# Ways to reduce blistering in built-up roofs

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# Ways to Reduce Blistering in Built-Up Roofs

*by R.M. Paroli and R.J. Booth*

**Blistering is a common problem with field-applied built-up roofing systems. This Update explains what blistering is, describes the causes and recommends ways of dealing with it.**

Statistical data from the United States show that blistering was the most common problem with built-up roofs from 1983 to 1992 (1). Blisters are raised surface areas over voids in a roof system that contain entrapped air and/or moisture. As the roof surface temperature rises, the pressure inside the blisters rises and the adhesion of the asphalt weakens. Usually noticeable on hot and sunny days, blisters range from small spongy spots to large pronounced areas.

*Figure 1. Blistering occurs when pockets of air and moisture trapped between the plies of the membrane, or between the membrane and substrate, expand and displace the membrane.*

It has been demonstrated that a perfect void-free roof cannot be laid even under ideal conditions (2). Voids can result from skips in bitumen mopping, entrapped debris, curled felts, uneven substrates, and from moisture on the roof or in the materials leading to entrapped gases and bitumen bubbling. Blisters develop from voids built into the roof.

One misconception about blisters is that they are perfectly sealed. This is not the case, for if it were, the blisters would never grow beyond the limits dictated by their gas content and the maximum temperature of the roof surface.

## Types of Blistering

Blistering of built-up roofing takes two main forms: blisters between the roof membrane and the substrate, and blisters between the membrane plies.

### Blisters Between the Roof Membrane and the Substrate

Pockets of air and moisture, trapped between the membrane and substrate, expand in the sudden heat of the sun and displace the membrane to form a small blister. The blister will only be formed when the substrate material has low permeability; under these circumstances, temperatures from the heat of the sun can rise too quickly for trapped air and water vapour to escape through the substrate. Pressures will then develop in the air

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pockets, which can cause displacement and stretching of the roof membrane, increasing the size of the air pocket/blister.

If the roof membrane suffers an irreversible stretch, subsequent cooling will not cause the air pocket to return to its original size and a partial vacuum will be created in the now partly developed blister. Air and water vapour may be drawn slowly through the substrate to refill the original pocket of air, now slightly increased in size and ready to start another cycle of development of the blister when the sun appears again.

An increased occurrence of blistering between cellular foam insulations and roof membranes was initially thought to be due to gases escaping from the cells of these insulations. Although there is little evidence for this, it is clear that the impermeable nature of cellular foam insulations can increase the incidence of blistering because of their inability to vent gases both during and after the installation of the roof. The use of a fibrous coverboard (wood fibre, glass fibre, or perlite board) over cellular insulations is recommended to reduce the occurrence of blisters in built-up roofs (3,4).

**Blisters Between Membrane Plies**

The traditional concept of inter-layer blistering assumes that blisters are caused by air and moisture trapped between the layers during application. In reality, substantial blisters cannot form without a topping-up process to add more air and moisture between the layers. Pressure levels measured inside blisters are lower than those expected from sealed systems, and it is clear that blisters inhale and exhale daily (5).

In a perfectly closed and elastic system, a void within a roof will grow because of the expansion of air and/or water vapour by day, but it will revert to its original dimensions at night. Built-up roofing membranes are not perfectly elastic; they expand easily when they are warm but become stiff and resist returning to their original shape when they are cooled. Any permanent deformation of the membrane will create a vacuum within the blister and air will find its way into the enclosed space through microscopic cracks in bitumen moppings or along the felts themselves.

Blisters grow when:

- the volume of air sucked into them at night exceeds the volume of air forced out of them by day, and
- this increased pressure overcomes the peripheral bond of the blister.

### *Ways to Reduce Blistering*

A few small voids do not pose a problem with respect to membrane blistering as membrane elasticity and adhesion can accommodate small movements. Numerous large voids, however, will result in membrane blistering problems.

The following actions will limit the number and size of voids built into roofs:

- Use dry materials in dry conditions.
  - Seal concrete decks with good quality air/vapour retarders.
  - Store materials under tarps and off the roof surface.
  - Avoid any wetting of materials, as this brings moisture to the roof.
  - Make sure substrates are dry before commencing work.

- Use special precautions in winter. Days are shorter, the air is cooler and asphalt stays hot for a shorter period. This means there is more chance of having moisture present and less chance of it drying. What is more, “holidays” (voids in asphalt) are more likely to occur when asphalt cools quickly.
  - Start the workday later and finish earlier.
  - Use higher asphalt temperatures and insulated equipment.

- Ensure intimate contact between materials.
  - Fit insulation boards snugly and make sure they adhere well to the substrate.
  - Use fibrous coverboards over all cellular plastic insulations to allow venting of gases during application.
  - Broom-in organic felts to force any gases out of the roof before they become trapped as the asphalt sets.

