In a perfect world, we never get fat, our children are grateful for all we do for them, and when we remove the formwork—voila!—the concrete is as smooth as glass.

In the real world, our waistlines bulge, our children are embarrassed to be seen with us, and formed concrete looks like Swiss cheese. Well, maybe not that bad, but you get the point.

Surface voids, such as bug holes, form-tie holes, and honeycomb, are a fact of life in cast-in-place concrete construction. Depending on project specifications, they may need to be repaired.

On many jobs, filling surface voids is a contractor’s last task, so the chore often doesn’t receive the attention it deserves. Engineers and contractors must be aware that because these repairs are usually thin, they are prone to failure.

According to Glenn Smoak, author of the U.S. Bureau of Reclamation’s Guide to Concrete Repair (Ref. 1), failure of surface-void repairs often is caused by loss of moisture from the repair material. “These thin repairs often fail because the mix water evaporates from the surface and is absorbed by the existing concrete,” he says. “This leaves little water to hydrate the cement or to establish a strong bond.” Therefore, Smoak recommends repairing surface voids within 24 hours after removing the forms so the base concrete does not have time to dry out. He also advises wet curing the repairs for at least 2 weeks to prevent evaporation.

Following are accepted techniques for repairing common surface voids in formed concrete. Keep in mind that repaired areas are usually darker than the surrounding concrete, so if color match is important, consider replacing some of the gray cement with white cement. By installing test repairs on an inconspicuous area of the concrete, you can determine the right cement blend.

**Bug holes**

Bug holes are air bubbles trapped at the surface of formed concrete during placement and consolidation. They’re commonly seen on vertical as-cast sur-
faces and often don't require repair. But if repair is required, sack rubbing is an effective method.

A good mix for sack rubbing contains 1 part portland cement, 1 1/2 to 2 parts fine sand, and enough water to produce a consistency between that of thick paint and masonry mortar. Wet the concrete and apply the grout to the entire surface with a rubber hand float, forcing the grout into all the voids. The next step is to rub the excess grout off the surface, and the timing of this step is crucial. If done too soon, some of the grout may be pulled from the bug holes; if done too late, the grout may be hard to remove from the surface.

A common way to remove excess grout is to rub the surface with burlap. But Al Perez, president of Concrete Restoration Services, Irving, Texas, says that using closed-cell polystyrene works better because removing the grout with burlap can create recesses in the filled bug holes.

After removing the excess grout, cure, cure, cure. “You can spend an awful lot of money and effort on sacking, but if you don’t cure it right, it’s just going to wash out with the first rainfall,” says Smoak.

Form-tie holes

A common type of form tie uses plastic cones at the surface. The cones act as a spreader for the forms, aid in reducing grout leaks, and make breaking back snap ties easier. But after removal, a typical cone leaves a hole in the surface about 1 inch wide and 1 1/2 inches deep.

The most common way to fill form-tie holes is to simply trowel mortar into them, but these repairs rarely hold up. “You can go back the next day and scratch them out with your fingernails,” says Smoak.

Because of their high depth-to-width ratio, form-tie holes should be filled by dry packing, a technique with a history of producing durable repairs. Dry pack is a stiff sand-cement mortar containing 1 part portland cement, 2 to 3 parts sand, and enough water to produce a mortar that will just stick together when molded by hand into a ball. The low water content of dry pack results in minimal drying shrinkage, thereby improving durability.

Ideally, the smooth inside surface of form-tie holes should be roughened to promote a strong bond. “We used to take a 1/2-inch drill, stick a piece of wire rope in it, and rough up the edges,” says Smoak. “But with today’s labor costs, it’s just not economical.”

Nevertheless, Smoak says that dry pack can form an adequate bond with form-tie holes if the base concrete is in a saturated surface-dry condition (the surface is saturated but contains no standing water). He has found, however, that using an epoxy bonding agent works even better because it prevents the surrounding concrete from sucking water out of the dry pack.

To install dry pack, compact the mortar in the hole with a hardwood dowel or stick, striking it with a hammer (Fig. 1). Pack the mortar in layers about 1/2 inch thick, overfilling the hole slightly. Then place the flat side of a piece of hardwood against the hole and strike it several times with a hammer. If necessary, a few light strokes of the mortar with a rag may help the repair blend with the surrounding concrete.

**Honeycomb and larger voids**

Unlike bug holes and form-tie holes, which require specialized repair techniques, honeycomb and larger surface voids use procedures resembling those for typical concrete repairs. But there’s nothing typical
about the recommended approaches to repairing these voids. They vary greatly.

A common debate centers on the required minimum thickness of the repair. Some authorities do not require a minimum thickness, while others set limits, such as 1 inch or 2 inches. The need for a bonding agent, whether an epoxy or cementitious grout, is also unresolved.

In any case, good concrete repair practice calls for removing any loose material within the void. According to Jerry Ford of Dayton Superior Inc., Oregon, Ill., honeycomb often contains loose coarse aggregate if the void is caused by a leak in the form. If the void is caused by poor concrete consolidation, the coarse aggregates often are intact.

Use light chipping hammers weighing 15 pounds or less to remove the required amount of concrete. Because impact hammers can fracture the surface of the concrete that remains, follow chipping with sandblasting or waterblasting to remove this fractured surface.

A common way to place the repair material is to simply trowel it into the void. But Smoak says that contractors can achieve better results using a small pneumatic mortar gun to apply a grout similar to hand-applied dry pack (Fig. 2). A suitable mix contains 1 part portland cement and 4 parts sand and has a water-cement ratio of about 0.35. If the repair is deeper than 1 inch, apply the mortar in layers no thicker than \( \frac{3}{4} \) inch to avoid sagging and loss of bond. After placing each layer, wait about 30 minutes before placing the next layer. You don't have to scratch or otherwise prepare a preceding layer before placing the next, but do not let the in-place mortar dry. To complete the repair, overfill the void slightly. After the material has hardened slightly but can still be trimmed off with the edge of a steel trowel, shave off the excess material, working from the center toward the edges. When finishing the repair, exercise extreme care to avoid impairing the bond.

References
2. ACI Manual of Concrete Inspection, Publication SP-2 (92), American Concrete Institute, 1992.