HAHN READY MIX

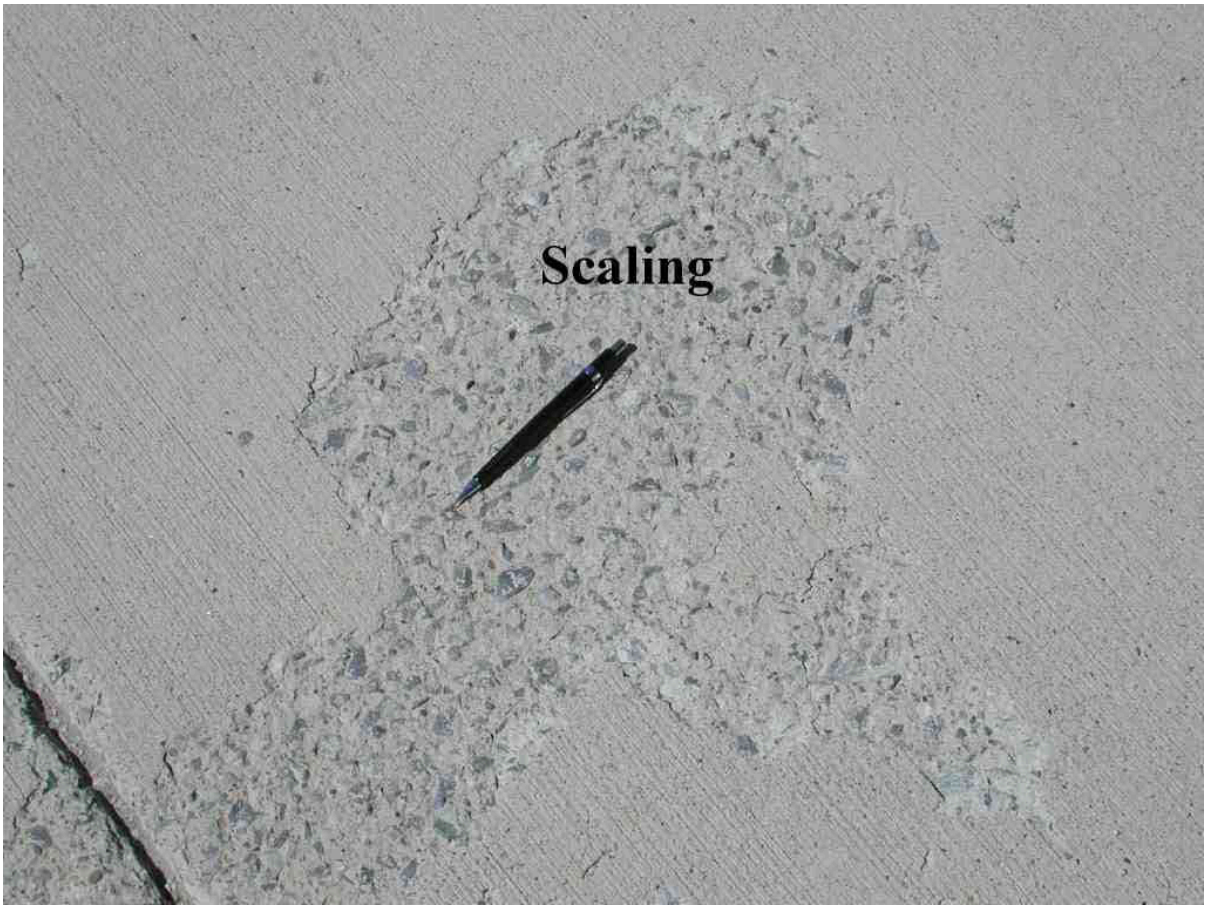
Common Hardened Concrete Issues Pt 2

Technical Bulletin #29 - May 2024

Other forms of Concrete Issues

In part 1, we discussed the different forms and causes of concrete cracks. In this Bulletin, we'll discuss other hardened concrete issues.

