concrete INFORMATION
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Removing Stains and Cleaning Concrete Surfaces

The major reasons for removing stains and cleaning concrete surfaces are either to improve the surface appearance or to prepare the surface for a surface treatment or concrete overlay. The methods used for each reason are described in the following paragraphs.

REMOVING EXTERNALLY CAUSED STAINS FROM CONCRETE

Most externally caused stains can be removed from concrete surfaces without difficulty, although sometimes it is necessary to repeat the treatment until the desired result is attained. Removal of old, long-neglected stains may require patience and, when the staining matter is not known, some experimentation. After removal, in many cases evidence of the stain may remain as a shadow because of the depth of its penetration into the pores of the concrete.

Methods

Stains can be removed from concrete by either dry (mechanical) or wet (chemical or water) methods or a combination of them.

Common dry methods—described later in the section "Cleaning Concrete Surfaces"—are sandblasting, flame cleaning, shotblasting, and mechanical cleaning methods such as grinding, scabbling, planing, and scouring. Steel-wire brushes should be used with care because they can leave metal particles on the surface that later may rust and stain the concrete. Nonmetal brushes, such as nylon, are preferred.

Wet methods involve application of specific chemicals according to the nature of the stain or the type of chemical used. The treatment acts in one of two ways: (1) it dissolves the staining substance so it can be blotted up from the surface or driven more deeply into the concrete; or (2) it bleaches or changes the staining substance chemically to a product that will not show.

The chemicals are either brushed on or applied as bandages or poultices. A *bandage* consists of layers of soft, absorbent, white, cotton cloth soaked in chemicals and pasted over the stain. A *poultice* is a paste made with a solvent or reagent and some finely powdered, absorbent, inert material. Selection of the solvent or reagent depends on the type of stain. The inert material can be calcium carbonate (whiting), calcium hydroxide (hydrated lime), talc (talcum powder), fly ash, fuller's earth, or diatomaceous earth (kieselguhr). Portland cement can also be used to make a poultice with solutions that do not contain water, acids, or trichloroethylene. The powder for any poultice must not react with the solvent or reagent. Enough of the solvent or reagent is added to a small quantity of the inert material to make a smooth paste. The paste is spread in a ¼-in.- to ½-in.-thick (6- to 13-mm) layer onto the stained area with a trowel or spatula and allowed to dry. The solvent dissolves the staining substance and absorbs it into the poultice. There it migrates to the surface where the solvent evaporates and the stain is left as a loose, dried, powdery residue that can be scraped or brushed off. The chief advantage of a poultice is that it prevents the stain from spreading during treatment and tends to pull the stain out of the pores of the concrete. Solutions are usually proportioned by volume (for example, 1 part acid to 10 parts water). Always add acid to water, not water to acid. For aesthetics, a pigmented coating can be applied to cover some stains or discoloration that cannot be adequately removed (see the section "Covering Stains").

Precautions

The cleaning procedure should be carefully planned. No attempt should be made to remove the stain until it is identified and its removal agent determined. If the staining substance cannot be identified, it is necessary to experiment with different bleaches or solvents on an inconspicuous area. The indiscriminate use of an inappropriate product or the improper application of a product may result in spreading the stain over a larger area or cause a more unsightly, difficult-to-remove stain. Removing stains from old concrete sometimes leaves the area much lighter in color than the surrounding concrete

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because surface dirt has been removed along with the stain or because the surface may have become slightly bleached.

Materials such as glass, metal, wood, or architectural concrete adjacent to the area to be cleaned should be adequately protected since they can be damaged by contact with some stain removers or by physical cleaning methods.

Many chemicals can be applied to concrete without appreciable injury to the concrete surface, but strong acids or chemicals with a strong acid reaction should be avoided. Even weak acids may roughen the surface if left on for any length of time. The stained area should be saturated with water before application of an acid solution so that the acid will not be absorbed too deeply into the concrete. Hydrochloric acid (muriatic acid) diluted to a 10% solution is often used as a finishing treatment to remove all traces of the staining material. It may, however, leave a yellow stain on white concrete, so phosphoric acid is preferable for use on white concrete. All acid-treated surfaces should be thoroughly flushed with water.

Chemicals for removing stains from concrete can be obtained from sources such as commercial and scientific chemical suppliers, drugstores, hardware stores, supermarkets, or service stations.

Caution. *Most of these chemicals are toxic, carcinogenic, flammable, or generally hazardous and require adequate safety precautions: Skin contact and inhalation must be avoided. As a general precautionary rule, safety goggles and rubber or plastic gloves and clothing (i.e., rain gear) should be worn. If not used outdoors, adequate ventilation must be provided. Respirators (air supply) or gas masks with an organic vapor canister and full faceplate should be used with highly toxic, vaporous chemicals. Storage and handling instructions printed on container labels must be followed. Unused portions that have been taken from the original containers should be discarded; they should never be put back into the original containers. Chemicals should never be stored in unidentified containers. See Reference 6 for more information on the health hazards of various chemicals.*

The following methods of stain removal represent a good starting point, although at times it is necessary to adapt them to circumstances encountered in the field.

Some stains can be removed by more than one method. The most effective method in each case is best determined by trial and error. Before large stains are tackled, a small quantity of the removing agent should be prepared and applied to an inconspicuous area to assess its effectiveness. It is advisable where possible to try a few different agents before making a choice; however, the agents from one treatment must be completely removed before a new agent is applied to avoid stain-producing or toxic reactions. Also, to avoid hazardous conditions, do not mix different agents together. The effectiveness of the method on the sample area should not be judged until it has dried for at least one week.

Treatments for Specific Stains

Aluminum

Aluminum stains appear as a white deposit that can be treated with diluted hydrochloric acid. Saturate the stained surface with water and scrub with a solution of 10% hydrochloric acid following the precautions given for chemical cleaning later in this text. Weaker solutions should be used on colored concrete to prevent a change in color. Rinse thoroughly with clear water to prevent etching of the surface and penetration of the dissolved aluminum salts into the concrete. Should this happen, the salts later may reappear on the surface as efflorescence (see section on efflorescence).

Asphalt

See procedures for removing bitumen stains.

Bacteria

See "Microorganisms."

Beer

See "Beverages."

Beverages

If hot water and soap do not work, coffee, tea, alcoholic beverages, and soft drink stains can be removed by applying a bandage saturated with 1 part glycerol (glycerin) diluted with 4 parts water. Two parts of isopropyl alcohol may be added to this mixture to hasten the removal action. The bleaches described for removal of smoke stains are also effective in removing stubborn coffee and other stains. A poultice of talc and trichloroethylene can be used on tough stains.

Bitumen

Bitumens (asphalts, tars, or pitches) have very good adhesion to concrete. Consequently, stains caused by them are very difficult to remove, especially if the bitumen has been allowed to penetrate deep into the concrete surface. The degree of penetration depends on the type of bitumen. Before applying any treatment, scrape off any excess bitumen and scrub the surface with scouring powder and water.

Cutback Bitumen. Cutback bitumen is a solution of bitumen in a solvent. It penetrates deep into concrete and is practically impossible to remove completely. The intensity of a cutback-bitumen stain can be reduced by application of a poultice impregnated with toluene (toluol), kerosene, trichloroethylene, or carbon tetrachloride. Benzene (benzol), which is derived from coal tar and is not to be confused with benzine, which is derived from petroleum, can also be used; however, its use it not recommended due to its toxic and leukemogenic effects. After the poultice is removed, scrub the surface with scouring powder and water.

