Tips on Integrally Colored Concrete

Concrete that's colored all the way through can be used in walls as well as flatwork. The color can't wear off. And exposed aggregate or deep-broomed finishes are possible because the concrete is colored throughout.

To get good results with integrally colored concrete, pay particular attention to the following details.

Mix Design: Use a minimum cement content of 470 pounds per cubic yard (a 5-bag mix).

Aim for the lowest slump that can still be placed and finished readily and don't exceed a 5-inch slump. Adding extra water to increase slump may cause excessive bleeding and non-uniformity in color.

Avoid using any admixtures that contain calcium chloride. Calcium chloride may cause salt deposits to form on the concrete surface and discolor it.

For air-entrained concrete subjected to freezing and thawing, be aware that some coloring agents such as carbon black will reduce air content. The amount of air-entraining admixture may have to be increased to keep the air content at desired levels.

For large projects, make a mockup wall panel or slab that requires at least 3 cubic yards of concrete. Use the same cement brand, aggregate type, and construction methods that will be used on the job. If necessary, make adjustments in the amount of color added before the project gets under way. Special color blends to match existing structures or specific color needs are available in batch-size packages.

Batching and Mixing: Don't add the color pigment first. It may stick to the mixer baffles and not get uniformly distributed. The best sequence is to first batch some of the aggregate, both coarse and fine, and water. With the mixer running, add the color and mix for at least a minute before adding the balance of materials. Turn the drum at mixing speed for an additional 3 to 5 minutes before the truck leaves the yard.

If pigment is batched from large bags, always use a whole number of bags per truck. Don't try to batch partial bags.

On jobs requiring more than one truckload of concrete, use the same size truck for each load. This is especially important if color is batched from large bags. If you're using three 50-pound bags for a 10-yard load, switching to an 8-yard truck will require using a partial bag of color pigment. Imprecise batching of color pigments almost always causes variations in color.

Don't change cement brands in the middle of the job. Cements from different sources are different shades of gray. Changes in cement color cause changes in the concrete color.

Watch slump particularly closely during batching. Slump variations often indicate that water content has changed, perhaps because of cleanout water left in the truck or changes in the aggregate surface moisture content. Changes in water content also cause color variations.

Forming and Placing Concrete for Vertical Surfaces: Seal joints in forms for vertical surfaces. Water leakage at joints causes changes in water-cement ratio and discoloration near the leak.

Use a nonstaining form release agent and thoroughly clean forms before reusing them. Remnant cement from dirty forms can stain colored surfaces.

Don't allow heads of internal vibrators touch the forms. This causes dark spots called vibrator burns.

It may be necessary to precondition new natural grain wood forms before they're used on a job. This can be done by coating them with a cement slurry that also contains the pigment to be used, then removing the coating.

Make sure that any steel, whether rebar or snap ties, has at least 1½ inches of concrete cover to prevent stains caused by corrosion.

Finishing and Curing Flatwork: Don't start finishing colored concrete until the bleed water has evaporated. Finishing too early causes discoloration and a weak, nondurable surface.

Use mechanical floats or trowels if possible. The one-way motion of the blades creates a more uniform colored surface than the back-and-forth motion used in hand finishing. Move edgers in one direction only to produce a more uniform color.

Concrete in the sun sets at a different rate than concrete in the shade. This may cause differences in color. If possible, time the pour to avoid having sunlit and shaded areas.

Don't add water to the surface during finishing operations. Added water may create a blotchy surface.

Use a liquid membrane-curing compound. Curing with water, wet burlap, plastic sheets, or waterproof paper can cause color to be non-uniform.

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Discoloration of Concrete

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 a concrete construction practice. Following are some of the main causes.

Water-Cement Ratio: A change in the water-cement ratio of a concrete mix can significantly affect color. Such a change may result from localized changes in construction practices or from a batch-to-batch variation in the concrete's water or cement content. A high water-cement ratio will usually produce a light-colored concrete, a low ratio a darker color. Subgrades should also be uniformly moistened before concrete slab-on-ground placement to avoid discoloration due to a localized loss of water from the concrete to the subgrade.

