increase air content in the mortar slightly, so use with other air-entrained mortar ingredients should be very carefully controlled or avoided entirely.

*Bond enhancers* are intended to improve adhesion to smooth, dense-surfaced units such as glass block. Made of acrylic polymer latex, polyvinyl acetate, styrene butadiene rubber, or methol cellulose, bond modifiers cannot be used with air-entraining agents or air-entrained cements.

In marine environments or where deicing salts may be used, calcium nitrite *corrosion inhibitors* are used to offset the effects of chloride intrusion and prevent steel reinforcement and anchors from corroding. Corrosion inhibitors may also accelerate setting time and reduce entrained air content.

*Integral water repellents* reduce the water absorption of hardened mortar by as much as 60%. They are typically used in conjunction with architectural concrete masonry units that have also been treated with an integral water repellent admixture. Stearate-, fatty acid–, or polymeric-based water repellents reduce the capillarity of the mortar while still permitting moisture vapor transmission. Using water-repellent-treated mortar with untreated masonry units, or vice versa, can reduce mortar-to-unit bond and the flexural strength of the wall. Reduced bond can negate the effects of the water repellent by allowing moisture to penetrate the wall freely at the joint interfaces. Mortars and block treated with integral water repellents achieve better bond and better moisture resistance only if the admixtures are chemically compatible. Wall panels should be tested both for flexural bond strength and water permeance compared to an identical but untreated wall.

Some integral water repellents based on fatty acids or stearates other than calcium stearate perform satisfactorily only for a limited time. Solvent migration eventually renders the treatment ineffective. Obtain manufacturer's test data on long-term performance to verify that the service life of the product is commensurate with the expected service life of the masonry.

### 2.3.7 Mortar Colors

Natural and synthetic *pigments* are used to color masonry mortar (*see Fig. 2-17*). Most mortar colorants are made from iron oxide pigments. Iron oxides are nontoxic, colorfast, chemically stable in mortar, and resistant to ultraviolet radiation. Iron oxides come in yellows, reds, browns, and blacks. Chromium oxides (which produce greens) and cobalt (which produces blue) also are stable in alkalis and resist ultraviolet radiation. Ultramarine blues, which are made from sulfur, sodium carbonate, and kaolin, are less stable in mortar. Carbon black and lampblack (used to make blacks and browns) are less weather resistant than the iron oxides used to make the same colors.

Iron oxide pigments are either natural or synthetic. Natural iron oxides are made by crushing and grinding iron ore to a fine particle size. Synthetic iron oxides are made by several processes, including precipitation of iron salts, calcination of iron salts, and as a by-product in the manufacture of aniline, which is used in dyes. Synthetic iron oxides have more tinting power, so less pigment is required per unit of mortar to produce a given color. Synthetic oxides also produce brighter, cleaner colors than natural iron oxides. Natural and synthetic pigments may also be blended together.

Beyond a certain point, called the saturation point, the color intensity of the mortar does not increase in proportion to the amount of pigment added. The saturation point varies, depending on the tinting strength of the particular pigment. Synthetic iron oxides generally are saturated at about 5% of the weight of the cement, and natural oxides at about 10%. Adding pigment beyond the saturation point produces little additional color.

| Concrete or Mortar Color[§] | Pigments Used[†] |
|---|---|
| Black, Gray | Black iron oxide, mineral black, carbon black |
| Brown, Red | Red iron oxide, brown iron oxide, raw umber, burnt umber |
| Rose, Pink | Red iron oxide (varying amounts) |
| Buff, Cream, Ivory | Yellow ocher, yellow iron oxide |
| White | White cement and white sand (no pigments required) |
| Green | Chromium oxide, phthalocyanine green |
| Blue | Cobalt blue, ultramarine blue, phthalocyanine blue |

[§] Color of finished concrete and mortar is affected by color of cement and aggregates.
[†] Synthetic iron oxides have more tinting power than natural iron oxides, so less pigment is required per unit of concrete or mortar to produce a given color. Synthetic oxides also produce brighter, cleaner colors.

**Figure 2-17** Concrete and mortar coloring pigments.

When pigments are used in recommended dosages, colored mortar has not been found to adversely affect the compressive strength of the masonry, but bond strength is reduced by 3 to 5%. Colored mortar can be made at the job site from powdered or liquid pigments. Powdered pigments are used most frequently, and the majority are packaged so that one bag contains enough pigment to color 1 cu ft of cementitious material (i.e., for each 1-cu ft bag of masonry cement, portland cement or lime, one bag of color is added). Pigment manufacturers supply charts that identify the exact number of bags of pigment required for various mortar proportions. Similarly, liquid colorants are generally packaged so that 1 qt of pigment is needed for each bag of cementitious material. Manufacturers can also custom blend and package pigment so that one bag or bottle contains enough colorant for an entire batch of mortar. Liquid pigments create less mess and blowing dust than dry powders, but they also cost more. The same pigments used to color mortars are used to produce colored concrete masonry units. Some manufacturers market colored masonry cements, mortar cements, and prebagged portland lime-mortar mixes in which pigments are preblended in the bag with the other ingredients.

The color of a finished mortar joint is affected by the properties of the component materials, including the sand aggregate and cement, the workmanship, curing conditions, cleaning procedures, joint type, and joint tooling techniques. When colored mortar is used, it is best to evaluate and select materials on the basis of samples that closely approximate job-site materials and design, and to incorporate the colored mortar into a job-site sample panel before acceptance.

### 2.3.8 Grout Admixtures

Shrinkage-compensating admixtures (commonly called grouting aids) are the most common grout additives. Grout typically shrinks 5 to 10% after placement as the surrounding masonry units absorb water. To minimize volume loss, maintain good bond, and give workers more time to vibrate the grout