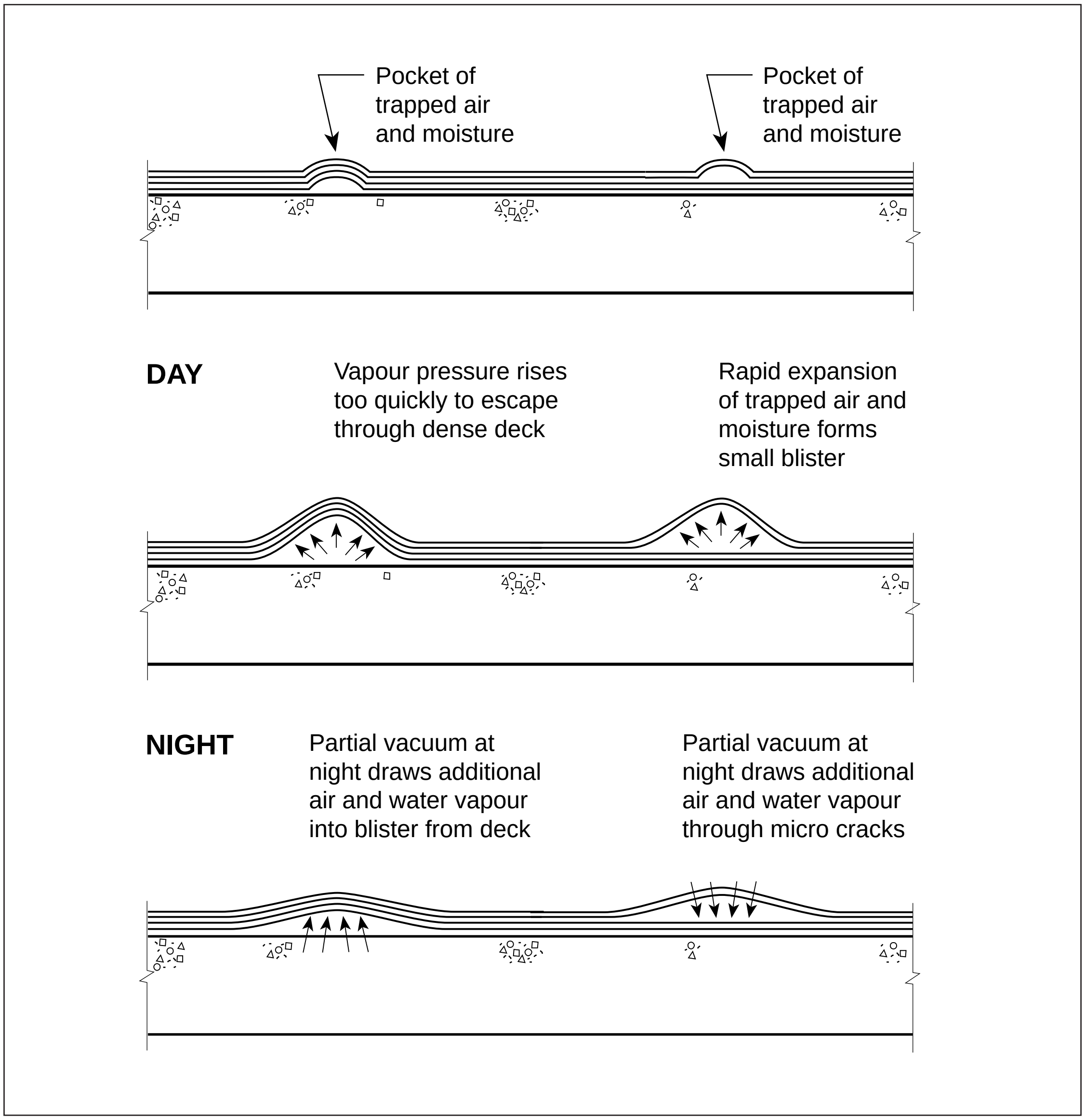


*Figure 2.* *Formation of roof membrane blisters*

## *Treatment of Blisters*

Small blisters, less than .6 m (2 ft) long, are better left unattended. They usually do not cause problems, provided they remain watertight and do not become too large. Larger blisters should be repaired promptly, especially if the protective coating or gravel surfacing has slumped off.

Eroded bare spots on small blisters can be treated with a cold-process asphalt coating and sprinkled with gravel. If a blister approaches a diameter of about .6 m (2 ft), it is recommended that its outer boundary be marked so that it can be checked periodically to determine if it is getting larger.

When they grow to about 1.5 m (5 ft), or if they occur in a high-traffic area, blisters should probably be repaired. To prevent the breaking of blisters, avoid stepping on them, if at all possible, particularly when the membrane is cold.

If a blister is broken or otherwise capable of taking in water, the usual repair process is to remove the entire raised portion and patch the remaining void with alternate layers of asphalt and successively larger pieces of felt. Alternatively, an "X" can be cut into the blister, the corners of the cut peeled back, the resulting cavity filled with asphalt, and the corners pressed back into the bitumen. The blister is then patched as above.

As an alternative to traditional repair methods, contractors should consider using specially designed vents developed by the Cold Regions Research and Engineering Laboratory of the U.S. Army Corps of Engineers. These vents, which allow for quick repair, are available commercially (5).

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