Another method is to apply a bandage saturated with a solution of equal parts of dimethyl sulfoxide and water. Let the bandage remain for one hour. Then remove and scrub the area with more of the solution, using a stiff brush.

Sandblasting also can be used to remove cutback bitumen stains, but the sandblasting must be carried very deep or the bitumen that has penetrated into the concrete will give the surface a salt and pepper look. Other abrasive cleaning methods and flame cleaning are also helpful.

Emulsified Bitumen. Bitumen emulsions contain very small drops of bitumen dispersed in water. They do not penetrate the concrete very deep. Scrub the stain area with scouring powder and water. Do not use solvents because they will increase the penetration of the stain and satisfactory removal will be impossible.

Molten Bitumen. Molten bitumen can be removed satisfactorily because it does not penetrate the concrete. Cool the bitumen with ordinary ice, not dry ice, until it is brittle and chip it off with a chisel. Scrub the surface with abrasive powder to remove the residue and rinse with clear water.

Blood Stains

Wet the blood stain with clear water and cover it with a thin, even layer of sodium peroxide powder. *Take care not to breath any of the peroxide dust nor to allow it to come in contact with the skin, as it is very caustic.* Sprinkle the powder with water or apply a water-saturated bandage and allow it to stand for a few minutes. Wash with clear water and scrub vigorously. Next, brush a 5% solution of acetic acid (vinegar) on the surface to neutralize any alkaline traces left by the sodium peroxide. Rinse with clear water at the end of the treatment.

Hydrogen peroxide or trisodium phosphate can be substituted for the sodium peroxide, although they may not work as well. Vinegar neutralization is not necessary with the hydrogen peroxide treatment.

Bronze

See "Copper and Bronze."

Calking Compounds

Scrape off as much of the calking compound as possible and apply a poultice impregnated with denatured alcohol. Let stand until dry. After this treatment, most calking compounds become brittle and can be brushed off easily with a stiff brush. Finally, wash the surface thoroughly with hot water and strong soap, trisodium phosphate, or a commercial scouring compound.

Candy

Candy stains can be washed away with soap and water and moderate scrubbing. Chocolate stains can be washed with ammoniacal alcohol (1 part ammonium hydroxide solution containing 26% ammonia, and 9 parts denatured alcohol). Severe artificial food coloring stains can be treated with bandages or poultices made with carbon tetrachloride or chloroform.

Chocolate

See "Candy."

Clay

See "Soil."

Coal Tar

See "Bitumen."

Coffee

See "Beverages."

Copper and Bronze

Runoff water from copper flashings and bronze fixtures usually leaves bluish-green stains, although in some cases they are brown. To remove them, dry mix 1 part ammonium chloride with 4 parts fine-powdered talc, calcium carbonate, or clay. Add ammonium hydroxide (household ammonia) and stir to make a smooth poultice. Place this over the stain, and leave until dry. Repeat the treatment as often as necessary and finally scrub well with clear water.

Creosote

Creosote is a clear to yellowish oily liquid from wood tar distillation or a yellowish to greenish-brown oily liquid from coal tar. Creosote stains can be removed with a poultice of calcium carbonate, hydrated lime or talc, and benzene (toxic and leukemogenic). The stained area should then be scrubbed with scouring powder and water.

Curing

See "Curing Compounds" and "Discoloration from Concreting Practices."

Curing Compounds

Generally, curing compounds will be worn off in a relatively short time by the abrasion from normal use or by natural weathering. However, if an accelerated treatment is required, or if the stained surface is not subjected to abrasion, the following procedures can be used.

Curing compounds have different chemical formulations. They may have a synthetic resin base, a wax base, a combination wax-resin base, a sodium silicate base, or a chlorinated-rubber base. The base of the

curing compound should be identified before an attempt is made to remove it.

Curing compounds based on sodium silicate can be removed by vigorous brushing with clear water and a scouring powder. On small areas, wax, resin, or chlorinated-rubber curing compounds can be removed by applying a poultice impregnated with a solvent of the chlorinated-hydrocarbon type, such as trichloroethylene, or a solvent of the aromatic hydrocarbon type, such as toluene. A mixture of 10 parts methyl acetone, 25 parts benzene, 18 parts denatured alcohol, and 8 parts ethylene dichloride also can be effectively used. Allow the poultice to stand for 30 to 50 minutes. Scrub the surface with clear water and a detergent at the end of the treatment. On large areas consult the curing compund manufacturer for a suggested removal method.

Old stains can be best removed by mechanical abrasive methods such as light grinding or sandblasting.

See "Discoloration from Concreting Practices" for more information.

Dirt

Airborne dirt can collect on any concrete surface to form a dark and sometimes oily buildup or stain. Buildings with architectural concrete may need to be cleaned of air pollution-induced dirt deposits to regain their original appearance. Some dirt can be removed by scrubbing with detergent and water or 1 part hydrochloric acid in about 20 parts water. However, special proprietary cleaners, made to remove dirt with minimal attack of the concrete, are often preferred over hydrochloric acid solutions that attack concrete.

A solution of 1 part phosphoric acid to about 3 parts water can be used to scrub away light to moderate amounts of dirt with little to no attack of the concrete. Proprietary cleaners, made with hydrochloric acid and buffers to protect the concrete, are used to remove severe dirt buildup. An alkaline prewash followed by an acetic acid wash is another cleaning method. Special cleaning solutions can be specially designed to remove particular types of dirt.

The methods used to remove oil can be helpful in removing very oily dirt. Steam cleaning and light sandblasting or waterblasting are also effective.

Once a surface is clean, it is good practice to apply a breathable clear sealer (such as a methacrylate or acrylic-based material) or a clear water-repellent penetrating sealer (such as silane or siloxane) to resist dirt buildup and make future cleaning easier. Some cleaning specialists prefer the silane or siloxane treatments for their high breathability (often with a 95% vapor transmission). Also see "Graffiti" stain removal.

Discoloration from Concreting Practices

To remove most discoloration caused by chloride admixtures or finishing and curing methods, the first 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 reduce dark discoloration such as trowel burns. 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 lessen mottled discoloration. Undiluted vinegar (weak acetic acid) is also helpful. Before an acid is applied, the surface should be dampened with water to prevent the acid from being absorbed deep into the concrete. Treating a dry slab with a 10% solution of caustic soda (sodium hydroxide) gives some success in blending light spots with a dark background. The sodium hydroxide solution should be left on the surface 1 to 2 days, followed by a thorough rinsing with water.

Yellow stains on terrazzo floors caused by finishing can be removed by scrubbing with 1 part hypochlorite solution (household bleach) and 5 parts water. A poultice with this solution is also helpful.

Greenish-blue discoloration from iron sulfides and ferrous oxides in blast-furnace slag can be treated with a 3% solution of hydrogen peroxide.

As a final resort, a good—but an expensive—remedy to remove most discoloration is to treat a dry surface with a 20% to 30% water solution of diammonium citrate (about 2 lb per gallon of water).* Treatment consists of applying the solution to a dry surface for about 15 minutes. The white gel formed by the solution should be diluted with water and continuously agitated by brushing. The gel should be scrubbed off with water after the treatment. Water curing between or after treatments increases the treatment's effectiveness. Two or three treatments should be adequate.

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. Remedial methods should be implemented as soon as possible after the discoloration is noticed.

