Scaling Concrete Surfaces

Technical information prepared by Ohio Concrete

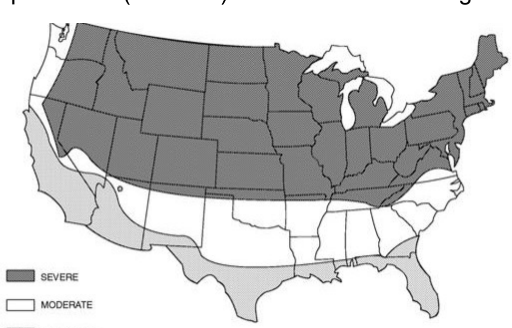
SCALING:

Scaling, as defined by ACI Committee 116R, is the 'local flaking or peeling away of the near-surface portion of hardened concrete or mortar'. It is primarily a physical action created by hydraulic pressures from repeated cycles of water freezing within the concrete. The expansive force by ice formation is exacerbated with deicing chemicals by increasing the saturation of concrete and number of freezing and thawing cycles. The distress mechanisms of scaling with freeze-thaw cycles combined with deicing chemicals are complex on both a microscopic and macroscopic level.

ACI classifies scaling as light (*loss of surface mortar without exposure of coarse aggregate*), medium (*loss of surface 0.2 to 0.4 in. in depth and exposure of coarse aggregate),* severe (*loss of surface 0.2 to 0.4 in. in depth with some loss of mortar surrounding aggregate particles 0.4 to 0.8 in. in depth*) and very severe (*loss of coarse aggregate particles as well as surface mortar, generally to a depth greater than 0.8 in.*)

SCALING IN OHIO:

Ohio is in a severe exposure level weather climate where exterior concrete is subjected to continuous moisture, cycles of freezing and thawing, and use of deicing chemicals making it more susceptible to scaling. Thus, exterior concrete must be proportioned with durable ingredients achieving adequate strength, density and a proper air-void system throughout its depth by proper placement, finishing, curing and protection to resist hydraulic pressures (stresses) that can cause scaling.



TYPICAL CAUSES OF SCALING:

The most common causes of scaling are related to one or a combination of the following factors:

- The use of non-air-entrained or too little entrained air, especially at the surface resulting in a poor air-void system,
- Using concrete with low strength or excessively high water-cementitious ratio allowing deeper permeation of water and deicing solutions,
- Improper finishing operations that works or traps water at the slab's top resulting in a low strength, low durability surface layer,
- Early or accelerated drying of the exposed concrete surface during finishing that inhibits strength/durability development resulting in a weak surface,
- Lack of, or inadequate curing and protection. Choosing the appropriate curing and protection methods, with the proper timing and amount must match ambient conditions at time of placement to ensure desired concrete properties, especially at the surface (i.e. strength, permeability resistance, and durability),
- Exposure of new concrete (less than a year old) to freezing and thawing before it has been adequately cured, not achieving a compressive strength of 4,000 psi, and not allowed to air dry. Intentional application or incidental exposure to deicing chemicals at this early age greatly increases the likelihood of scaling,
- Exposure to aggressive/corrosive (magnesium or ammonium-based) salts and fertilizers.

GUIDELINES TO MINIMIZE THE POTENTIAL FOR SCALING IN OHIO

1. Use a proper concrete mix with durable and well graded aggregates, low water-cementitious ratio – 0.45 or less, minimum 4000 PSI compressive strength, (consistent with the requirements of ACI 332, Code for Residential Concrete), and 5 - 8% entrained air for 3/4 – 1 inch size aggregates.
2. Utilize proper finishing practices. Concrete that is prematurely floated or troweled while added water or bleed water is on the surface tends to scale. Excessive floating or troweling, including with power equipment, ruptures the entrained air bubbles at the surface and weakens the surface paste which leads to scaling. Remixing water into the top of the slab can cause the formation of a crust of surface laitance that will scale. In addition, finishing concrete before the bleed water comes to the surface can entrap water near the surface forming a weakened zone or void, which can result in surface scaling or delamination.

3. Cure the concrete slab immediately after finishing for a minimum of 7 days, or longer when ambient temperatures are cooler, or until the concrete attains 70% of the specified compressive strength. Curing is the maintenance of consistent and desired moisture content and temperature directly following finishing so that properties such as strength and durability may develop, especially at the exposed surface. After curing, allow the concrete 30 days to air dry. The curing requirements include protection from either excessive hot or cold temperatures.
4. Properly slope the concrete surface to drain water away from the slab. Saturated concrete followed by freeze and thaw cycles is susceptible to surface deterioration.
5. Apply a commercially available silane or siloxane-based breathable, penetrating concrete sealer specifically designed for concrete slabs per the manufacturer's recommendations. The concrete should be reasonably dry prior to the sealer application. Applying a sealer is best done when the concrete is cooling down rather than heating up, which usually occurs in the early evening.

ADDED PREVENTION MEASURES

1. Limit the job site addition of water to maintain the w/c ratio below 0.45.
2. Follow proper curing practices per ACI 308R-01 - Guide to Curing Concrete. Caution, concrete that may not have sufficient drying time before exposure to freezing temperatures, such as that placed later in the year, should not have deicing chemicals applied during its first winter. Instead consider using sand or grits for traction over snow and ice.
3. Follow proper hot weather and cold weather concrete construction practices per ACI 305R-10 (Hot Weather) and ACI 306R-10 (Cold Weather) Guidelines.
4. Clean the concrete surfaces and apply a commercial penetrating sealer every 3-5 years per the manufacturer's instructions.
5. Include field inspection services to test the concrete material upon arrival after any re-tempering with water or additives, recording unloading time, and observe the finishing and curing operations.

DEICERS

DO NOT use deicing salts in the first year after placing the concrete, especially if concrete was placed after September. The presence of deicer solution in water-soaked concrete during freezing causes additional buildup of internal pressure. Reducing the deicer application concentrations or rates will result in less damage to concrete.

REPAIR/TREATMENT

Although surface mortar scaling is not desired, it is generally a cosmetic issue not affecting the integrity and application of the slab and therefor may not require repair. For larger areas exhibiting pronounced surface loss, spot grinding to a uniform texture and evenness by removing the affected depth of scaling can be performed. Note that the appearance may be inconsistent.

Resurfacing with thin bonded toppings are also available. The surface will first need to be prepared to a clean, rough texture surface. Test a small section with the topping for adhesion and appearance (color not likely to match existing) before moving forward.

A common treatment for light to moderately scaled exterior concrete surfaces is the application of a sealer to help create a moisture barrier, thus preventing the water to penetrate into the concrete. This can be accomplished with a light power washing of the surfaces to remove all loose material and debris. After a short drying period treat the surface with a high quality penetrating sealer. These products are designed to penetrate into the pores of concrete, and once there, react with the alkaline materials and moisture to form a barrier that limits water and deicer penetration. The application rates will vary based on the specific product.

References:

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