Concrete in Practice
What, why & how?
NRMCA

CIP 13 - Blisters on Concrete Slabs

WHAT are Blisters

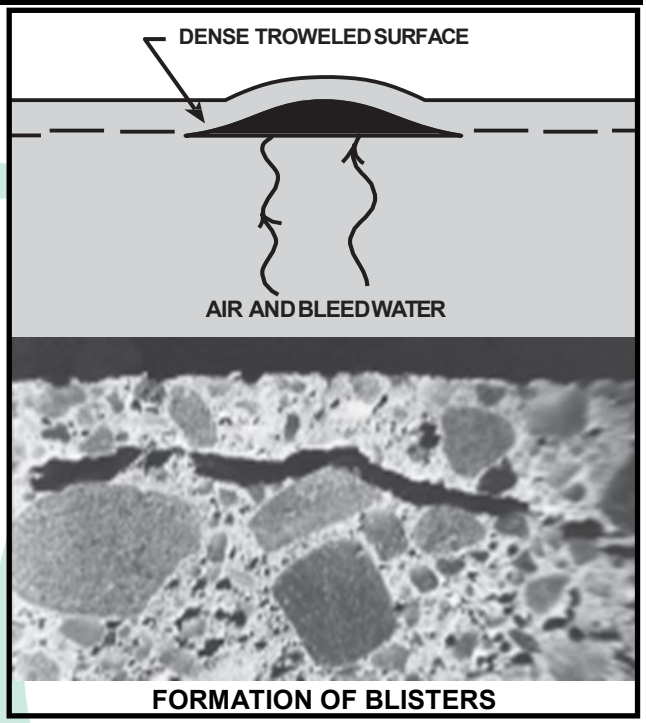
Blisters are hollow, low-profile bumps on a concrete slab surface, that can range in size from ¼ to 4 inch (12 to 100 mm) in diameter with a dense skin of mortar about ⅛ in. (3 mm) thick covering an underlying void. The dense surface is typically caused by successive finishing with a trowel and generally when the surface is prematurely finished or if the concrete surface stiffens or sets faster than the underlying concrete. Blisters may occur shortly after the completion of the finishing operation. In poorly lighted areas, small blisters may be difficult to see during finishing and may not be detected until they break under traffic.

WHY do Blisters Form

Blisters typically form on the surface of fresh concrete when either entrapped air or bleed water migrate through the concrete and become trapped under the surface that has been sealed to almost airtight due to premature and excessive finishing of the slab surface. Larger areas of this type of surface defect are referred to as delamination. See CIP 20. These defects are not easily repaired after concrete hardens.

Blisters are more likely to form for the following reasons:

1. Insufficient or excessive vibration is employed. Insufficient vibration retains entrapped air in fresh concrete that will migrate upwards. Excessive vibration on higher slump concrete, such as caused by the use of vibrating screeds, pushes coarse aggregate downward and works up a thick mortar layer to the surface.
2. An improper tool is used for floating the surface or it is used improperly. The surface should be tested to determine which tool does not seal the surface. Typically a wood float is used for air-entrained concrete' magnesium or aluminum floats are used on air-entrained concrete. The float tool should be kept as flat as possible. Float pans may cause finishing to begin too early because of the greater weight distribution and should be timed to ensure the surface is ready.
3. When conditions are conducive to excessive evaporation of bleed water, the concrete surface may appear to be ready for final finishing, when, in fact, the underlying concrete is still releasing bleed water and entrapped air. Rate of evaporation is related to ambient and concrete temperature, humidity and windy conditions.
4. The subgrade is cooler than concrete and the ambient temperature. The top surface sets faster than the underlying concrete and the surface appears ready to be finished while the concrete is still bleeding.
5. Entrained air is used or is higher than normal. Rate of bleeding and amount of bleed water is reduced in air-entrained concrete giving the appearance that the concrete is ready to float and finish.
6. The slab is thick and it takes a longer time for the entrapped air and bleed water to rise to the surface.
7. The concrete mixture is sticky from higher content of cementitious materials, higher sand content, or excessive fines in the sand. These mixtures also bleed less and at a slower rate. A mixture with less sand or fines will release most of the entrapped air with normal vibration.
8. A dry shake surface hardener is prematurely applied, particularly over air-entrained concrete. Surface hardeners should properly integrate into



FORMATION OF BLISTERS

underlying concrete.

9. The slab is placed directly on top of a vapor retarder or a saturated base, preventing bleed water from being absorbed by the subgrade.