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 placing, finishing, and curing practices. Concreting practices should not be allowed to vary, as any disruption or change in the concrete mixture, formwork, finishing, or curing can result in significant and sometimes permanent discoloration. For more information see References 1 and 11.

Efflorescence

Efflorescence is a deposit, usually white in color, that may develop on the surface of concrete (or masonry) construction. It sometimes appears within a few days after the concrete is placed (while the concrete is drying) and the migrating water brings water-soluble constitu-

*Diammonium citrate (ammonium citrate, dibasic) is available from J. T. Baker Co., 222 Red School Lane, Phillipsburg, N.J. 08865 (Product No. 0682); Pfizer Inc., 2400 W. Central Road, Hoffman Estates, Ill. 60196; and other chemical supply companies.

ents to the surface, or it appears in older concrete where outside water has brought water-soluble constituents through the concrete to the surface. Efflorescence can consist of one of several compounds formed either from elements of the soil or the concrete itself. Calcium carbonate deposits are perhaps the most common form of efflorescence. They are formed when calcium hydroxide in the concrete is leached to the surface and reacts with carbon dioxide in the air to form calcium carbonate.

The first step in eliminating efflorescence is to stop water from coming through the concrete. Without water transmission through the concrete or once the concrete is permanently dry, efflorescence cannot occur.

Most efflorescence can be removed by dry brushing, water rinsing with brushing, light waterblasting, or light sandblasting followed by flushing with clean water. Water-soluble compounds, such as chloride salts are easily removed with water cleaning methods. Water-insoluble efflorescence, such as calcium carbonate, needs to be removed with abrasive techniques or it may be necessary to wash the surface with a 1% to 10% solution of muriatic acid. For integrally colored concrete, only a 1% to 2% solution should be used to prevent surface etching that may reveal the aggregate and hence change color and texture. Other acid solutions that can be used consist of (1) 1 part phosphoric acid in 9 parts water or (2) 1 part phosphoric acid, 1 part acetic acid, and 19 parts water.

Before applying an acid solution, always dampen the concrete surface with clean water to prevent the acid from being absorbed deeply into the surface, where damage may occur. Application should be to small areas of not more than 4 sq ft (0.4 m^2) at a time, with a delay of about 5 minutes before scouring off the deposit with a stiff bristle brush. After this treatment, the surface should be immediately and thoroughly flushed wth clean water to remove all traces of acid. If the surface is to be painted, it should be thoroughly flushed with water and allowed to dry.

It is often helpful to determine the type of compound in the efflorescence so that a cleaning solution can be found that readily dissolves the efflorescence without adversely affecting the concrete. Before any treatment is used on any concrete surface, the method should be tested on a small, inconspicuous area to be certain there is no adverse effect.

Since acid and other treatments may change the appearance slightly, the entire surface should be treated to avoid discoloration or mottled effects. See Reference 14 for more information.

Epoxies

Most solidified epoxies can be removed from small areas by burning them off with a blowtorch. Adequate ventilation must be provided since black acrid smoke will be given off. If a black stain remains, it can be treated as indicated for smoke stains. Abrasive blasting is more appropriate for large areas.

Finishing

See "Discoloration from Concreting Practices."

Fire

See "Smoke."

Food and Food Coloring

Many food stains can be removed with water and soap or powdered detergent. For difficult stains, such as severe artificial food coloring stains, poultices or bandages made with carbon tetrachloride or chloroform can be used. Carbon disulfide also removes severe food stains; however, its use should be avoided because of its explosive and highly toxic nature.

For more information, see "Beverages," "Candy," "Fruit," "Gum," and "Ice Cream."

Fruit

Fruit stains are organic and can be removed by scrubbing with a solution of a synthetic powdered detergent and warm water.

Fungus

See "Microorganisms" and "Mildew."

Graffiti

A large number of commercially available products are suitable for removing spray-paint and felt-tip markings from concrete surfaces. These products are generally effective also for removing crayon, chalk, and lipstick. The manufacturer's directions should always be followed. If satisfactory results are not obtained with the first remover applied, a second or third attempt with other products should be made. A single product may not remove both spray-paint and felt-tip-pen stains.

If a proprietary cleaner is not available, methylene chloride can be used. While wearing protective clothing, brush methylene chloride onto the surface, wait 2 minutes, and rinse with water during continued brushing. Oxalic acid or hydrogen peroxide can be used to help bleach out some of the pigment from concrete pores. Solutions of sodium hydroxide, xylene, or methyl ethyl ketone are also helpful in removing graffiti. Effective cleaning can also be accomplished with waterblasting and sandblasting.

After the graffiti is removed, or preferably before a structure is placed in service, an antigraffiti coating or sealer should be applied. The surface treatment should prevent graffiti from entering the pores of the concrete and should facilitate removal of the graffiti, preferably without removing the surface treatment.

Aliphatic urethanes are considered the best antigraffiti coatings because of their resistance to solvents, yellowing, and abrasion. Solvents such as mineral spirits or methyl ethyl ketone can remove most graffiti from an aliphatic polyurethane without compromsing the urethane coating. Acrylics, epoxies, silanes, and siloxanes are also used to make graffiti removal easier; however, acrylics dissolve with the solvent and epoxies tend to yellow or discolor. Silanes and siloxanes may not resist certain graffiti materials as well as the urethanes, but

they do maintain a high breathability at the concrete surface while resisting penetration of graffiti materials into the concrete.

Grease Stains

Grease does not penetrate into concrete, so scraping and scrubbing usually will remove it.

Scrape off all excess grease from the surface and scrub with scouring powder, soap, trisodium phosphate, or detergent. If staining persists, methods involving solvents are required.

Use refined naptha solvent (mineral spirits) or a chlorinated-hydrocarbon solvent such as trichloroethylene* to make a stiff poultice. Apply to the stain and do not remove until the paste is thoroughly dry. Repeat the application as often as necessary. If required, scrub with strong soap, scouring powder, trisodium phosphate, or proprietary cleaners specially formulated for removing grease on concrete. Rinse with clear water at the end of treatment.

For large areas, such as an entire floor, use butyl cellosolve *(with proper ventilation)* or a metasilicate or other alkaline floor cleaner to emulsify all grease and oil on the slab surface. Brush scrubbing is usually required. Before the cleaning solution dries or the emulsion breaks down, flood-rinse with water after scrubbing. Other solvents that can be used to remove grease include sodium carbonate, carbon tetrachloride, and chloroform.

Greenish-Blue Discoloration

See "Discoloration from Concreting Practices."

Gum

The chemical composition of chewing gum varies from one manufacturer to another and the artificial colorings used can be strongly staining. Consequently, chewing gum and chewing gum stains are very difficult to remove from concrete surfaces. First try the removal suggested for calking-compound stains. Another way is to scrape off as much chewing gum as possible and then remove the rest with a solvent such as chloroform, carbon tetrachloride, or a special proprietary solvent.

Ice or aerosol freezing agents can be used to embrittle the gum in order for it to be chipped or scraped off. Artificial food coloring stains from gum can be treated with bandages or poultices made with carbon tetrachloride or chloroform.

Ice Cream

Ice cream stains can be removed with waterblasting or steam cleaning. Residual food-coloring stains can be removed with a poultice containing chloroform or carbon tetrachloride. Also see "Candy," "Food and Food Coloring," and "Gum."

Ink

Inks vary in chemical composition (writing ink, indelible ink, synthetic-dry ink) so that removal of ink stains may require some trial and error.

