WHAT are Delaminations?

In most delaminated concrete slab surfaces, the top 1/8 to 1/4 inch (3 to 6 mm) is densified, primarily due to premature and improper finishing, and separated from the base slab by a thin layer of air or water. The delaminations on the surface of a slab may range in size from several square inches to many square feet. The concrete slab surface may exhibit cracking and color differences because of rapid drying of the thin surface during curing. Traffic or freezing may break away the surface in large sheets. Delaminations are similar to blisters, but much larger (see CIP 13).

Delaminations form during final troweling. They are more frequent in early spring and late fall when concrete is placed on a cool subgrade with rising daytime temperatures, but they can occur at anytime depending on the concrete characteristics and the finishing practices used.

Corrosion of reinforcing steel near the concrete surface or poor bond between two-course placements may also cause delaminations (or spalling). The resulting delaminations are generally thicker than those caused by improper finishing.

Delaminations are difficult to detect during finishing but become evident after the concrete surface has set and dried. Delaminations can be detected by a hollow sound when tapped with a hammer or with a heavy chain drag. A procedure is described in ASTM D 4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding. More sophisticated techniques include acoustic impact echo and ground-penetrating radar.

WHY does Delamination Occur?

Bleeding is the upward flow of mixing water in plastic concrete as a result of the settlement of the solids. Delamination occurs when the fresh concrete surface is sealed or densified by troweling while the underlying concrete is still plastic and continues to bleed and/or to release air. Delaminations form fairly late in the finishing process after floating and after the first troweling pass. They can, however, form during the floating operation if the surface is overworked and densified. The chances for delaminations are greatly increased when conditions promote rapid drying of the surface (wind, sun, or low humidity). Drying and higher temperature at the slab surface makes it appear ready to trowel while the underlying concrete is plastic and can still bleed or release air. Vapor retarders placed directly under slabs force bleed water to rise and compound the problem.

Factors that delay initial set of the concrete and reduce the rate of bleeding will increase the chances for delaminations. Entrained air in concrete reduces the rate of bleeding and promotes early finishing that will produce a dense impermeable surface layer. A cool subgrade delays set in the bottom relative to the top layer.

Delamination is more likely to form if:

1. The underlying concrete sets slowly because of a cool subgrade.
2. The setting of the concrete is retarded due to concrete temperature or mixture ingredients.
3. The concrete has entrained air or the air content is higher than desirable for the application.
4. The concrete mixture is sticky from higher cementitious material or sand-fines content.
5. Environmental conditions during placement are conducive...
to rapid drying causing the surface to “crust” and appear ready to finish.

6. Concrete is excessively consolidated, such as the use of a jitterbug or vibrating screed that brings too much mortar to the surface.

7. A dry shake is used, particularly with air-entrained concrete.

8. The slab is thick.

9. The slab is placed directly on a vapor retarder.

Corrosion-related delaminations are formed when the upper layer of reinforcing steel rusts thereby breaking the bond between the steel and the surrounding concrete. Corrosion of steel occurs with reduced concrete cover and when the concrete is relatively more permeable causing chlorides to penetrate to the layer of the steel (See CIP 25).

**References**

1. Guide for Concrete Floor and Slab Construction, ACI 302.1R American Concrete Institute, Farmington Hills, MI [www.concrete.org](http://www.concrete.org)
2. Slabs on Grade, ACI Concrete Craftsman Series, American Concrete Institute, Farmington Hills, MI.
3. Concrete Slab Surface Defects: Causes, Prevention, Repair, IS177, Portland Cement Association, Skokie, IL, [www.cement.org](http://www.cement.org)
6. Concrete in Practice Series, NRMCA, Silver Spring, Maryland, [www.nrmca.org](http://www.nrmca.org).

**Follow These Rules to Avoid Delamination**

1. Do not seal surface early—before air or bleed water from below have escaped.
2. Avoid dry shakes on air-entrained concrete.
3. Use heated or accelerated concrete to promote even setting throughout slab depth.
4. Avoid placing concrete directly on vapor retarders, if the application allows.
5. Do not use air-entrained concrete for interior slabs that will receive a trowel finish.
6. Avoid placing concrete on substrate with a temperature of less than 40° F (4° C).