NRMCA

What, Why & How?

Scaling Concrete Surfaces

CONCRETE IN PRACTICE — CIP 2

WHAT is Scaling?

Scaling is local flaking or peeling of a finished surface of hardened concrete as a result of exposure to freezing and thawing. Generally, it starts as localized small patches which later may merge and extend to expose large areas. Light scaling does not expose the coarse aggregate. Moderate scaling exposes the aggregate and may involve loss of up to $^1/_8$ to $^3/_8$ inch [3 to 10 mm] of the surface mortar. In severe scaling more surface has been lost and the aggregate is clearly exposed and stands out.

Note—Occasionally concrete peels or scales in the absence of freezing and thawing. This type of scaling is not covered in this CIP. Often this is due to the early use of a steel trowel, over-finishing or finishing while bleed water is on the surface. (see CIP 20 on Delaminations)

WHY Do Concrete Surfaces Scale?

Concrete slabs exposed to freezing and thawing in the presence of moisture and/or deicing salts are susceptible to scaling. Most scaling is caused by:

a. The use of *non-air-entrained concrete* or too little entrained air. Adequate air entrainment is required for protection against freezing and thawing damage. However, even air-entrained concrete will scale if other precautions, as listed below, are not observed.

b. Application of excessive amounts of calcium or sodium chloride deicing salts on concrete with inadequate strength, air entrainment, or curing. Chemicals such as ammonium sulfate or ammonium nitrate, which are components of most fertilizers, can cause scaling as well as induce severe chemical attack on the concrete surface.

c. Any finishing operation performed while bleed water is on the surface. If bleed water is worked back into the top surface of the slab, a high water-cement ratio and, therefore, a low-strength surface layer is produced. Overworking the surface during finishing will reduce the air content in the surface layer, making it susceptible to scaling in freezing conditions.

Scaling concrete surface

d. Insufficient curing. This omission often results in a weak surface skin, which will scale if it is exposed to freezing and thawing in the presence of moisture and deicing salts.

HOW to Prevent Scaling

a. Concrete exposed to freezing and thawing cycles must be air-entrained. Severe exposures require air contents of 6 to 7 percent in freshly mixed concrete made with $^3/_4$-inch [19 mm] or 1-inch [25-mm] aggregate. In moderate exposures, where deicing salts will not be used, 4 to 6 percent air will be sufficient. Air-entrained concrete of moderate slump (up to 5 inches [125 mm]) and adequate quality should be used. In general, concrete strength of 3500 psi [24 MPa] for freezing and thawing exposure and 4000 psi [28 MPa] when deicers are used should be adequate to prevent scaling.

b. *DO NOT* use deicing salts, such as calcium or sodium chloride, in the first year after placing the concrete. Use clean sand for traction. When conditions permit, hose off accumulation of salt deposited by cars on newly placed driveways and garage slabs. Subsequently, use salt sparingly. *Never use ammonium sulfate or ammonium nitrate as a deicer;* these are chemically aggressive and destroy concrete surfaces. Poor drainage, which permits water or salt and water to stand on the surface for extended periods of time, greatly increases the severity of the exposure and may cause scaling. (This is often noticed in gutters and sidewalks where the snow from plowing keeps the surface wet for long periods of time.)

c. Provide proper curing by using liquid membrane curing compound or by covering the surface of newly placed slab with wet burlap. Curing ensures the proper reaction of cement with water, known as hydration, which allows the concrete to achieve its highest potential strength.

d. *DO NOT* perform any finishing operations with water present on the surface. Bull floating must promptly follow initial screeding. Delay finishing operations until all the bleed water has risen to and disappeared from the surface. This is critical with air-entrained concrete in dry and windy conditions where concrete that is continuing to bleed may appear dry on the surface.

e. Do not use a jitterbug or vibrating screed with high slump concrete, as it tends to form a weak layer of mortar on the surface.

f. Protect concrete from the harsh winter environment. It is important to prevent the newly placed concrete from becoming saturated with water prior to freeze and thaw cycles during winter months. Apply a commercially available silane or siloxane-based breathable concrete sealer or water repellent specifically designed for use on concrete slabs. Follow the manufacturer's recommendations for application procedures and frequency. Another option is a 1:1 mixture of boiled linseed oil and mineral spirits applied in two layers. The concrete should be reasonably dry prior to the application of a sealer. Late summer is the ideal time for surface treatment. The sealer can be sprayed, brushed, or rolled on the surface of the concrete. *CAUTION:* Linseed oil will darken the color of the concrete and care should be taken to apply it uniformly.

HOW to Repair Scaled Surfaces

The repaired surface will only be as strong as the base surface to which it is bonded. Therefore, the surface to be repaired should be free of dirt, oil or paint and, most importantly, it must be sound. To accomplish this, use a hammer and chisel, sandblasting, high-pressure washer, or jack hammer to remove all weak or unsound material. The clean, rough, textured surface is then ready for a thin bonded resurfacing such as:

a. Portland cement concrete resurfacing
b. Latex modified concrete resurfacing
c. Polymer-modified cementitious-based repair mortar

References

1. *Guide to Durable Concrete*, ACI 201.2R, American Concrete Institute, Farmington Hills, MI.
2. *Scale-Resistant Concrete Pavements*, IS117.02P, Portland Cement Association, Skokie, IL.
3. *Protective Coatings to Prevent Deterioration of Concrete by Deicing Chemicals*, National Cooperative Highway Research Program Report No. 16.
4. *Guide for Concrete Floor and Slab Construction*, ACI 302.1R, American Concrete Institute, Farmington Hills, MI.
5. *Residential Concrete*, National Association of Home Builders, Washington, DC.
6. *Slabs on Grade*, Concrete Craftsman Series CCS-1, American Concrete Institute, Farmington Hills, MI.
7. Eugene Goeb, *Deicer Scaling: An Unnecessary Problem*, Concrete Products, February 1994.

Follow These Rules to Prevent Scaling

1. For moderate to severe exposures, use air-entrained concrete of medium slump (3-5 in. [75-125 mm]) and cure properly.
2. Do not use deicers in the first winter.
3. Seal the surface with a commercial sealer or a mixture of boiled linseed oil and mineral spirits.
4. Use correct timing for all finishing operations and avoid the use of steel trowels for exterior concrete slabs.
5. Specify air-entrained concrete. In cold weather, concrete temperature should be at least 50°F [10°C], contain an accelerating admixture, and be placed at a lower slump.

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