

Pinto Concrete: Is There a Cure?

Pinto concrete refers to large, irregular-shaped, dark-colored blotches on the surface of concrete flatwork. Sometimes called mottling, it most commonly occurs in residential driveways, patios, sidewalks, and basement floors. It can be so unsightly that the owner may insist on immediate corrective action, or worse yet, replacement of the concrete (Fig. 1).

Discoloration Causes

The Portland Cement Association studied mottling and other forms of discoloration some 30 years ago and concluded that there were several possible causes.⁽¹⁾ In their studies, no single factor seemed to cause discoloration. However, combinations of factors caused very severe discoloration. The factors included:

- Calcium chloride admixtures
- Hard-troweled surfaces
- Inadequate or inappropriate curing
- Variations in water-cement ratio caused by concreting and finishing methods
- Changes in the concrete mix

Calcium chloride retards hydration of the tetracalcium aluminoferrite phase, which is the darkest compound found in most cements. When it's retarded, it retains the dark color. Depending on the cement alkali content, discoloration caused by chlorides may be of two types:

1. Light spots on a dark background (characteristic of mixtures in which the ratio of cement alkalis to calcium chloride is relatively low)
2. Dark spots on a light background (characteristic of mixtures in which the ratio of cement alkalis to calcium chloride is relatively high).

Hard troweling is often associated with discoloration, primarily because it densifies and darkens the surface. Discoloration is also more noticeable on smooth, hard-troweled surfaces than on rough-textured, floated or broomed surfaces.

Curing and water-cement ratio affect color because larger amounts of hydrated material darken the surface. Thus, well-cured, low-water-cement-ratio concretes are darker than poorly cured, high-water-cement-ratio concretes. Variations in curing caused by

wrinkles in sheet curing materials such as plastic film are attributed to differences in hydration and to differences in efflorescence of soluble compounds—primarily calcium hydroxide.

Discoloration resulting from changes in the concrete mix may be due to water-cement-ratio differences, but could also be caused by changes in cement source.

Changes in supplementary cementing materials may also cause color differences.

Finally, the PCA study identified some miscellaneous factors that could contribute to discoloration. These included variations in subgrade absorptivity and variations in evaporation rate at the surface. Both of these also influence water-cement ratio, and rapid drying also increases the concentration of soluble compounds such as calcium hydroxide at the concrete surface. Although not mentioned in the PCA study, entrapment of water immediately below the finished surface is also believed to cause pinto discoloration.⁽²⁾

Corrective Measures

Removing discoloration is much more difficult than removing stains. Letting the concrete weather sometimes reduces the contrast in color but doesn't always produce results satisfactory to the owner. One recommended solution is applying pure vinegar and allowing it to stand on the surface for about 30 minutes before brooming it off using lots of water.⁽³⁾ A second application may be necessary. This reportedly opens the surface and allows hydration of the ferrites mentioned above.

A contractor suggests treating dark discoloration by applying the flame from a hand-type blow torch directly to the darkened concrete surface.⁽⁴⁾ This reportedly lightens the dark spots but is time-consuming and is probably not a practical solution for large areas.



Fig. 1 Severe discoloration of concrete flatwork is usually caused by a combination of factors.



Fig. 2. Before-and-after photos of a sidewalk show the results of applying a proprietary product used to treat discoloration.

In the PCA study, brushing on a 20% to 30% solution of diammonium citrate was a promising remedial measure. When applied to a dry discolored surface, the solution reportedly penetrated the surface, digested the paste constituents that caused the discoloration, and made the surface more porous. The higher porosity permitted easier penetration of water, promoting gradual surface lightening by hydration of ferrites. An immediate surface lightening also occurred. This was attributed to deposition of two reaction products—silica gel and calcium citrate—which formed a tenacious light-colored coating after drying. For best color uniformity, the entire slab had to be treated. Step-by-step details for this procedure are given in Reference 1.

A proprietary liquid containing agricultural minerals and a small amount of sulfuric acid has been used successfully by several West Coast concrete producers and contractors to treat discoloration.⁽⁵⁾ It's usually diluted with an equal portion of water and is first applied to only the dark spots after pre-moistening the entire slab with water. If spots are very

dark, the product can be applied without adding water. For small areas a sponge is used, and for larger areas, a canister-type pressure sprayer. After the surface dries, a white powder comes to the surface and is rinsed off with water. This process is repeated several times and works best if applications are done on consecutive days. The number of needed applications—usually 3 to 5—depends on how dark the spots are. One last application over the entire surface evens out the color. Results of using the product on a discolored sidewalk are shown in Fig. 2.

Because it contains acid, the product lightly etches the concrete surface. Applicators should wear goggles, acid-proof gloves, and other personal protective equipment as needed. They should also carefully watch the concrete surface condition to prevent excessive etching.

Use Trial Applications

As with most concrete cleaning procedures, it's best to start with the most dilute cleaning chemicals and proceed to stronger ones. For in-

stance, try the 50-50 mixture of water and proprietary chemical first. Use small test patches until you get the right combination of chemical strength and number of needed applications. Once this trial-and-error period is over, you'll have gained enough experience to use the products more confidently and efficiently.

References

1. Greening, N.R., and Landgren, R., *Surface Discoloration of Concrete Flatwork*, Research Department Bulletin RX203, Portland Cement Association, 1966, 17 pages.
2. Dabney, C., private communication.
3. Ernst, S., letter to Problem Clinic, *Concrete Construction*, October 1991, p.748.
4. Petrilli, F.P., letter to Problem Clinic, *Concrete Construction*, October 1991, p. 751.
5. For information, contact B.D. Sims, P.O. Box 75, Murrieta, CA 92564.

Note: Reference 1 can be purchased from Order Processing, Portland Cement Association, by calling 1-800-868-6733.