Black Inks. Black inks include india inks and printing inks that generally consist of finely divided carbon held in suspension in liquid by gums, shellac, and so on. Usually a vigorous scrubbing with strong soap or scouring powder will remove the carbon particles.

Indelible Inks. Indelible inks often consist entirely of synthetic dyes and their stains can be effectively removed by the methods described for synthetic-dye inks. However, some indelible inks contain silver salts that cause a black stain. This stain can be treated by applying an ammonium hydroxide bandage. Usually several applications are necessary.

Prussian-Blue Inks. Prussian blue is a ferrocyanide of iron and stains made by it cannot be removed by a sodium perborate, Javelle water,** or chlorinated lime poultice. However, they will yield to treatment using an ammonium hydroxide or strong soap solution bandage.

Synthetic-Dye Inks. Many red, green, violet, and other bright-colored inks are water solutions of synthetic dyes. Stains made by these inks and many ordinary writing inks can usually be removed by applying a poultice impregnated with a strong solution of sodium perborate in hot water, which is left on the stain until dry and then brushed off. Repeat the application if some of the color is visible after the poultice is removed. If a brown stain remains, treat it by method A for "Rust."

Other treatments include an ammonium hydroxide bandage; a Javelle water (disinfectant or cleaning agent) bandage or poultice; a poultice of equal parts of chlorinated lime and calcium carbonate reduced to a paste with water; a bandage or poultice impregnated with a saturated solution of potassium hypochlorite and potassium chloride; a poultice of equal parts of chlorinated lime, calcium hypochlorite, and calcium carbonate.

Iodine Stains

An iodine stain will gradually disappear of its own accord. Removal can be hastened by applying an alcohol-impregnated poultice. Allow the paste to dry, then scrape it off and wash the surface with clear water.

Joint Sealants

See "Sealants."

Microorganisms

Organisms such as algae and lichens can be destroyed by the application of a sodium hypochlorite solution (5%), a household bleach solution, 2% formalin (formaldehyde with a small amount of methanol in an aqueous medium), or by a 3% to 5% aqueous solution of copper

*Do not use trichloroethylene with portland cement to make a poultice as it reacts with strong alkalies such as cement or fresh concrete and forms dangerous gases.

**Javelle water can be made by dissolving 3 lb (1.4 kg) of sodium carbonate in 1 gal (3.8 liters) of hot water in a plastic container. In another container, add water to ¾ lb (⅓ kg) of calcium hypochlorite to make a paste. Combine the sodium carbonate solution and calcium hypochlorite paste, add water to make 2 gal (7.5 liters) of solution, stir, and cover. After lime solids settle, remove the liquid and dispose of the solids.

nitrate or sulfate. Biocides such as isothiazolinone chloride can be used to destroy bacteria.

Mildew

Prepare a solution of 1 oz (0.03 kg) of commercial laundry detergent, 3 oz (0.09 kg) of trisodium phosphate, 1 qt (0.95 liters) of commercial laundry bleach, and 3 qt (2.8 liters) of water. Apply to the area with a soft brush. Rinse with clear water after the treatment.

Moss

Exterior concrete surfaces that are not exposed to sunlight and remain in a constantly damp condition may exhibit signs of plant growth such as moss. These growths have been successfully removed by application of ammonium sulfamate (marketed under the manufacturer's brand name and available in garden supply stores). The treatment must be done according to directions furnished with the compound. Should an unsightly powdery deposit be left on the surface, it can be removed by washing with water.

Another method is to use a solution of 1 part sodium pentachlorophenate to 8 parts water by volume. It should be applied so that the moss or other growth is thoroughly saturated. If the surface is exposed to rain within 24 hours following the application, some of the solution will be lost and a further application may be necessary. About one week after the pentachlorophenate solution has been applied, all vegetable growth should have been killed and the residue can be removed by brushing. The surface will usually retain sufficient weed killer to inhibit further growth for some time.

Other chemical solutions that can be used are sodium hypochlorite (laundry bleach); formaldehyde (1 part formalin in 49 parts water); copper nitrate or copper sulfate—5 oz (0.14 kg) to 1 gal (3.8 liters) of water. Boiling water alone may also be used.

For best results, the surface should be sealed after dirt and dead moss have been brushed off. There are a variety of paints or transparent sealers commercially available for this type of application. An effective sealer may consist of a mixture of 33% sodium silicate in water with the addition of 1% ammonium chloride as coagulator. This sealer allows growth to be washed off easily, but will not prevent its formation. Other sealers, such as 7 oz (0.2 kg) by weight of magnesium fluosilicate or zinc fluosilicate in 1 gal (3.8 liters) of water, are also helpful.

Oil—Drying

Drying oils (linseed, soybean, tung) penetrate concrete surfaces easily and require immediate attention.

If the oil has not yet dried out, soak up the excess with an absorbent material such as paper toweling or cloth. Wiping should be avoided as it spreads the stain and drives the oil into the concrete. Cover the spot with a dry, powdered, absorbent material (such as hydrated lime, fuller's earth, calcium carbonate, portland cement, or fly ash) and let stand for a day and then sweep it up. Repeat this treatment until no more oil is absorbed by the powder. If a light stain remains, apply a poultice impregnated with refined naptha solvent (mineral spirits). If a noticeable stain persists, or if the oil has penetrated into the concrete and dried out, other methods are required.

Method A. To a mixture of 1 part trisodium phosphate, 1 part sodium perborate, and 3 parts powdered talc, add liquid soap or a strong solution of soap in hot water to form a stiff paste. Apply as a ⅛-in.-thick (3.2-mm) poultice over the stain and leave until dry. Remove and repeat the application as often as necessary by remixing the dried poultice with liquid soap or strong soap solution. Scrub with clear water at the end of the treatment.

Method B. Apply a bandage saturated with hydrogen peroxide of 6% to 8% strength and place over it a second bandage saturated with diluted ammonium hydroxide to accelerate the bleaching action. Rinse with clear water at the end of the treatment.

Oil—Lubricating or Petroleum

Lubricating or petroleum oils readily penetrate into the concrete surface. If the free oil is removed promptly, there will be little danger of staining. Soak up the surface oil immediately with an absorbent material such as paper toweling or cloth. Wiping should be avoided as it spreads the stain and drives the oil into the concrete. Cover the spot with dry, powdered absorbent, inert material (the same as in a poultice) or portland cement, and leave it for one day. Remove and repeat this treatment until no more oil is absorbed by the powder. If a stain persists or if oil has been allowed to remain for some time and has penetrated the concrete, other methods are required.

Remove all liquid or solidified oil from the surface and scrub the area with strong soap, scouring powder, trisodium phosphate, or proprietary detergents specially formulated for removing oil on concrete. One of the following methods can then be used.

Method A. Make a poultice with a solution of 1 part trisodium phosphate in 6 parts water. Apply to the stain and allow to remain until dry. This may require 24 hours. Remove the dried paste and scrub the surface with clear water.

Method B. Make a poultice with a solution of 5% sodium hydroxide (caustic soda). Let dry for 24 hours, remove, and scrub the surface with clear water.

Method C. Make a poultice with mineral spirits or benzene (toxic). Apply to the stain and allow to remain for one hour after the solvent has evaporated. Repeat the application as often as necessary. Scrub with clear water at the end of the treatment.

