrosion. A narrow scratch may be effectively self-healed by the increase in volume of the zinc corrosion products sealing over the exposed steel. A wider scratch, though not sealed over, may still be protected by the throwing power of the zinc, the large area of zinc effectively protecting the narrow exposure of base metal by galvanic action. The edges of a cut sheet are protected in this way. Eventually, as the zinc is lost, the zone of exposed steel will become broader and will cease to be protected. It then corrodes.

Of the other types of corrosion affecting corrugated steel, the most important is crevice, or oxygen concentration cell corrosion. Crevices or narrow gaps are formed where galvanised sheets are overlapped at joins. These hold water (by capillary attraction), and with time the concentration of oxygen in the water deep inside the crevice becomes lower. The adjacent metal is then less noble than the same metal at the open end of the crevice.

Although only one metal (zinc) is involved, the result is that the less noble area deep in the crevice corrodes in preference to that near the open end. The practical effect is that zinc is lost from the area of the crevice at a much faster rate than elsewhere. This is an important reason why rusting of corrugated sheets usually occurs first at the overlapping joins.

PROLONGING THE LIFE OF A CORRUGATED ROOF

Maintenance

Keeping the roof clean is an important maintenance objective. Steeply pitched sections are straightforward, as dirt and water run off readily. This is why steep pitches last longer. It is good practice to regularly sweep lower angle sections, such as verandahs, to keep the roof free of debris.

Stones, twigs, branches, heavy seed pods, and indeed anything else (such as pieces of timber and old roofing nails) left lying on the roof, produce small crevices between object and roofing, leading to accelerated loss of zinc coating in that area. Frequency of cleaning will vary from place to place and needs to be balanced against any adverse effects, such as excessive walking on the roof.

Regular checks to ensure that the roof sheeting is well nailed or screwed down are important. Loose fixings allow wind to blow rain in and further dislodge the sheeting.

Patching

The patching of small holes can extend the life of a sheet and delay its replacement until the other sheets need attention. Traditional patching materials include lead soldered over the hole as if it were a flashing, thick bituminous pastes and even cement reinforced with hessian. Modern patching

usually involves the ubiquitous silicone resin applied from a convenient 'gun'.

Temporary repairs

When lap sheets have rusted around their fixings the insertion of a slip sheet can extend the life of the roof covering. This can be a metre length of matching profiled corrugated sheeting placed between a rusted lap joint. It protrudes 100 mm below the lap joint and is secured on the adjacent corrugate.

Painting

Maintaining a sound paint film prolongs the life of corrugated roofing, even when much of the zinc coating has been lost from the sheet. Rust converters, alkyd-based primers containing anti-corrosive pigments, and special primers for use over zinc coatings are readily available. Modern rust converters provide a ready-primed surface that accepts most types of finishing paint. Notes on the protection of iron and steelwork, removal of lead-based paints, and paint coatings are provided in the information sheet on Metalwork. This can be further supported by Australian Standard AS2311-1992 The Painting of Buildings, which provides guidance for the best primers and finishing coats.

REPLACEMENT OPTIONS

There is a range of options for the replacement of a roof when it is beyond maintenance.

Partial replacement

When a few sheets or a complete section of roof need replacement, they should be replaced with material matching the profile and appearance of the existing roof. Second-hand sheets may meet this need. If this is not possible, new sheeting may be required which may not match the profile of the old. In this case, one approach is to move sheets around on the roof so that complete pitches or sections can be of sound old material, while other pitches are the new sheeting.

Complete replacement

Complete replacement of an old roof raises the problem that modern materials are different from those used until the 1950s and 1960s. As well as producing a watertight functional roof, the aim of replacement should be to match the appearance of the original as closely as possible. Issues to be resolved include:

- profile
- materials
- colour
- sheet length
- fastenings
- availability of traditional materials
- compatibility of materials.

