



Making sense of risk

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# Roof systems

Asia Pacific



## Roof systems

The roof is the main barrier that stands between your business and the elements. Roof systems range from the simple to the complex, and involve diverse materials with different life spans and vulnerabilities to weathering. For any roof to provide effective protection, it must be installed correctly and maintained regularly.

In order to reduce the potential for roof damage at your place of business, it is wise to inspect it regularly, and to do that, it is important to understand the most common types of roof and roofing materials.

### Roof terminology

**Ballast:** Smooth, round stones or concrete paver blocks that hold the roof cover – typically a membrane – in place.

**Blisters:** Trapped air pockets under the roof or between layers that can burst and compromise the roof.

**Curb:** A raised frame used to mount mechanical units, such as air conditioning or exhaust fans, or skylights on a roof.

**Felt:** Water-resistant roofing sheets applied between the roof deck and the roofing material. Layers consist of organic or inorganic non-woven fabric that may be coated with bitumen or coal-tar pitch.

**Flashing:** Pieces of sheet metal or other material used to strengthen and waterproof certain joints and angles (such as in roof hips and valleys) or where the roof cover comes in contact with a wall, curb or chimney.

**Membrane:** A variety of layered materials used to form a continuous surface for a roof system. A membrane may be the combination of polyester felt, fibre, fibreglass, or a combination of polyester and fibreglass and layers of bitumen, modified bitumen, or other rubberised material. Its purpose is to protect the building from water infiltration.

**Ponding:** Water collecting on a roof for more than 48 hours due to poor drainage. Ponding, also known as standing water, may be caused by insufficient roof slope (in the case of 'flat' roofs) or as a result of deflection of the roof), clogged downpipes or drains.

Ponding can expose membranes to moisture, delaminate the membrane layers, promote fungal growth and even lead to roof collapse.

**Substrate:** An underlying supporting layer of the roof.

**Wind uplift:** The upward force exerted by wind travelling across a roof. This force varies across the roof and often causes more damage at the perimeter and corners than in the centre of the roof.

### Types of roof

The range of roof systems includes: a simple wood deck covered with tiles or shingles; a sloped metal deck with no cover; a steel deck with varying substrates and covers; and so-called 'flat' roofs (which should in fact have a slight pitch).

#### Built up roof (BUR)

A BUR consists of layers of reinforcing materials embedded in bitumen and surfaced with a bitumen coating, gravel, granules or a reflective coating. A rough surface coating is preferable to a smooth surface covering, as it protects against hail damage and slows the process of UV oxidation. (Refer to the Liberty document **Hail action plan** for more information.)

Potential problems:

- **Hail damage:** Hail may cause tears or perforations in the membrane.
- **Cracks:** Ultraviolet (UV) rays can cause oxidation and degradation of the bitumen, causing it to lose flexibility and durability and become brittle.

- **Blisters:** Soft bubbles form when moisture is trapped beneath the surface. They are more noticeable on warm days.
- **Ridges:** Thermal expansion of the roofing material and separation of the underlying insulation from the roof deck can both cause ridges, which if left unchecked can tear the roofing material.
- **Combustion:** Bitumen is combustible.

#### Modified bitumen roofing

Bitumen with one or more polymers added to increase its plastic or rubber qualities is known as modified bitumen. Roofs using modified bitumen membranes may be single-, two- or three-ply systems, often depending on the substrate that has been installed.

The membranes may be backed by a range of reinforcing materials including fibre, polyester felt or a polyester/fibreglass composite, depending on the intended application. Modified bitumen roofing may be surfaced with mineral chips, granules, foil, reflective paint or other coatings.

Modified bitumen membranes are applied with an overlap of several centimetres using a hot torch, hot bitumen or a cold process, depending on the type of modifier.

Potential problems:

- **Seam defects:** Defects are caused by thermal expansion and contraction, stresses or defective installation techniques.
- **Punctures:** Trauma from tree branches, foot traffic, dropped tools and mechanical system components may all cause punctures. Vibrations from equipment can dislodge fasteners, which can then puncture the membrane.
- **Blisters:** These are an indication that moisture has penetrated the membrane.

- **Oil-based contaminants:** These may be transmitted to the roofing via roof-mounted exhaust ducts.
- **Exposure of the felt backing:** Weather extremes over time can cause exposure of the backing material, which readily absorbs moisture.
- **Combustion:** Bitumen is combustible.

### Ethylene Propylene Diene Monomer (EPDM) roofing

EPDM membranes are single-ply roofs that are regarded as durable and relatively resistant to UV rays and temperature fluctuation. They are flexible and adaptable to a variety of applications in that they may be mechanically fastened, adhered, or ballasted in place with stone or roof pavers.

Potential problems:

- **Seam defects:** Poor installation techniques can cause seam failure, and deterioration of membranes (becoming brittle and shrinking with age) may put stress on the seams.
- **Attachment failure:** Wind uplift may cause detachment of the membrane.
- **Shrinkage:** This may occur over the entire surface as the membrane ages.
- **Reactions:** The membrane may react with incompatible substances, such as grease, oil and petroleum solvents.
- **Blisters:** The localised loss of adhesion of the membrane from the underlying roof material is usually the result of trapped moisture.
- **Flashing disruption:** When the membrane becomes brittle or shrinks with age, the flashing may pull away.