Cement: Individual brands and types of cement may differ in color; therefore, changing the brand or type of cement midway into a job may noticeably change the color of concrete.

Mineral Admixtures: Changes in the amount, source, and chemistry of a mineral admixture can affect concrete color. The extent of the discoloration will depend upon the color and the amount of admixtures used. Some mineral admixtures resemble portland cement and have no effects on concrete color. Silica fume may give concrete a dark grey tint. Dark grey fly ashes may also give concrete a darker colored fly ashes can produce a tan color in concrete if used in large quantities.

Finishing: The type and time of finishing of slabs can significantly alter their color. Hard steel troweling significantly reduces the water-cement ratio of the surface concrete, resulting in a darker color. Localized areas of trowel burn (hard troweling of the surface after it has become too stiff to trowel properly) can cause extreme discoloration by reducing the water-cement ratio at the surface.

Curing: Discoloration caused by curing procedures may be related to (1) the particular curing method used, (2) changes in the curing method used, or (3) non-uniformity of curing. Some curing compounds can discolor concrete surfaces, and air-cured concrete (that is, no curing at all) can cause the worst discoloration.

Efflorescence: Efflorescence is a crystalline deposit, usually white in color, which occasionally develops on concrete or masonry surfaces after construction is complete. Water in moist or wet hardened concrete dissolves soluble salts. This salt-water solution migrates to the surface by evaporation or hydraulic pressure where the water evaporates, leaving a deposit of salt (usually a carbonate) at the surface. If the water, evaporation, or salts are not present, efflorescence will not occur.

Aggregate: Aggregate color may influence concrete color. Occasionally, dark areas occur over coarse aggregate particles near the surface. These dark spots lighten with drying. Some aggregates, such as iron oxides and sulfides, can cause unsightly rust stains if they are located near the surface.

Forms: The type, kind, and condition of formwork can influence surface color. Forms with different rates of absorption produce surfaces with different shades of color. For example, unsealed wood forms will absorb moisture form the concrete, which causes dark-colored surfaces due to the reduced water-cement ratio. Sealed, nonabsorbing-forms, on the other hand, produce lighter surfaces. Absorption discoloration often occurs when form release agents are not uniformly applied to absorptive forms. A change in the type or brand of form release agent can also change concrete color.

Leaky joints in forms can allow water loss from the concrete, producing a change in the water-cement ratio and thereby causing discoloration. Segregation of the concrete within the forms can cause discoloration and sand streaking.
Forms that separate or pull away from the concrete surface, allowing air to come in contact with the surface, can cause a drying discoloration of the exposed area.

Remedies for Discoloration: To remove most discoloration caused by chloride admixtures or finishing and curing methods, the first, and usually effective, remedy is an immediate, thorough flushing with water. The slab should be alternately flushed and then dried overnight until the discoloration disappears. If possible, hot water should be used. Scrub brushes can help remove surface deposits.

If the water wash and scrubbing is unsuccessful, acids and other chemicals can be used. A dilute solution of hydrochloric acid (about 1% to 2% concentration) can remove carbonate efflorescence. Harsh acids should not be used, as they can expose the aggregate. Acid washing using weaker acids, such as 3% acetic acid or 3% phosphoric acid, will remove efflorescence and lessen mottled discoloration. Before an acid is applied, the surface should be dampened with water to prevent the acid from being absorbed deep into the concrete. Acid and other chemical washes should be tested on a small, inconspicuous portion of the discolored concrete to detect possible detrimental effects of the method as well as to determine the method's effectiveness in reducing the discoloration.

Recommendations to Avoid Discoloration: To avoid or minimize discoloration of concrete: (1) do not use calcium chloride admixtures; (2) use consistent concrete ingredients, uniformly proportioned from batch to batch; and (3) use proper and timely placeing, finishing, and curing practices. Concerting practices should not be allowed to vary, as any disruption or change in the concrete mixture, formwork, finishing, or curing can result in significant discoloration.

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