HOW to Prevent Blisters

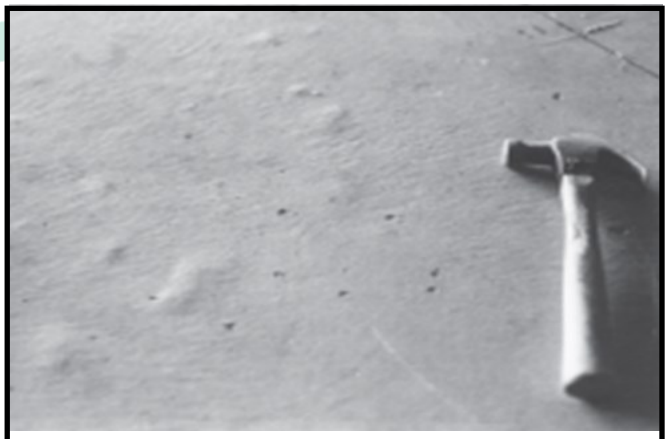
The finisher should be wary of a concrete surface that appears to be ready for final finishing before normally expected. Emphasis in finishing operations should be on placing, consolidation, strike off, and floating the concrete without working up a layer of mortar on the surface. For initial floating, float blades should be flat to avoid densifying the surface. Use of power float pans should be properly timed.

Subsequent finishing should be delayed to allow for bleeding and the concrete to achieve set. With high evaporative conditions, cover the slab with plastic sheet; or use fog sprays or evaporation retardants. If the surface is crusting, modify finishing procedures to keep the surface open and to avoid folding air into the concrete with the finishing tools. Adequate set is generally when a worker's shoe makes a ¼ in. (6 mm) imprint on the slab; less for power finishing. With power finishing, continue operations before the slab has set through its depth.

In cold weather the subgrade should be heated. Concrete temperature should exceed 50°F (10°C) and contain an accelerating admixture for faster set.

Non air-entrained concrete should be used for interior slabs. Steel troweling air-entrained normal weight concrete should be avoided. Concrete mixtures should not have a high water content, high mortar fraction, or excessive cement content. Slump should be in the range of 3 to 5 in. (75 to 125 mm).

Blisters may form during the second or third pass of troweling as the blades are tilted causing air and water to be moved beneath the surface to accumulate at spots. This indicates that the trowel blades are inclined too much for the existing conditions. The trowel blades should be flattened to eliminate and rebond the blister areas. A wood tool could be used to open up the surface. In some cases, climatic conditions and the concrete mixture may be the factors that are causing blisters. The crew size should be adequate to handle finishing larger areas or for tight schedules to complete work, so that timing of finishing operations is not too early on some portions of the slab. Additional information and recommendations are given in ACI 302.1R.



BLISTERS ON CONCRETE SLAB

References

1. Guide for Concrete Floor and Slab Construction, ACI 302.1R, American Concrete Institute, Farmington Hills, MI, www.concrete.org
2. Slabs on Grade, ACI Concrete Craftsman Series, CCS 1, American Concrete Institute, Farmington Hills, MI.
3. Concrete Slab Surface Defects: Causes, Prevention, Repair, IS 177, Portland Cement Association, Skokie, IL. www.cement.org
4. Concrete Surface Blistering—Causes and Cures, Carl O. Peterson, Concrete Construction, September 1970. www.concreteconstruction.net
5. CIP 14 - Finishing Concrete Flatwork; CIP 20 - Delamination of Troweled Concrete Surfaces, NRMCA CIP Series. Alexandria, VA, www.nrmca.org.
6. Finishing, Concrete Construction, August 1976, www.concreteconstruction.net

Follow These Rules to Avoid Blisters

1. Order the right concrete mixture for slab surfaces that have to be hard troweled.
2. Concrete should have uniform setting through the depth of the slab in cooler weather.
3. Do not add excessive water to the load before it is discharged.
4. Do not overwork the surface to trap air or bleed water while the concrete is still plastic. Use a wooden float on non-air-entrained concrete to prevent early sealing.
5. Avoid using dry shakes surface hardeners on air-entrained concrete.
6. Avoid placing slabs directly on vapor retarders or on saturated subgrade. Avoid premature finishing.
7. Protect surface from premature drying and evaporation that results in surface crusting.
8. Avoid excessive consolidation, such as by using a vibratory screed on slumps over 5 inches (125 mm).
9. Air entrained normal weight concrete should not be steel troweled. If required by specifications, modify finishing procedures to allow air and bleed water to escape before final troweling.

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