DISCOLORED CONCRETE FLATWORK
...the causes and how to minimize them.

The public has come to think of concrete as a decorative as well as utilitarian material. As a result, their standards for its surface appearance have risen considerably.* They expect concrete in its many guises—floors, sidewalks, driveways, patios and walls—to be attractive. But concrete can become discolored due to conditions present in the concrete itself or as a result of external factors.

In this section we will deal with discoloration of concrete caused by concrete mix design and ingredients, and concreting practices before the concrete has hardened. Discoloration arising from these causes ordinarily takes one of three forms: (1) large areas of contrasting color; (2) black spots or dark "leopard" spots; and (3) white patches caused by efflorescence. Factors which can result in surface discoloration include color and composition of the cement, water/cement ratio, curing, admixtures, and finishing practices.

Gross widespread areas or sections of slabs which contrast with other areas often result because of a change in the cement being used. As is known, cement from different plants can contrast markedly in color before and after it is hydrated. Aggregates also can vary in color from one source to another but this is a minor factor. If more than one ready mix supplier is being used for a job, the resulting color of their concrete could be distinctly different if they use different brands of cement in addition to different mix proportions.

Naturally, there is no way of reducing this contrast in color, since it extends throughout the concrete section, except by application of a coating such as paint over the surface. If uniform color will be important on a job, care should be taken to ensure that all exposed concrete will be made from similar materials.

Even with the same concrete ingredients, a distinct change in color can result from a change in the water/cement ratio. A low water/cement ratio cement paste is characteristically darker than one with a high ratio. Construction practices and mix designs which could result in localized variations in the water/cement ratio—such as conditions conducive to bleeding, and indentations in the surface which could collect water—must be avoided.

Non-uniform curing and the curing procedure employed also have a bearing on variation in concrete color. Air-cured concrete—concrete which is not moist-cured at all—exhibits the greatest amount of discoloration. Thoroughly moist-cured concrete exhibits the least amount of discoloration. Gradations between these two conditions exhibit corresponding amounts of color variations. Non-uniform curing will result in patchy, unattractive discoloration.

Uneven curing will often result in uneven coloring. Therefore, if even coloration is important, care must be exercised to ensure that the curing membrane is applied over the entire surface of the slab in a reasonably uniform amount. Moisture barriers such as polyethylene film and waterproof paper must be thoroughly sealed at joints, anchored carefully along edges and be as flat as possible.

Curing by means of a flexible moisture barrier, such as polyethylene film, can result in a pronounced mottled effect. This is referred to as the "greenhouse effect." It is experienced when such materials are allowed to become rippled over concrete containing calcium chloride. On warm days each ripple becomes in effect a miniature greenhouse wherein a water evaporation-condensation cycle is repeated many times. The results are white efflorescence plus variations in color caused by

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build-up of condensate water at the perimeter of the ripple and at low spots in the concrete surface. It is extremely difficult and time-consuming on a project of anything but the smallest size to smooth out the wrinkles that a polyethylene film is prone to form. Other means of curing are recommended where uniform surface color is important.

As has been implied, calcium chloride in concrete can contribute to the amount of discoloration experienced. The effect of calcium chloride will depend on the alkali content of the cement used. If there is a relatively small amount of cement alkalis, compared to the calcium chloride, light spots may occur on a dark background when the concrete is not moist cured. If the converse is true—a high ratio of cement alkalis to calcium chloride—dark spots on a light background often develop in the absence of moist curing. (See “Moist Spots on Floor,” CONCRETE CONSTRUCTION December, 1966, pages 484-486.)

On smooth, hard troweled slabs, complaints are sometimes raised on the development of dark and light spots. Such complaints are infrequently experienced with rough finished surfaces (burlap drag, rough broomed, or floated) because the rough texture camouflages the discoloration to some extent and spotting is not as frequently encountered with this type of surface finish.

Blackening of the surface is especially common when the flatwork is burned by late and vigorous troweling. It appears that this blackening occurs due to a combination of abrading of the metal from the trowel on the hardened concrete and a pronounced reduction of the water/cement ratio at the surface. Curing and subsequent corrective treatments effect little, if any, improvement.