Method D. Dip a bandage in a mixture of equal parts of acetone and amyl acetate. Apply to the stained area with the bandage extending well over the boundaries of the stain. Cover the bandage with either a dry, heated slab (concrete or stone) or a glass pane. The heated slab will draw the dissolved oil out of the stained area into the bandage. The glass pane will force the dissolved oil deeper into the concrete and it will not show on the

surface. Keep the cloth saturated until the stain is removed. If the solvent spreads the stain beyond the boundaries of the bandage, a larger bandage should be used.

Method E. Saturate a bandage with methyl chloroform or trichloroethylene and place it over the stain. Cover with a heated slab or glass pane.

Oil stains can be effectively removed by sandblasting, except that this will roughen the surface.

Commercial proprietary degreasing products are available. Their application should conform to the manufacturer's instructions.

Oil Stains on Concrete Driveways and Parking Lots

In addition to the methods given for removing oil stains, the following simple methods should effectively remove oil stains from driveways and parking lots.

Method A. Saturate the area with mineral spirits or paint thinner. Then cover with an absorbent material such as dry portland cement, talc, cat litter, Fuller's earth, corn meal, or cornstarch. Let stand overnight, and then sweep away the cover. Repeat if necessary.

Method B. If an oil stain resists method A, scrub with a trisodium phosphate solution.

Method C. Bleach the surface with laundry bleach.

Paint, Shellac, and Varnish

Different treatments are required for wet and dried paint films.

Wet Paint. Carefully soak up freshly spilled paint with an absorbent material such as paper toweling or soft cloth. Wiping should be avoided as it will spread the stain and drive the paint into the concrete. Immediately scrub the stained area with scouring powder and water. Scrubbing and washing should be continued until no further improvement is noted. Wait three days for the paint to harden because paint removers or solvents used on wet paint or films less than three days old spread the stain and increase its penetration into the surface, making removal very difficult. After three days use a method for removal of dried paint.

Dried Paint. Scrape off as much as possible of the hardened paint. Apply a poultice impregnated with a commercial paint remover. Allow to stand for 20 to 30 minutes. Scrub the stain gently to loosen the paint film and wash off with water. Any remaining residue can be scrubbed off with scouring powder. Commercial paint removers are available in the form of a gel solvent. Test these on a small area on a trial basis.

For removing spray paint stains see the treatment for graffiti.

Color that has penetrated the surface can be washed out with dilute hydrochloric or phosphoric acid. This treatment can be applied also to dried enamel, lacquer, or linseed-oil-based varnish. For shellac stains, the paint remover should be replaced by alcohol.

Other efficient paint removers include the following:

a. A mixture of 10 parts methyl acetone, 25 parts benzene, 18 parts denatured alcohol, and 8 parts ethylene dichloride.
b. A solution of 2½ lb (1.13 kg) of sodium hydroxide (caustic soda) in 1 gal (3.8 liters) of hot water. The sodium hydroxide solution can be applied with a poultice or can be brushed onto the surface.

Old, dried paint films may require sandblasting or burning off with a blowtorch.

Flaking paint can be removed by painting it with a latex paint of vinyl acetate-acrylic copolymers or vinyl acetate-maleate copolymers. This will adhere to the unwanted film and both films can then be removed by a dilute alkali such as sodium or potassium hydroxide.

Urethane varnishes are best removed by mechanical abrasive methods such as grinding or sandblasting.

Perspiration and Urine Stains

Apply one of the bleaches described for removal of smoke stains as a bandage or as a talc poultice. Perspiration stains are sometimes greasy and may first require scrubbing with hot water and trisodium phosphate or a strong detergent.

For deeper, more stubborn uric acid stains in toilet rooms the following procedure is used:

Dissolve 2 lb (0.9 kg) of trisodium phosphate crystals in 1 gal (3.8 liters) of hot water. In a separate, shallow enameled pan, mix 12 oz (0.34 kg) 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 2 gal (7.6 liters) of solution. Stir well, cover the jar, and allow the lime to settle.

To the stained surfaces, apply a layer ¼ in. (6 mm) thick of this clear top liquid, converted to a thick paste by the addition of powdered talc. After it has dried, scrape it off with a wooden tool. Be sure not to spill this liquid either on metal or on colored fabrics, because it will corrode the metal and bleach the fabric. After cleaning, a sealer can be applied to make future cleaning easier or, in extreme cases, to seal the concrete to eliminate a urine odor.

Pink Stain

Phenol-formaldehyde resins in plywood used for forming concrete or phenolics in some joint sealants can cause pink stain when they react with alkalies in concrete. The stains will usually go away without treatment. However, if rapid removal is necessary, use a bandage or poultice containing sodium or potassium hypochlorite or Javelle-water solutions.

Plaster

Fresh plaster should be scraped off and the remaining plaster washed away by scrubbing with cool water and soap or 1 part hydrochloric acid to 19 parts water followed by a water rinse. Hardened plaster can be chipped off, followed by the acid wash to remove remaining plaster. Gypsum plaster is easier to remove than portland cement plaster.

Rainwater

Rainwater runoff stains are caused by materials picked up by the water, such as copper or soil; therefore refer to individual staining items such as soil or rust for stain removal techniques.

Rubber Tire Marks

See "Tire."

Rust (Iron Oxide)

Iron rust stains are easily recognizable by their rust color or their proximity to steel and iron in or on the concrete. Sometimes large areas are stained by a curing water that contains iron. The appearance of the concrete can be greatly improved (with mild rust stains usually completely removed) by mopping with a solution containing 1 lb (0.45 kg) of oxalic acid powder per gallon (3.8 liters) of water. After 2 or 3 hours, rinse with clear water, scrubbing at the same time with stiff brushes or brooms. An ammonified solution of thioglycolic acid can be used in place of the oxalic acid solution. Bad spots may require a second treatment. For deeper stains the following methods can be used.

Method A. Dissolve 1 part sodium citrate in 6 parts lukewarm water and mix thoroughly with 7 parts of lime-free glycerol (glycerine). Make a stiff poultice with calcium carbonate or kieselguhr (diatomaceous earth used for polishing). Apply a thick layer on the stain with a trowel and leave for two to three days. Scrape or brush off when dry. If staining persists, the treatment should be repeated. Wash thoroughly with clear water. This treatment may be too slow to be practical with severe stains. Ammonium citrate can be used in place of sodium citrate for more rapid stain removal, although the surface may be slightly etched.

Method B. This method is preferable for deep and intense iron stains. Saturate a bandage with a solution of 1 part ammonium citrate or sodium citrate in 6 parts lukewarm water and apply it over the stain for half an hour. The solution also can be brushed on the stain at 5- to 10-minute intervals. Following this treatment, if the stain is on a horizontal surface sprinkle it with a thin layer of sodium hydrosulfite crystals, moisten with a few drops of water, and cover with a poultice made of powdered inert material and water. On a vertical surface, place the poultice on a trowel, sprinkle on a layer of sodium hydrosulfite crystals, moisten lightly, and apply to the stain so that the crystals are in direct contact with the stained surface. Remove the poultice after one hour.

If the stain has not completely disappeared, repeat the operation with fresh materials. When the stain disappears, scrub the surface thoroughly with water and make another application of the sodium citrate solution as in the preliminary operation. The purpose of this last step is to prevent reappearance of the stain.

Occasionally, brown iron stains may change to black when treated with sodium hydrosulfite. This may also happen if the poultice is left on for longer than one hour. Should the stain become black, treat it with hydrogen peroxide until it is oxidized back to the brown color. The sodium hydrosulfite treatment should then be resumed proceeding as above.