Scaling



You can find an in-depth discussion on scaling in Tech Bulletin #4. Essentially, scaling is caused by freeze-thaw damage or salt attack on the surface paste of concrete flatwork. Most often the reasons for scaling to occur include lack of air entrainment, over-finishing, lack of curing, addition of deicer salts, or late-season pouring without proper protection or time to gain freeze-thaw resistance.

Aggregate Popouts

Aggregate Popout

Courtesy PCA

Aggregate popouts occur when a highly absorptive piece of aggregate located near the surface of concrete flatwork absorbs water and then freezes, expands, and ruptures the paste above the aggregate. Commonly, these aggregate particles are chert or shale that are naturally occurring in the coarse or fine aggregate deposits and nearly impossible to identify before they present themselves as a popout. Popouts are not typically a structural concern but can be very unsightly. Popouts can be repaired by drilling the expansive particle out and then patching over them, but this often is more noticeable than the original popout. The only effective preventative measure is to refrain from using aggregates known to cause popouts on exterior concrete flatwork.

Mortar Flaking

Often mistaken for popouts, mortar flaking is a form of scaling where the paste above an aggregate particle becomes weak and is washed away from the surface of the concrete. Mortar flaking is caused by the paste above an aggregate particle drying out during finishing operations and the aggregate particle blocking the pathway of bleed water to hydrate the paste in that area. This is more likely to happen on high evaporation rate days, and can be prevented with proper curing operations. The easiest way to differentiate mortar flaking and aggregate popouts, is popouts will often split the particle and the remainder in the popout will be soft. Mortar flaking happens over a hard aggregate particle and does not split the rock.

Dusting

Dusting concrete surfaces are a symptom of early-age carbonation of the concrete surface or a very weak surface concrete layer due to high water cement ratios. The latter of these is often caused by refinishing bleed water into the surface or adding additional water to the surface for finishing operations. These actions create an extremely high surface water-cement ratio resulting in very low surface strength and susceptibility to wear and abrasion in the form of dusting. The other major cause of dusting - carbonation - is a chemical reaction on the surface of early age concrete where high carbon intensity in the air bonds with the paste in the concrete to form calcium carbonate, which will not gain strength or bond with the rest of the concrete and will dust off. Often this will happen on winter interior floor pours where heaters

are in use and the area is not properly ventilated. **Critically, if the level of carbon in the air is high enough to cause carbonation, it is most likely not safe to work in for extended periods.** There is a high correlation between dusting concrete surfaces and carbon monoxide poisoning in finishers working on the slab. Dusting can sometimes be controlled with a surface hardener, but likely much of the very fine top surface of the concrete will simply wear off. Dusting can also be caused by unsealed virgin wood form liners, as the concrete will pull sugars out of the wood and impair the strength of the concrete surface.

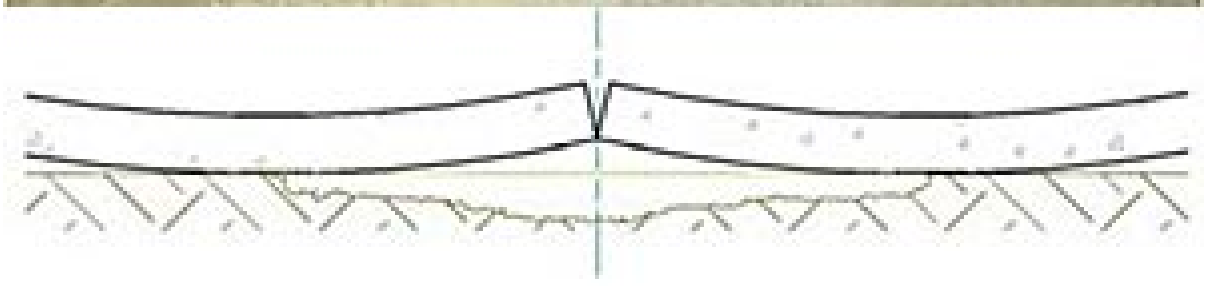
Blisters

Concrete blistering happens when air entrained concrete is steel troweled to create a finished floor. It is easily prevented by keeping the air content of the concrete at 3% or below. Minor blistering can often be worked through, but severe blistering can result in local delamination of the surface paste.

