

Concrete in Practice

What, why & how?



CIP 23 - Discoloration

WHAT is Discoloration

Discoloration on concrete surfaces is the non-uniformity of color or hue on the surface of a single concrete placement. It may take the form of dark blotches or mottled discoloration on flatwork surface, gross color changes in large areas of concrete caused by a change in the concrete mixture, or light patches of discoloration caused by efflorescence. In this context, it is not intended to include stains caused by foreign material that comes in contact with the concrete surface after placement and curing, such as storm water runoff, vegetation, irrigation, corrosion products, and oil from automobiles.

WHY does Discoloration Occur

Variation in color due to changes in cementitious materials or fine aggregate in subsequent batches in a placement could occur, but is generally rare and insignificant. Concrete with a higher w/cm will generally be lighter in color. Certain fly ashes can result in darker concrete due to higher carbon content. Concrete containing slag cement generally has a lighter color. In newly placed, concrete containing slag cement, a yellowish to greenish coloration may be evident. This is typically seen on vertical surfaces after formwork is removed. This discoloration disappears with time on exposure to air and sunlight. It has no impact to the quality of concrete. Silica fume concrete is typically darker in color. Inconsistent use of admixtures, insufficient mixing time, and improper timing of finishing operations can cause discoloration on slab surfaces. The discoloration of concrete cast in forms or in slabs on ground is usually the result of a change in either the concrete composition or concrete construction practice. No single factor is identified as a primary cause for discoloration.

Factors found to cause discoloration include: the use of flake form of calcium chloride that may not completely dissolve, variation in cement



Discoloration on a Slab on Ground

alkali content, delayed hydration of cement, some types of admixtures, hard-troweled surfaces, inadequate or inappropriate curing, concreting practices and finishing procedures that cause surface variation of the water-cementitious materials ratio, and changes in the concrete mixture proportions or constituents.

HOW to Avoid Discoloration

1. Calcium chloride in concrete can cause discoloration. Flake or pelletized calcium chloride, when not mixed uniformly, discolors more than liquid calcium chloride.
2. The type, kind, and condition of formwork can influence surface color. Forms with different rates of absorption will cause surfaces with different shades of color. A change in the type or brand of a form release agent can also change concrete color.
3. Eliminate trowel burning (hard troweling of surface after it has become too stiff to trowel properly) of the concrete. Concrete which has been hard-troweled may have dark discoloration as a result of densifying the surface, which reduces the w/cm. The resulting low w/cm affects the hydration of the cement ferrites which contributes to a darker

color. Concrete surfaces that are troweled too early will increase the w/cm at the surface and lighten the color. In general, greater finishing will result in lower w/cm and result in darker colored concrete.

4. Concrete which is not properly or uniformly cured may develop discoloration. Uneven curing will affect the degree of hydration of the cement. Curing with polyethylene with causes discoloration due to moisture condensation. When portions of the plastic sheeting are in direct contact with the concrete while other portions are not, it leads to variable hydration that causes variations in color. An even application of a quality spray-on curing compound may be a better alternative. Curing paper or an absorbent curing cover can be placed flat without wrinkles.
5. The discoloration of a slab may be minimized or prevented by moistening absorptive subgrades, following proper curing procedures, and adding proper protection of the concrete from drying by the wind and sun.
6. With colored concrete, applying a texture or other pattern can minimize the perception of varying color between subsequent loads placed in a slab.

HOW to Remove Discoloration

Certain treatments are successful in removing or decreasing the surface discoloration of concrete flatwork. Discoloration caused by calcium chloride admixtures and some finishing and curing methods can be reduced by repeated washing with hot water and a scrub brush. The slab should be alternately flushed and brushed and dried overnight. This can be repeated until the discoloration disappears.

If a discoloration persists, a dilute solution (1% concentration) of hydrochloric (muriatic) acid or of weaker acids (3% concentration) like acetic (white vinegar) or phosphoric acid may be tried. Before using acids, dampen the surface to prevent it from penetrating into the concrete and flush with clean water within 15 minutes of application.

The use of a 20% to 30% water solution of diammonium citrate (2 lbs. in 1 gallon of water) has been found to be an effective treatment for most discoloration. Apply the solution to a dried surface for 15 minutes. A

whitish gel that forms should be diluted with water and brushed. The gel should be completely washed off with water. Immediately begin wet curing of the treated area and continue wet curing for a minimum of 72 hours. More than one treatment may be required.

Some types of discoloration, such as trowel burns, may not respond to any treatment. It may be necessary to paint or coat the surface. Some types of discoloration may, however, fade with wear and age.

Reference 3 provides guidance for removing stains and discoloration from concrete by mechanical and chemical methods.

PRECAUTIONS

Chemical methods to remove discoloration may significantly alter the color of concrete surfaces. Inappropriate or improper use of chemicals to remove discoloration may aggravate the situation. A trial treatment on an inconspicuous area is recommended. Acids should be thoroughly flushed from a concrete surface.

The user of chemicals should refer to a Safety Data Sheet (SDS) or manufacturer guidelines to be aware of the toxicity, flammability, and/or health hazards associated with the use of the material. The appropriate safety procedures, such as the use of chemical resistant gloves, goggles, respirators, and chemical resistant clothing may be required in the SDS.

References

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