Unless adequate ventilation is provided, this method should not be used indoors because a considerable amount of toxic sulfur dioxide gas will be emitted when sodium hydrosulfite comes in contact with moisture. Use proper respiratory safety equipment.

If roughening of the surface is not objectionable, iron stains can also be removed by mechanical means such as sandblasting or waterblasting accompanied by stiff brushing with soap powder. The mechanical methods may be more applicable than chemical methods in cases of light iron stains over large areas.

Sealants

Joint sealants can be removed with flame cleaning methods. See the "Bitumen" section for removal of asphaltic and coal-tar sealants. Elastomeric-joint-sealant manufacturers can provide information on removing individual products. Also see "Calking Compounds."

Sealers or coatings can be removed as per manufacturer's instructions. Also see sections on bitumen, epoxy, graffiti, and paint.

Skunk Spray

See "Perspiration and Urine Stains."

Slag

See "Discoloration from Concreting Practices."

Smoke

Smoke is a difficult stain to remove. Apply a trichloroethylene poultice. Brush off when dry and repeat the application if necessary. Scrub thoroughly with clear water at the end of the treatment. Such a poultice must be handled carefully and used only with good ventilation because of the toxic nature of the active reagent.

As an alternate treatment for large areas, scour the surface with powdered pumice or grit scrubbing powder to remove surface deposits and wash with clear water. Follow this with application of a poultice impregnated with a commercial sodium or potassium hypochlorite solution (for example, Clorox) or an equally effective bleach prepared as follows:

In a 2-gal (7.6-liter) stoneware jar, dissolve 2 lb (0.91 kg) of trisodium phosphate in 1 gal (3.8 liters) of hot water. In an enameled pan, mash 12 oz (0.34 kg) of chlorinated lime with water to form a paste. Add this paste to the solution of trisodium phosphate. Add water to make 2 gal (7.6 liters). Stir well, then cover the jar and allow the lime paste to settle. Decant the clear liquid. Javelle water is an equivalent bleach that can be prepared in the same way except that the trisodium phosphate is replaced by 3 lb (1.4 kg) of sodium carbonate (washing soda). These bleaches are strongly corrosive and should always be diluted

with four to six times their volume of water before using.

Cover the poultice with a slab of concrete or a glass pane, making sure the poultice is pressed firmly against the stain. If the stain is on a vertical plane, devise a method to hold the poultice snugly in place. Resaturate the poultice as often as necessary.

Soft Drinks

See "Beverages."

Soil

Fine sands can be washed away with water and scrubbing. Clayey materials may need to be scrubbed away with hot water and a detergent or trisodium phosphate. A low-pressure water wash is useful for large areas.

Tar

See "Bitumen" for coal tar.

Tea

See "Beverages."

Terrazzo

For stains on terrazzo see "Discoloration from Concreting Practices" or applicable staining materials.

Tire

Tire skid marks can be removed with flame cleaning equipment.

Tobacco Stains

If the stain is not severe, use a poultice of hot water and grit scrubbing powder of the type commonly used on marble, terrazzo, and tile floors. Stir the powder into the hot water until a mortar consistency is obtained. Mix thoroughly and apply in a ½-in. (13-mm) layer. When dry, scrape off and scrub with clear water. Repeat the treatment if necessary.

For more severe stains, make a stiff poultice with one of the bleaches described for the removal of smoke stains and apply with a trowel over the stain. To apply with a brush, add about 1 tsp of sugar to each pound (0.45 kg) of the powdered material used in the poultice. Leave until dry, scrape off, and scrub with clear water.

Urine

See "Perspiration and Urine Stains."

Varnish

See "Paint, Shellac, and Varnish."

Wax

Commercial wax removers should be used to remove wax. The cleaner should stand on the surface briefly, then be scrubbed lightly, wetted with water, scrubbed again, and rinsed away.

Wood Stains

Under damp conditions, wood will rot and cause a chocolate-colored stain that is readily distinguished from most other stains by its dark color. The best treatments are those recommended for smoke stains. Removal can be accelerated by first scrubbing the surface thoroughly with 1 part glycerol (glycerine) diluted with 4 parts of water.

Wood Tar

See "Smoke" and "Creosote" stain removal procedures.

Miscellaneous Stains

Stains varying in intensity from light yellow to brown sometimes occur on interior concrete and terrazzo floors. They may be due to the original finishing of the floor or the cleaning operations. Such discolorations are usually not hard to remove; it is possible to bring the surface back to its original appearance by applying a Javelle-water-impregnated poultice or by scrubbing the surface with Javelle water.

Stains other than those discussed can be removed by experimenting with different bleaches or solvents on an inconspicuous area. The treated area should always be thoroughly scrubbed with clear water after the treatment so that no traces of the removing agent remain.

CLEANING CONCRETE SURFACES

The method selected for cleaning concrete depends on the purpose of the cleaning and on the extent of the work to be done. It may entail a bucket and brush, a hammer and chisel, water-pressure and steam washing, grit blasting, chemical cleaning, flame cleaning, or special mechanical power tools.

When faced with the decision to clean concrete, a careful investigation is advisable, which may bring to light unexpected facts. Accurate diagnosis of the problem is essential for effective and successful cleaning. There is no really simple technique for normal situations: Water and chemical cleaners can lead to other problems caused by excessive moisture or unanticipated chemical reactions; grit blasting and flame cleaning will change the texture and appearance of the surface; power tools can damage thin sections or remove more concrete than is desirable. Oils, grease, and certain penetrating chemicals must sometimes be removed before water or abrasive cleaning methods are used.

When cleaning concrete is necessary, the following text will provide some guidance for selecting the least

damaging method. The methods described below have merit for removing stains from concrete for appearance purposes, preparing surfaces for coatings and sealers, and preparing concrete for overlay and patch repair work. However, for stain removal and some coating applications, it is desirable to minimize abrading of the concrete surface; whereas an abraded, rough texture is desired for repair work (patches and overlays) and certain coating applications. For more information, see the references and the ASTM standards at the end of this publication.

Before deciding on a particular method, clean a relatively small, inconspicuous area to assess the efficiency of the method and the appearance and condition of the surface after the treatment. The reasons for cleaning must be considered carefully because results with methods intended to improve only the appearance can differ substantially from results with methods to prepare the surface for a coating or concrete overlay.

Abrasive Blasting

Dry (Sandblasting). Dry abrasive blasting, such as sandblasting, drives an abrasive grit at concrete surfaces to erode away dirt, paint, various coatings or contaminants, and any deteriorated or damaged concrete. (See also "Metallic-Shot Blasting.")

Sandblasting changes the appearance of the concrete surface. It is left with a rougher texture that may hold even more dirt and pollutants than before and hasten the need for recleaning. Sandblasting removes the edges at arrises and the sharp detail on moldings and ornaments. Even the flat surface of hard, polished aggregate will become scarred and dulled. Sandblasting can provide an excellent rough-textured surface for bonded repair work.

Although the sandblasting operation is not complicated, certain procedures and precautions known to experienced operators should be followed to ensure a uniformly clean surface.

Fig. 1. Sandblasting can clean any size or shape surface—horizontal, vertical, or overhead and remove weak, deteriorated concrete.

