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Discolouration

1. WHAT is Discolouration?

Discolouration is non-uniformity of colour or shading of hardened concrete surface. It may appear as spotted or mottled light or dark blotches, gross colour change in large areas of the concrete, or as early light patches of efflorescence. Discolouration resulting from spillage of foreign materials on the concrete is not discussed in this Tech-Tip

2. WHY Does Discolouration Occur?

Discolouration due to changes in cementitious materials or fine aggregate sources in subsequent batches in a placement sequence could occur, but is generally rare and insignificant. Concrete with a higher w/cm will be generally lighter in colour. Inconsistent use of admixtures, insufficient mixing time, and improper timing of finishing operations can also cause discolouration. Studies have shown that no single factor is responsible for all discolouration.

Factors found to influence discolouration include: calcium chloride admixtures, variations in cement alkali contents, delayed and uneven hydration of the cement paste, admixtures, hard-troweling of concrete surfaces, inadequate or inappropriate curing, concreting practices and finishing procedures that cause variations in the water-to-cementing materials ratio at the concrete surface, and changes in the concrete mix design proportions or constituents.

Efflorescence is a generally harmless powdery deposit, usually white in colour that may appear on the surface of hardened concrete or masonry. It is caused by the migration to the concrete surface of water and soluble salts through evaporation or hydraulic pressures. The water evaporates and leaves a salt deposit on the surface.

Chemicals in the concrete can also react with the air to cause efflorescence. For example, soluble lime at the surface of the concrete can combine with carbon dioxide in the air to produce a white calcium carbonate deposit.

3. HOW to Prevent Discolouration.

a. Minimizing the use of high-alkali cements will reduce the occurrence of discolouration.
b. The possibility of discolouration is reduced if calcium chloride admixtures are eliminated from the concrete mix.
c. Efflorescence can often be prevented by incorporating fly ash into the concrete mix design. Fly ash reacts with water, and free lime given off by cement hydration, to tie up soluble lime that can be a source of efflorescence.
d. Formwork and forming practices can influence surface colour. Forms with different absorption rates can effect cement hydration rates and cause variations in concrete surface colour. Changing the type or brand of forms, releases agents which can also affect the colour consistency of concrete surfaces.

References
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e. Eliminate trowel burning of the concrete surface. Trowel burn is a darkening of the finished surface. One cause is that trowel fragments break off and become embedded in the surface. Another cause is that hard -troweling may densify the concrete surface and reduce the water-cement ratio: the lower water-cement ratio effects hydration of ferrites in the cement and contributes to a darker colour. Conversely, early troweling may increase the surface water-ratio and result in a lighter colour.
f. Improper or non-uniform curing may cause discolouration. Uneven curing can affect cement hydration and result in uneven shading. Covering concrete with waterproof paper or polyethylene sheeting may cause streaking and mottling, because it is difficult to place and keep the covering in complete contact with the covering will tend to be lighter than those which are not. As an alternative to such coverings, a quality curing compound can be evenly applied to the surface of the fresh concrete.
g. To minimize discolouration, moisten absorptive subgrades, follow proper curing procedures and protect concrete from drying by wind, sun, etc.

4. HOW to Remove Discolouration.

The first (and often effective) method for removing or minimizing concrete surface discolouration is an immediate, thorough flushing with water. Allow concrete to dry and then repeat flushing and drying until discolouration disappears. For more stubborn stains, repeated washings with hot water and a scrub brush may be required. Discolouration caused by calcium chloride admixtures, and by some finishing and curing methods, can be reduced by this method.
The water-washing method is the least harmful to both the concrete and the environment, but is not without potential problems. Damage may occur if the wet concrete surface is subjected to freezing temperatures and water can bring soluble salts to the concrete surface, causing efflorescence.

Some success in blending light spots into a darker background may be achieved by treating a dry slab with a 10% solution of caustic soda (sodium hydroxide.)

If discolouration persists, a dilute (1% concentration) of hydrochloric (muriatic) acid or dilute solutions (3% concentration) of weaker acids such as acetic (vinegar) or phosphoric acid may be effective. Dampen the concrete surface prior to applying the diluted solution, to prevent thoroughly with clear water within 15 minutes of application. This treatment may be effective to lesser carbonation and mottled discoloration.

The use of a 20% to 30% water solution of diammonium citrate (1 kg in 4 kg of water) has been found to be a very effective treatment for most discolouration. Apply the solution to a dry concrete surface for 15 minutes. A whitish gel that forms should be diluted with water and brushed. Subsequently, the gel should be completely washed off with water. More than one treatment may be required. This chemical is expensive in small quantities, and should be considered as a last resort.

Some types of discolouration, such as trowel burn, may not respond to treatment. In these cases, paint or other coatings may be necessary to mask the discolouration. Keep in mind, however, that many types of discolouration may fade with wear and age.

Caution
Before using any chemical to treat concrete discolouration, refer to the Safety Data Sheet (SDS) or manufacturer guidelines for information on toxicity, flammability, and/or health and environmental hazards associated with the use of the material. Appropriate safety procedures such as the use of gloves, goggles, respirators, waterproof clothing are strongly recommended.

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