Other factors which have an effect on discoloration include subgrade, protection, dusting the surface with cement, and application of mortar or cement paste to the surface. Concrete placed on a subgrade with varying absorptive capacities will vary in water/cement ratio according to the amount of water absorbed by the subgrade. This, in turn, will produce dark and light areas. In a like manner, concrete which is not protected from drying winds and sun will experience varying amounts of curing and deposition of salts on the surface. Dusting overly wet concrete surfaces with cement to speed finishing time and smearing of plastic mortar or cement paste on concrete surfaces which have hardened too much to complete finishing result in discoloration.

to avoid discoloration

(1) Prepare carefully. Develop a uniform non-absorptive subgrade; schedule concrete deliveries and the work crew to avoid variations in placing and finishing procedures; arrange for adequate protection of the concrete.

(2) Avoid, if possible, ordering concrete from more than one source; if this is impossible, make sure that they use the same cement, aggregates, and admixtures. Avoid the use of calcium chloride, especially in concretes with a low alkali content.

(3) Standardize concreting and finishing practices and protect the concrete between finishing operations.

(4) Time troweling to prevent burning of the surface.

(5) Cure the concrete thoroughly and uniformly, using a wet-curing technique if possible.

corrective measures

(1) Large areas of contrasting color caused by different concrete-making materials: As was stated earlier, the only corrective treatment for this type of discoloration is the application of some type of opaque coating. This coating could be paint; or in the case of colored concrete, the use of one of the floor waxes in various colors offered by some manufacturers to match their color floor shake materials. (See “Building A Dust-Free Colored Industrial Floor,” CONCRETE CONSTRUCTION, January, 1967, pages 3-4.)

(2) Dark spots: In concrete not containing calcium chloride, dark spots can often be removed with a single washdown of water. In concrete containing calcium chloride, it is often necessary to wash the area several times. It appears that best results are obtained when such discolored concrete is washed soon after the spots appear.
(3) Light spots: Light spots are usually more difficult to remove. Repeated washings or weathering often causes the dark background to lighten, approaching the shade of the spots. A chemical corrective treatment often used to eradicate light spots is the application of a strong lye wash. With this type of treatment, a ten percent solution of sodium hydroxide (caustic soda) is distributed over the dry slab. This is allowed to remain in place for 1-2 days and then is removed by thoroughly washing the surface. This type of corrective treatment is most effective when applied soon after the concrete has been cured.

Strong acid treatments generally have proven to be costly and dangerous to apply, difficult to control, and not particularly effective in reducing this type of discoloration.

Tests have indicated that di-ammonium citrate might be a safe, highly effective means of removing discoloration. Unlike acids, it is not dangerous to handle. When applied to a dry, discolored slab it penetrates the surface and works on the hardened cement paste to render the slab surface more porous. After the treatment the surface should be scrubbed and wet down thoroughly for several days. This water can then penetrate more easily to promote further hydration, which results in a lightening of the concrete. The treatment produces a tenacious gel coating of light coloring.

(4) Efflorescence: The most effective treatment for efflorescence is generous, prolonged flushing of the surface soon after the efflorescence appears. Scrubbing the set concrete with a very stiff non-metal brush also will sometimes be of help. If these two techniques fail, a very dilute (1 to 2 percent) phosphoric acid solution will remove calcium carbonate efflorescence from hard-troweled slabs. Alternately, a 3 percent solution of acetic acid or phosphoric acid can be employed.

**DISCOLORATION CAUSED BY OUTSIDE FACTORS**

Concrete can be discolored by a number of materials if they are spilled on it or come into contact with it. Listed below are some stains which are commonly encountered, together with means of identifying them and eradicating or minimizing them.

Iron stains: these may be recognized by their rust coloring and their proximity to iron or steel objects. For very light colored stains, such as those encountered when water used for curing has a high iron content, the following corrective technique should be employed. Mop the surface with a solution of one pound of oxalic acid powder per gallon of water; after 2-3 hours, rinse the surface with water and scrub it with stiff brushes or brooms. More pronounced iron stains may be treated by one of these two techniques. Trowel onto the stained surface a paste consisting of one part of sodium citrate and 6 parts water that has been mixed thoroughly with an equal volume of glycerine and tempered with whiting. After the paste has dried, it should be replaced in a few days with a new application of the moist paste. Alternately, for especially dark iron stains, the surface may be covered with cloth or cotton batting that has been soaked with a solution consisting of one part...
sodium citrate crystals in 6 parts' water. This should be allowed to stay in place for 10-15 minutes. On horizontal surfaces, the surface should then be sprinkled with a thin layer of hydrosulphite crystals which have been moistened with water and covered with a stiff paste of whiting and water. On vertical surfaces a whiting paste that has been sprinkled with hydrosulphite and moistened slightly should be applied over the area. These pastes should be removed in one hour (if left on too long they will cause a black stain) and the surface should be thoroughly flushed with clear water.