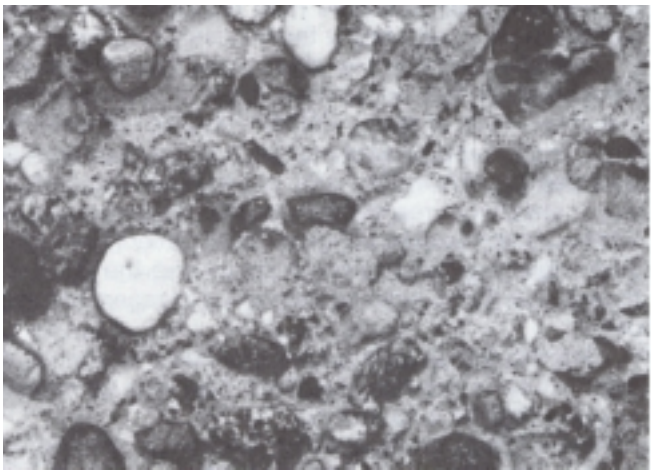

Fig. 2. Closeup of rough texture produced by extensive sandblasting. The degree of roughening can range from light (very little change in surface texture) to heavy (removal of surface mortar to expose coarse aggregate).

Sandblasting equipment is available in various capacities. A venturi-type nozzle should be used on the gun for its solid-blast pattern rather than a straight-bore nozzle that produces lighter fringe areas. A remote control system attached to the sandblast pot gives the operator instant control of starts and stops as well as direction. The man operating the gun must be protected from dust and rebounding grit by a well-fitting air-line hood in which a positive pressure of clean, filtered air is maintained. Other members of the blasting team should wear suitable protective clothing and equipment such as an approved respirator under a hood. Silica dust is a particularly dangerous substance because free silica can cause lung damage. The grit and dust particles must be removed by air blasting, brooming, pressurized water, or vacuum methods before a coating or repair material is applied.

Wet. Wet abrasive blasting is very similar to dry abrasive blasting (sandblasting) except that water is introduced into the air-grit stream at the nozzle. An adapter is secured to the nozzle for attaching to city water supply. The water eliminates most of the visible dust but smaller, harmful particles remain a hazard to health and the same protective equipment and clothing are needed as for dry abrasive blasting. The wet-abrasive-blasting method will avoid the nuisance of dust but it involves an extra operation of rinsing off the surface after blasting to remove residual dust and dirt scum.

Chemical Cleaning

The materials used in chemical cleaning can be highly corrosive and frequently toxic. They require special equipment for their application and protective clothing for workers. In addition, protection may be necessary for adjacent areas, nearby buildings, and lawns, trees, and shrubs. For these reasons, chemical cleaning is best left to the specialist. If, however, a nonspecialist undertakes

the cleaning job, he should read the directions on the cleaner carefully and follow them closely.

Chemical cleaners are often water-based mixtures formulated for use on specific types of concrete and masonry. Most of them contain organic compounds called surfactants (surface-active agents) that work as detergents to allow the water to penetrate the surface dirt or stain more readily, thus hastening its removal. In addition, the mixtures contain a small amount of either acid or alkali, which assists in separating the dirt from the surface. Solvent-based (nonwater) cleaners are also used.

Cleaning with proprietary compounds, detergents, or soap solutions generally requires the same procedure as given here for acid etching.

Acid etching is often suggested as a satisfactory method for cleaning a concrete surface. Hydrochloric acid, also known as muriatic acid, is widely used because of its ready availability. Hydrochloric acid should not be used in areas where chlorides are prohibited.

The procedure for cleaning concrete using a diluted acid solution is as follows:

1. Mix a 10% solution of muriatic acid (1 part acid to 9 parts clean water) in a nonmetallic container. Pour the acid into the water to mix. Stronger acid solutions may have to be used if the etching action is insufficient.
2. Mask or otherwise protect windows, doors, ornamental trim, and metal, glass, wood, and stone surfaces from acid solutions.
3. Remove dust and dirt from the area to be cleaned and presoak or saturate with water.
4. Apply the acid solution to the damp surface with spray equipment, plastic sprinkling cans, or a long-handled stiff-fiber brush. Allow the solution to remain for 5 to 10 minutes. Nonmetallic tools may be used to remove stubborn particles.
5. Rinse thoroughly. Flush the surfaces with large amounts of clean water before they can dry. Acid solutions lose their strength quickly once they are in contact with cement paste or mortar; however, even weak, residual solutions can be harmful to concrete. Failure to completely rinse the acid solution off the surface may result in efflorescence or other damaging effects. Test with pH paper and continue rinsing until a pH of 7 or higher is obtained (see ASTM D4260 and D4262).

Flame Cleaning

Flame cleaning can be used to remove substances such as oil, old paint, and dirt from concrete surfaces to give a new look or to improve bond with a new surface coating. Flame cleaning is accomplished by moving a special multiflame blowpipe over the concrete surface. The blowpipe burns acetylene and oxygen, producing a flame of very high temperature—approximately 5600°F (3100°C). The hot flame causes the surface layer of concrete to spall and shave off the aggregates. Oil, paint, and other impurities are burned away while the moisture in the surface is evaporated. The high-pressure gas blows away the loose material and exposes a new, clean surface.

A manual blowpipe for smaller surfaces, hard-to-reach places, and walls is available in 6- and 10-in. (150- and 250-mm) widths. A rolling carriage blowpipe 20 in. (500 mm) wide is used for cleaning larger surfaces. If the concrete is of such quality that the surface partially melts, a rotating wire brush should be used to remove residual material.

Because the surface undergoes extremely rapid heating, particles in the concrete may erupt with great force. The operator of the flame equipment must wear protective clothing, gloves, a hardhat with neck protection and visor, and, if necessary, welding goggles.

Mechanical Cleaning

Concrete can be cleaned by power equipment capable of loosening and removing the surface to a close tolerance. Machines of many types and sizes are available, identified by descriptive names such as planers, profilers, grinders, groovers, texturers, scarifiers, cutters, scabblers, scalers, and scourers. The cleaning is done by carbide-tipped, conical cutter bits; grinding stones of various grits; multiple, segmented saw blades; hardened-steel cutter wheels in bundles; multiple-point tungsten-carbide bits; steel wire brushes; or tungsten-tipped flails.

It is essential to remove the debris and dust that remain after mechanical cleaning before applying any surface coating or new concrete.

Metallic-Shot Blasting

Self-contained, airless, portable blasting equipment can effectively clean horizontal or slightly inclined concrete

Fig. 3. Scarifiers use steel cutters to remove the concrete surface.

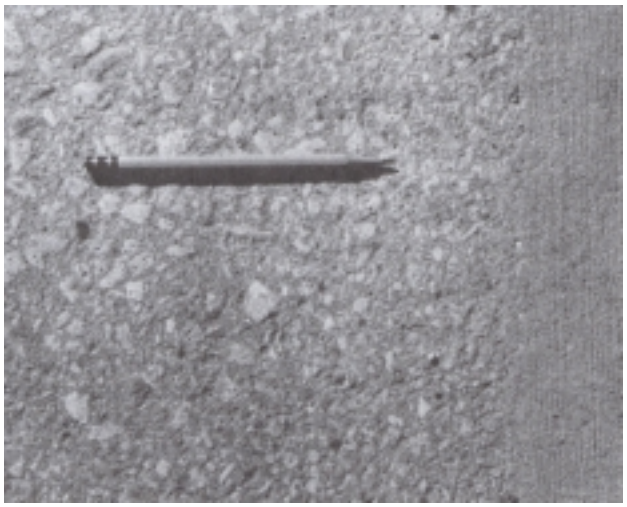

Fig. 4. Scarified surface showing exposed and fractured coarse aggregate next to nonscarified surface.

surfaces. Special units are available for vertical work. The removal of surface contaminants such as old paint, dirt, and loose and weakened concrete is accomplished by the impact of metallic abrasives thrown by a rapidly rotating centrifugal wheel onto the surface to be cleaned. The equipment includes components for dust and noise control as well as the recovery, cleaning, and recycling of the metallic abrasive.