Delamination

Delaminations often occur on finished concrete floors that were not allowed to bleed out fully. If the surface is densified too early, bleed water will be trapped under the densified layer and cause a weak area that will debond and separate the surface from the rest of the concrete. Timing of finishing is critical and control of bleed water can minimize the risk of delaminations. Delamintions can also be caused by rebar corrosion.

Curling



Curling is covered in depth in Tech Bulletin #24, but is caused by differential shrinkage within a slab. This can be prevented by addressing the shrinkage potential of the mix design, thickening the slab, or minimizing the joint spacing, among other strategies.

Bugholes and Honeycombing

Honeycombing and bugholes are imperfections on vertical concrete surfaces. This could be caused by lack of proper vibration and consolidation, a mix being too dry to properly consolidate, a mix not friendly to consolidation due to gap gradations in the aggregates used, or a mix being so wet that it segregates. Sometimes the paste will even run out of gaps in the formwork, leaving the aggregate behind, as often happens in corners. Bugholes and honeycombing are rarely structural issues and are often fixed by repairing with a mortar application to the affected area. However, this can be unsightly on a decorative above grade structure.

Calcium Oxychloride Formation

(a)

(b)

Calcium oxychloride formation is a major concern in Midwestern pavements. Chlorides from deicing salts reacts with inert calcium hydroxide (remember C-H in Tech Bulletin #3?) in the joints to form an expansive product called calcium oxychloride. This product expands and over time absolutely destroys the concrete around the joint. This is why so many of the area's pavements have joint patching or other repairs. The simplest way to address this issue is to reduce the C-H in the concrete, which can effectively be done with high amounts of SCMs like Fly Ash and Slag. A primary premise of the Performance Engineered Mix program that birthed the C-SUD mix designs was to address this phenomenon.

Sulfate Attack

Luckily, sulfate attack is rare to unheard of in our area, but it is a critical concern in many areas of the country. Delayed Entringite Formation (DEF), which we discussed

in the Mass Concrete Tech Bulletin, is actually a form of internal sulfate attack, but here we'll focus on *external* sulfate attack. The reactions that cause sulfate attack are extremely complex, but essentially sulfates in soil, water, fertilizers or other industrial waste products enter into the concrete and change the chemical bonds of the concrete. Critically, they attack the C-S-H molecules, which give the concrete it's strength. Sulfate attack can be minimized by lowering the w/cm ratio, using a Type V cement, class F fly ash, slag, or silica fume.

Efflorescence

Efflorescence is the "sweating" of soluble salts out of concrete. Typically, efflorescence is more noticeable and more of an issue on decorative concrete, but it is not normally harmful. Moisture moving through concrete can carry soluble salts that originated from the subgrade or that were integrated into the concrete from the cement, water or aggregates and bring them to the surface. They are often then washed away by rain or snow, unless they are trapped under a sealer. It may be necessary to strip the sealer, pressure wash the efflorescence away, and then reseal in those situations. Occasionally, a mild acid or even light sandblasting is necessary to remove the salts.

Discoloration

Concrete discoloration is one of the most difficult issues to diagnose as the list of causes is nearly endless. Common causes include: variability in environmental exposures, variability in shading, variability in finishing operations, variability in application of curing methods or sealers, variability or contamination in the subgrade, contamination in constituent materials of the concrete mix, batching error, jobsite addition of water and/or incomplete mixing to incorporate the new water, spills or other external factors, changing mix designs between pours, changing admixture dosages between pours, etc, etc. Many times, concrete will "bleach out" over time and the coloration differences will lessen or become completely unnoticeable. Sometimes, discoloration can be the first clue of a larger issue which requires removal of the concrete.

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