PROFILE

The desirability of matching the profile is straightforward; a roof with a standard (3 inch) corrugation will look very different from one with a wide (5 inch) corrugation. Matching the corrugations may not always be possible, limiting the possibility of partial replacement as a conservation option.

MATERIALS AND COMPATIBILITY

Except in some particular environments, Zincalume is a superior coating to the traditional galvanised or zinc coating. The greater durability of the aluminium–zinc alloy gives Zincalume much greater life expectancy than zinc coatings of the same thickness. However, replacing an old roof with Zincalume-coated steel may not be the best solution, because Zincalume has a different surface texture to a galvanised coating and retains its gloss for much longer than zinc. Many people find the gloss finish objectionable and out of keeping with the matt appearance of traditional zinc.

Zincalume sheeting and zinc-coated materials cannot be used together in situations where rainwater runs from (inert) Zincalume onto small areas of zinc coating such as gutters. This means that replacing the roof also means replacing the gutters and downpipes in Zincalume. In turn, since Zincalume cannot be soldered, the joins in the gutters must be popriveted and sealed with silicone, producing an additional change in appearance.

There are concerns about the use of Zincalume in conjunction with traditional lead flashing, because corrosion occurs when the two are in contact. Other flashing materials like soft zinc are available, but their use means a further change and loss of original fabric. Isolating the old lead flashing from the Zincalume by inserting polyethylene sheeting (such as damp-proof course material) is the best way of retaining the existing flashing. To be effective the isolation barrier must be complete and be brought right to the edge of the flashing.

SHEET LENGTH

Modern production methods enable corrugated sheet to be produced in lengths much longer than is usually required. This means that most roofs can be covered in a single row of sheets, eliminating the need for overlapping joins which are a major source of corrosion.

These advantages need to be weighed against the change in appearance that full-length sheets bring. On steeply sloping roofs of short sheets the joins can be seen as the shadow line of the overlapping sheet and, less obviously, the additional nailing needed at the join. These provide a distinct horizontal element to the appearance of many roofs and their loss may lead to a change in the character of the roof. On the other hand, there can be little objection to full-length sheets on planes of a roof that are not readily visible.

FASTENINGS

Like sheet lengths, the issue here is visibility. Traditional slot-headed roofing screws (or nails) and washers should be used on those parts of a roof that contribute to the building's appearance, while modern hexagonal nut-headed screws should only be used on less visible parts of a roof.

AVAILABILITY OF TRADITIONAL MATERIALS

Galvanised or zinc-coated steel is still manufactured in Australia and is available in a range of thicknesses and strengths, and in several different weights (thicknesses) of zinc coating. Fundamentally, the thicker the zinc coating the longer the life of the sheet.

Further Reading

BHP Steel (JLA) Pty Ltd 1991-95, *Technical Bulletins,* Sheet & Coil Products Division, BHP Steel, Sydney. 21 technical bulletins on a range of topics including:

TB-8: 'Flashing materials for Zincalume and Colorbond steel sheet'.

TB-10: 'Cut edge protection of zinc-coated and zinc/aluminium alloy coated steel sheet'.

TB-15: 'Recommended steel gutter systems'.

Department of Industry and the Institution of Corrosion Science and Technology 1982, *Guides to Practice in Corrosion Control*, UK Department of Industry, London.

No 12: 'Paint for the protection of structural steelwork'.

No 13: 'Surface preparation for painting'.

No 14: 'Bimetallic corrosion'.

Standards Association of Australia 1992, Australian Standard *AS2311-1992 The Painting of Buildings*, Standards Association, Sydney.

Trethewey, K.R. & Chamberlain, J. 1988, *Corrosion: for Students of Science and Engineering*, Longman Scientific & Technical, Harlow, UK.

Warr, A. 1992, 'The technology of the corrugated shed' in Freeman, P. & Vulker, J. (eds) *The Australian Dwelling*, Royal Australian Institute of Architects, Red Hill, pp.85-91.

Notes

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