After the abrasive impacts on the concrete surface, it is passed through an air-wash separator that removes foreign materials; the recovered abrasive is recirculated through the blast wheel. Pulverized concrete, dust, and contaminants are removed to a filter-bag dust collector, making the method virtually pollution free. Shotblasting is commonly used to prepare slabs for overlays and coatings.

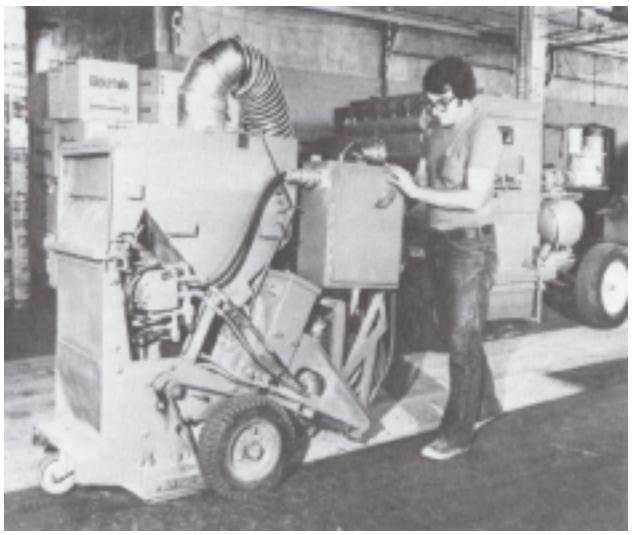

Fig. 5. Airless, self-contained shotblasting equipment can clean horizontal surfaces without contaminating the work area with dust or debris.

Steam Cleaning

In steam cleaning, water is pumped to a flash boiler where it is converted to steam and then directed onto the concrete. Brushes and abrasive stones usually are necessary to asist in removing dirt. Today, improved methods and cleaning products have largely supplanted steam cleaning for buildings, although steam can sometimes help remove deep-seated soiling after acid etching and reach awkward areas. Steam cleaning essentially leaves the concrete surface intact.

Water Spray

Low Pressure. In low-pressure water spraying, only enough water is sprayed onto the surface to keep the deposits of dirt moist until they soften. Larger amounts of water are no more effective, and they might oversaturate a wall and penetrate to the building interior, causing additional problems. Cleaning should begin at the top of the structure so that surplus water will run down and presoften the dirt below. How long it will take to soften the dirt is found by trial; it could be a few minutes or days. On some surfaces the softened dirt can then be removed by hosing down the concrete, but usually it is necessary to assist removal with the gentle use of bristle brushes and nonferrous or stainless-steel-wire brushes. Abrasive stones can be used to remove stubborn dirt from some surface areas.

The low-pressure water spray method is effective only when the dirt lies lightly on the surface or is bound to the wall with water-soluble matter.

High-Pressure Water Blasting. With the recent development of ultra-high-pressure water-jetting equipment, water can be used to clean hardened concrete and masonry surfaces effectively. High-pressure water blasting relies on the force of the water rather than on abrasives. Pressures up to 55,000 psi (380 MPa) are available; however, most of the work is accomplished at 5000 to 10,000 psi (35 to 70 MPa). Although usually not needed, sand can be injected into the high-pressure water stream to enhance cutting. Oils and grease are usually removed before water blasting.

A variety of equipment is available for this type of surface cleaning. Nozzles range from flat-fan pattern tips to a straight jet tip. The fan pattern acts as a blade that pries up and lifts away the undesirable surface accumulation. The straight jet could cut a hole completely through concrete. The techniques used are similar to sandblasting: correct distance from the surface, nozzle angle, and pressure are determined by the type and amount of material to be removed. Water blasting can be used to prepare surfaces for coating, remove dirt or stains, or abrade the concrete surface for repairs. It is also very useful in removing weak, deteriorated concrete.

COVERING STAINS

After stain removal procedures, some stains and discoloration may not come out of the concrete as desired. A

Fig. 6. Waterblasting can be used to clean a surface lightly without abrading the concrete or it can abrade the surface and remove weak concrete. The equipment shown removes the concrete surface (for a future overlay) with fine jets of water at pressures between 6000 and 17,000 psi (41 and 117 MPa). Wand-type waterblasting equipment is also available.

shadow of the stain may remain. Some stains or discoloration may be so severe or extensive it may not be economical or possible to remove them adequately. In these cases, it may be necessary to coat the concrete and cover up the stains to restore a pleasant uniform surface appearance. Before using a coating, be sure it can breathe as required, will properly adhere to the concrete, is durable under the exposure conditions, will not discolor or fade, and will not allow the stain to bleed through to the coating surface. Stain bleeding can be easily tested by coating an inconspicuous area and observing it for bleeding over a few days. Because of the bleeding ability of some stains, an impermeable sealer or pretreatment may need to be applied prior to the coating application. Most coatings require some surface preparation (cleaning) to bond properly to the concrete surface.

Coatings (colored or white) commonly consist of polymer-modified cementitious products, silicone emulsions, and other materials (see Reference 9). The concrete must also be sufficiently dry for certain coatings to be applied (see ASTM D4263). Many coatings also facilitate future surface cleanup. Special staining materials, such as penetrating acrylic resin and pigment stains, may be used in an attempt to color the concrete and blend in the discoloration to produce a more uniform appearance.

An overlay or self-leveling topping can be applied to cover horizontal surfaces (see References 7, 10, 15, 16, and 17). Cement plaster or possibly a grout cleandown can be applied over vertical or underside surfaces to hide unsightly areas (see References 8, 16, and 17).

PROTECTIVE SURFACE TREATMENT

After a stain is removed, or preferably before it occurs, a clear (or colored) surface treatment should be applied to prevent future staining materials from penetrating deep into the concrete and to facilitate stain or dirt removal. The sealer should be durable in the exposure conditions, properly adhere to or penetrate the concrete surface, not discolor or yellow, and have appropriate breathing properties. Many sealers need a surface pretreatment. Most clear coatings or penetrating sealers enhance or do not affect the concrete appearance.

Materials used to protect concrete surfaces include aliphatic urethane, methyl methacrylate, various modified acrylics, and epoxy sealers as well as penetrating-water-repellent sealers such as silane and siloxane. The silanes and siloxanes allow a high breathability or vapor transmission, which is important to many concrete structures. For locations in which a chemical is attacking the concrete and causing the staining, an appropriate sealer that can resist the environment must be used (see Reference 12). Also see "Graffiti" and Reference 2.

ASTM STANDARDS

American Society for Testing and Materials (ASTM)* documents on cleaning concrete are listed as follows:

D4258 Practice for Surface Cleaning Concrete for Coating

D4259 Practice for Abrading Concrete

D4260 Practice for Acid Etching Concrete

D4261 Practice for Surface Cleaning Concrete Unit Masonry for Coating

D4262 Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces

D4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

*ASTM, 1916 Race Street. Philadelphia, Pa. 19103.

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PORTLAND CEMENT ASSOCIATION

An organization of cement manufacturers to improve and extend the uses of portland cement and concrete through market development, engineering, research, education, and public affairs work.

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