### Polyvinyl Chloride (PVC) roofing

PVC-based membranes are used as single-ply roofing. Although the PVC polymer is rigid, plasticisers are added to increase flexibility. Modern PVC-based membranes are reinforced with polyester or fibreglass and may be mechanically fastened or ballasted in place.

Green or 'living' roofs and rooftop gardens are increasingly seen as having environmental and social benefits through helping to reduce noise, creating healthy outdoor urban spaces, and reducing a building's heating and cooling requirements.

A range of PVC-based membranes is used extensively to waterproof such roofs.

Potential problems:

- **Seam defects:** Poor installation techniques can cause seam failure, and deterioration of membranes (becoming brittle and shrinking with age) may put stress on the seams.
- **Attachment failure:** Wind uplift may cause detachment of the membrane.
- **Shrinkage:** This may occur over the entire surface as the membrane ages. This may be a particular problem with older PVC-based membranes, which may lack reinforcing and may not contain UV inhibitors. UV exposure can cause migration of the plasticisers, which makes the membrane vulnerable to shrinkage, cracking and punctures. Membranes installed directly over old bitumen roofs or polystyrene-based insulation can quickly become brittle as these substances accelerate the plasticiser migration.
- **Reactions:** The membrane may react with incompatible substances, such as grease, oil and petroleum solvents.
- **Blisters:** The localised loss of adhesion of the membrane from the underlying roof material is usually the result of trapped moisture.
- **Flashing disruption:** When the membrane becomes brittle or shrinks with age, the flashing may pull away.
- **Shattering:** Widespread fragmentation of older unreinforced membranes typically occurs with a sudden drop in temperature or during a hailstorm.

### Metal roofing

There are two types of metal roofing systems: structural and architectural. In structural metal roofing, the waterproofing layer is combined with the supporting deck layer. In architectural metal roofing, they are separate components.

Most metal roofing installations use steel, aluminium or copper.

Potential problems:

- **Corrosion:** All metal roofs may rust although protective coatings may slow or limit the process. Damage to the coating will accelerate corrosion. If neglected, rust can eat through metal panelling, making replacement the only viable option.
- **Fastener damage:** Corrosion, wind uplift, vibration and metal fatigue can all affect the integrity of metal roof fasteners. If enough fasteners loosen or fail, panels may shift and separate from the roof.
- **Seam failure:** Water penetration through gaps beneath roofing seams can cause loosening of panels and a greater risk of wind uplift.

### Hail damage

Hail may dent metal roofs and crack or break roofing tiles. The roof cap, flashing and other flat metal parts may take the brunt of the damage.

Smooth-surfaced roofs are more likely to be damaged by hail than well-maintained roofs covered by gravel or ballast. A blistered roof is more vulnerable to hail damage. (Refer to the Liberty document **Hail action plan**.)



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<http://www.architectureanddesign.com.au/suppliers/sika-australia/why-the-right-waterproofing-membrane-is-important>

<http://www.facilitiesnet.com/roofing/article/Comprehensive-Strategies-for-Effective-Roof-Inspections--15979>

<http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/managing-risk-falls-cop>

## Roof maintenance

Regular and thorough roof inspections are important in maintaining a safe and secure building. Scheduled inspections and follow-up maintenance may be the difference between a roof that lasts its expected lifespan and one that fails prematurely. Regular inspections reduce the need for expensive emergency repairs and reduce the likelihood of structural damage.

Roof inspections should be scheduled according to the seasons: after summer, when UV exposure and high temperatures may have caused damage, and after winter in areas that experience very low temperatures, snow or ice. Interim inspections should follow hail storms, severe rain storms, and after high winds.

Common problems that roofing inspectors should look for include:

- Restricted drainage from accumulated plant debris or construction materials can cause ponding.
- Ponding of water may damage roofing materials and can compress the roof insulation, further adding to the area of ponding.
- Fumes from externally venting exhaust systems that come into direct contact with roofing membranes can damage the membranes.
- The problems specific to different roofing types (detailed above) should be considered.

## Roof inspections checklist

**Conduct regular roof inspections and interim inspections after storms and high winds.**

Inspections are often best left to the professionals, since roofs are high up and often sloped. Get onto the roof through a roof hatch or fixed ladder against an outside wall and always manage the risk of falls in accordance with the relevant industry Codes of Practice.

Points to consider:

- Eliminate ponding, plant growth and storage.
- Remove debris from the roof and gutters.
- Ensure even distribution of roof ballast on a ballasted roof.
- Ensure roof-mounted equipment is securely attached to the roof.
- Remove any foreign material on the roof and investigate the origin and cause.
- Engage a roof contractor to evaluate and repair the roof when you notice:
  - Loose flashing
  - Loose bricks in chimney stacks
  - Deterioration of chimney stacks, antennas, guy wires, cables or anchors
  - Damage to air conditioners, vents or skylights
  - Cracks, blisters or brittle membranes.