SCALING CONCRETE SURFACES

WHAT is scaling?

Scaling of a concrete surface is the peeling or flaking of the finished surface. Scaling most often occurs on concrete exposed to cycles of freezing and thawing, although some concrete surfaces can scale without the effects of freezing and thawing. This type of scaling is found on interior slabs or floors often due to early use of steel trowels or finishing while bleed water is on the concrete surface.

WHY do concrete surfaces scale?

Concrete slabs exposed to freezing and thawing in the presence of moisture and/or de-icing chemicals are susceptible to scaling. Most scaling is caused by:

- The use of non-air-entrained concrete or too little entrained air. Adequate air entertainment is necessary for protection against freezing and thawing damage. However, even air-entrained concrete will scale if other precautions are not observed.
- Using concrete that has low strength that allows permeation of water.
- Using the improper concrete mixture or mixture proportions for the application.
- Application of excessive amounts of de-icing chemicals, particularly on newly installed concretes that tend to be saturated and of lower strength.
- Any finishing operation performed while bleed water is on the surface. If bleed water is worked back into the top of the slab, a very high water-cementitious ratio and therefore, a low strength surface layer is produced.
- Insufficient or no 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 de-icing chemicals.

HOW to prevent scaling?

The potential for scaling in concrete slabs can be reduced by using good quality dense concrete with entrained air, following good practices for installing and curing and by minimizing the use of de-icing chemicals.

For concrete that will be continuously moist, exposed to freezing temperatures and will be subject to the use of de-icing chemicals, the following recommendations should be followed:

- Use concrete meeting CSA Class C-2 exposure requirements (32 MPa with an air content of 5 to 8% in freshly mixed concrete made with 20 mm aggregate).

- For most slab construction, place concrete with a moderate slump of 75mm up to 125 mm. Do not add excessive water at the jobsite. High slump obtained by adding water increases the potential for segregation and excessive bleeding and can result in a weak mortar layer at the surface. Slump modifying admixtures can provide improved workability and retain good concrete quality (Sask C-2 Mix).

- The quantity of supplementary cementitious materials (SCMs) should not exceed one of the following: 25% flyash, 50% slag or 10% silica fume. SCMs are beneficial to concrete, however, at higher quantities change the rate of setting, bleeding and strength gain. These impact the process of finishing. With appropriate modifications of the finishing procedures, it is possible to use higher quantities of SCMs but would need to be evaluated.

- DO NOT use de-icing chemicals, such as calcium or sodium chloride, on new or recently placed concrete. Use clean sand for traction. Never use ammonium sulphate or ammonium nitrate as a de-icer; 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 causes scaling. (This is often noticed in gutters and sidewalks where the snow from plowing keeps the surface wet for long periods of time). Light applications of salts can be more damaging than heavy applications; even salts carried on cars may cause severe scaling of newly placed driveways and garage slabs.

- Providing proper curing is critical for concrete performance. Covering the surface of freshly placed concrete slabs with wet burlap or curing blankets that will keep the concrete surface moist for 3 to 7 days and at a minimum temperature of 10°C. Curing ensures proper hydration (reaction of cement and water), which allows the concrete to achieve its highest potential strength.

- Placing and finishing procedures can reduce the entrained air content in concrete, making it more susceptible to scaling. DO NOT perform any finishing operations with water present on the surface. Initial screeding must be promptly followed by bull floating. Do not overwork the surface of the concrete. Excessive finishing reduces the air content in the surface layer. For most exterior concretes, a broomed finish is sufficient.

- Do not use a jitterbug or vibrating screed on high slump concrete as it increases segregation and can result in a weak mortar layer at the surface.

- Protect concrete from the harsh winter environment. 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. The concrete should be reasonably dry prior to the application of a sealer. Late summer is the ideal time for surface treatment.

HOW to repair scaled surfaces?

Minor scaling is a cosmetic issue and may not need to be repaired. However, repairing concrete with excessive and progressing scaling may not be feasible.

It is possible to repair light to moderately scaled surfaces. The repaired surface will only be as strong as the base surface to which it is bonded. Therefore, the surface should be prepared to remove the unsound surface to be repaired and should be free of dirt, oil or paint. The surface receiving the repair 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:

- Portland cement concrete resurfacing.
- Latex modified concrete resurfacing.
- Polymer-modified-cementitious-based repair mortar.
- Non cementitious concrete resurfacing materials.

Note: Repair materials may not match the colour or characteristics of the original concrete.

References:

1. Guide to Durable Concrete, ACI 201.2R, American Concrete Institute, Farmington Hills, MI.
2. Scale-Resistant Concrete Pavements, Portland Cement Association, Skokie, IL.
3. Protective Coatings to Prevent Deterioration of Concrete by Deicing Chemicals, National Cooperative Highway Research Program No. 16.
4. Code Requirements for Residential Concrete, ACI 332, American Concrete Institute, Farmington Hills, MI.
5. Residential Concrete, National Association of Home Builders, Washington, D.C.
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.
8. Concrete In Practice Series, CP 5, 11, 14, NRMCA, Silver Spring, MD.
9. IS177 Concrete Slab Surface Defects: Causes, Prevention and Repair Portland Cement Assoc., Skokie, IL. http://www.cement.org/docs/default-source/fc_concrete_technology/durability/is177-concrete-slab-surface-defects-causes-prevention-repair.pdf
10. CIP 2: Scaling Concrete Surfaces, National Ready-Mixed Concrete Association.
11. CAN CSA A23.1-24/A23.2-24.