**Aluminum, copper and bronze stains:** aluminum stains are a white deposit. Copper and bronze stains are usually green, although they will occasionally be brown. Aluminum stains may be removed by scrubbing the surface with a muriatic acid solution. On ordinary gray concrete it should be a 10-20 percent solution; on colored concrete it should be weaker. For copper and bronze stains, apply a paste prepared by mixing dry one part ammonium chloride (sal ammoniac) and 4 parts powder talc with ammonia water added afterward. Several applications of this paste may be needed to remove old, persistent stains.

**Ink stains:** ordinary inks and red, green, violet, and other brightly colored inks consisting of water solutions of synthetic dyes may be removed by the application of a sodium perborate poultice. This may be made by mixing a strong solution of sodium perborate (available at most drugstores) in hot water and mixing it with whiting to form a thick paste. It is applied in a one-quarter-inch thick layer and allowed to dry. If a blue stain remains after the poultice has been removed the treatment should be repeated. If a brown stain remains, it should be treated with the sodium citrate paste described in the section on iron stains. Indelible inks which contain silver salts leave a black stain and can be removed by application of ammonia water. Some other materials that have proven effective for removing certain ink stains are Javelle water, chlorinated lime, and strong soap. Javelle water may be purchased at some drugstores or can be prepared as follows. Dissolve three pounds of washing soda in one gallon of water. In a separate container slowly add sufficient water to 12 ounces of chlorinated lime to make a smooth paste. Mash all lumps that appear in the paste. This paste is then added to the soda solution and enough water added to result in a total of two gallons. This liquid is then placed in a stoneware jar and allowed to settle. The clear liquid on top is the Javelle water.

**Tobacco and urine stains:** for light stains, a gritty scrubbing powder will sometimes be effective. The powder should be mixed with enough hot water to produce a mortar consistency. After it has been mixed thoroughly it is applied in a 1/2 inch thick layer and allowed to dry. Several applications are often needed to completely remove the stain. For deeper, more stubborn stains the following material is used. Dissolve two pounds of trisodium phosphate crystals in one gallon of hot water. In a separate shallow enamel pan, mix 12 ounces of chlorinated lime to a pastelike consistency by adding water slowly and mashing the lumps. Pour the trisodium phosphate solution and the paste into a stoneware jar and add enough water to produce two gallons of solution. Stir well, cover the jar and allow the lime to settle. Apply a layer 1/4 inch thick of this clear top liquid converted to a thick paste by the addition of powdered talc to the stained surfaces. After it has dried, scrape it off with a wooden tool. Be sure not to spill this liquid either on metal, which it corrodes, or on colored fabrics, which it bleaches.

**Fire or rotten wood stains:** rotten wood will cause a dark chocolate-colored stain. Scouring the surface with powdered pumice or a gritty scrubbing powder will remove any loose surface deposits. Then scrub the surface thoroughly with a solution of glycerine diluted in 4 times its volume of water. Afterward, the solution of trisodium phosphate and chlorinated lime mentioned under tobacco and urine stains is applied to the surface by soaking a flannel cloth and pressing it firmly against the concrete by means of a slab of concrete or glass. This treatment should be repeated as often as necessary to remove the stains.

**Oil stains:** one of the most commonly experienced stains on residential concrete is the oil stain on garage floors. The depth of penetration of the oil into the concrete mass will depend upon its porosity. If it is mopped soon after the oil is spilled and the area covered with such a dry powdered material as dry portland cement, Fuller's earth, hydrated lime, or whiting, no stain will be formed. If the stain has been allowed to set, cover it with a piece of flannel kept soaked with equal parts of acetone and amyl acetate, which in turn is covered with a concrete slab or pane of glass. (If the stain spreads, a larger cloth should be used.) A thorough scrubdown with benzine or gasoline will sometimes remove oil stains.

**Coffee stains:** applying a cloth soaked with a solution of one part glycerine to four parts water (by volume) will usually remove a coffee stain. Javelle water and the solution described for use on fire stains are also effective.

**Iodine stains:** although iodine stains will slowly disappear of their own accord, they may be removed quickly by wetting them with alcohol and afterward covering them with talcum powder or whiting. On vertical surfaces, a paste of talcum and alcohol may be applied to the stain.