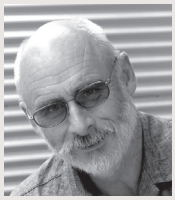

ROOF DESIGN

Good roof system design is a critical part of a good building. A roof designer must consider cost, performance and appearance, but it's important to keep a few other factors in mind.

By Trevor Pringle, ANZIA, BRANZ Principal Writer

Roofs are the crowning glory of our buildings. It was considered an essential part of the design that a building be capped, although in many designs, the roof is effectively concealed from external view. However, roof design should consider more than just looks. Obviously, good roof design must be aesthetically appropriate for the building design but must also ensure it:

- can be built – some roof configurations are overly complex, which increases the risk of poor installation
- meets durability and serviceable life expectations
- accommodates thermal movement
- sheds water effectively
- allows maintenance to be safely carried out
- is compatible with adjacent materials
- resists wind uplift.

Not all roofs were designed with maintenance in mind.

Durability

Under the Building Code, roof claddings are typically deemed moderately difficult to replace and must meet a durability requirement of not less than 15 years. However, most building owners will expect their roof to have a much longer serviceable life than this. Key influences on the life of the roofing system are the:

- ultraviolet light exposure – this can break down materials and cause fading
- temperature range
- local environment, particularly with metals – is it a benign or a corrosive environment, such as marine, severe marine or industrial?
- roof cladding material – its thickness, span and so on
- stability and performance of the supporting structure
- compatibility with adjacent materials and components
- coating system applied to protect the base material, for example, protecting metals from corrosion or bitumen from ultraviolet
- level of maintenance – for metals, allowing rainfall to clean the roof improves durability (roofs deteriorate more quickly in areas that do not get rain-washed)
- profile of a metal cladding – sharp folds or bends increase the risk of deterioration.

Thermal movement

Roofs can experience a wide range of surface temperatures, and roofing materials can exhibit a wide range of thermal expansion coefficients, so the roof system must be detailed to accommodate the expected movement. For some roofing systems, suppliers may specify ventilation requirements to reduce heat build-up within the roof.

It's also important to consider that high temperatures within the roof space may have an impact on the performance of roof and ceiling framing and the ceiling linings.

For example, the surface temperature of a dark-coloured steel roof in Blenheim may range from -10°C on a cold winter night to an estimated 90°C when air temperatures exceed 30°C on a hot summer day. Roofing materials, such as membrane roofing systems, will be subject to stress as a result of thermal movement in the supporting plywood substrate.

Roof drainage

Water that does not drain effectively from a roof surface can increase the risk of: →

To calculate the potential maximum contraction and expansion over an annual weather cycle, multiply the thermal expansion coefficient (in mm/m/°C) by the temperature range (in °C) by the length of the roof (in m).

For example, a 65 m aluminium roof with a high thermal movement (0.024 mm/m/°C) located in Blenheim where the temperature range is -10 to 90°C, the calculation would be:

0.024 mm/m/°C × 100°C × 65 m = 156 mm

Recoating was only carried out on those parts of the roof visible from the street.

Corrosion is an ongoing risk with an unpainted galvanised steel roof cladding in an industrial environment.

- gravity leakage through small roof breaches
- water being blown back up under flashings
- high stress between cold wet areas and hot dry areas of the roof
- corrosion damage with metal roofing.

The minimum slopes for different roofing systems are given in E2/AS1 or by the roof cladding manufacturers. When the design takes the slope of the roof to its minimum value or takes a metal roofing span to its limits, there is a risk of the fall being compromised by:

- construction inaccuracies – that is, the minimum pitch is not actually achieved on site
- sags in the support framing
- deflection in the roofing or its substrate, particularly where the roof is subject to foot traffic or where equipment has been mounted on the roof.

Maintenance

Roof claddings require maintenance throughout their life to ensure they achieve maximum durability. When designing the roof and selecting materials, it is important to consider how that maintenance will be carried out and what safety provisions are required, such as edge restraints. For example, a roof that is difficult to access should use a roof cladding that requires the least amount of maintenance possible, or if it uses a metal cladding, it should maximise the benefit from rain-washing of the surface.

For liquid-applied coatings, the roof must be readily accessible to allow regular recoating of the surface.

Compatibility

Compatibility is another important factor to consider when designing a roofing system. Ensure that the roof cladding is compatible with its fixings, flashings, substrate and the materials that drain water onto and off the roof. Incompatibility will lead to the accelerated deterioration of one of the materials.

For example, uncoated cedar weatherboards above an unpainted zinc-aluminium alloy-coated steel roof can lead to corrosion in the roofing and flashings.

Likewise, water from copper spouting should never drain onto steel or aluminium roof cladding, as the galvanic action will deteriorate the metal.

Wind loads

An essential part of the design and specification of a roof cladding and its supporting structure is its ability to resist wind loads, particularly uplift acting over the roof.

Factors that influence the structural design of a roof include the:

- wind zone
- slope
- foot traffic
- span of the roof and its support battens or purlins
- profile used for profiled long-run metal
- weight
- fixing method (concealed clip, crest fixed or crest fixed with load-spreading washers).

METALS AND CORROSION

The local atmospheric conditions – known as the corrosion zone – have the greatest influence on the durability of steel and aluminium roof claddings. Suppliers have developed a range of coating options to suit different corrosion zones, and it is important to have a clear understanding of these and the level of corrosivity present when specifying the roofing system.

While aluminium is typically more corrosion resistant, in marine environments it may suffer from a process known as fretting. Fretting occurs when movement between the aluminium and any adjacent material (such as a fixing) removes the protective layer of aluminium oxide that forms on a natural aluminium finish. By continuously removing the protective oxide, the process exposes the raw aluminium and accelerates the metal degradation. Unfortunately, fretting can be missed, as it is often not apparent.