Bonding new concrete to old

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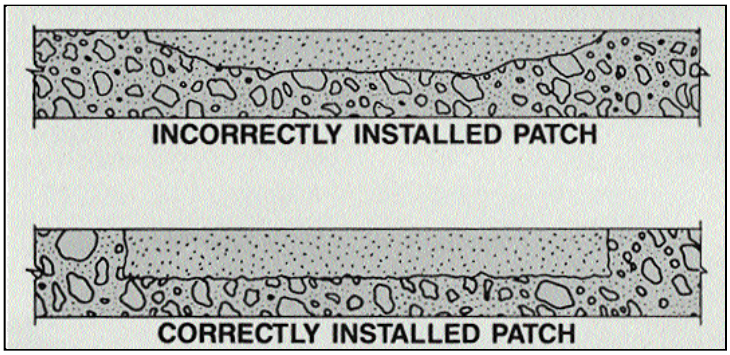

Figure 1. **The feathered edges of the top drawing will break down under traffic or will weather off. The chipped area should be at least ¾ inch deep (see bottom drawing) with the edges at right angles or undercut to the surface.**

Bonding fresh, plastic concrete to old, hardened concrete increases the strength of the composite material. Fresh patches, concrete adjacent to construction joints, and overlays all benefit from bonding to the hardened concrete substrate. Bond is not, however, guaranteed. It must be ensured through proper surface preparation, material choice and use, and curing. Ignoring one of these components does not mean a one-third decrease in bond; it may result in the total loss of bond.

Surface preparation

All damaged, loosened, or unbonded portions of existing concrete should be removed by chipping hammers or other mechanical methods. Prepare the exposed concrete by wet sandblasting, waterblasting, or shotblasting. Then clean it and allow it to dry thoroughly. This removes any laitance, soft mortar, dirt, wood chips, form oil, or other foreign materials that may interfere with proper bonding of the new concrete.

Pressurized water and air is commonly used for surface preparation. Be sure that water used in cleaning is itself clean and also that no contaminants are present in the compressed air. ACI 503 (Ref. 2) recommends that all equipment supplying compressed air be equipped with efficient oil and water traps to prevent surface contamination from the compressed air supply.

Acid etching was once considered another way to prepare a surface, but experience shows that this method is not as dependable as mechanical methods (ACI 503R). Also, some cleaning acids contain chlorides that can start rebar corrosion. Acid etching is not recommended unless no other means of cleaning is possible.

Patches

Patches are easier to make and more successful if they are made as soon as practical, preferably when the concrete is still green. Successful patches can be made, however, at any time. The edges of the defective area should be chipped or cut straight and at right angles to the surface, or slightly undercut to provide a key at the edge of the patch. Most contractors saw cut around the defective material. This helps define the scope of work for the laborers and provides a right angle surface cut.

Whatever the method, no featheredges should be permitted (Figure 1). When chipping around reinforcement leave at least a l-inch space around each exposed bar. Always leave rebar partially embedded.

Construction joints

Workers can prepare the surface of construction joints during the first concrete placement. For horizontal construction joints, the top surface of fresh concrete can be roughened while still plastic. Green concrete, 12 to 24 hours old, can be easily cut or wire brushed to create a roughened surface.

Sometimes workers sprinkle or mix retarders into the top layer of concrete. Delaying the set allows the surface to be roughened up to 48 hours after the pour.

For vertical construction joints placed against bulkheads, the concrete surface is generally too smooth to permit proper bonding. Stiff-wire brushing may be sufficient if the concrete is less than 3 days old. Otherwise bushhammering or sand or waterblasting may be needed. Follow this by washing to remove all the dust and loose particles.

Overlays

For bonded two-course floors, the

surface of the partially set base course is usually brushed with a coarse wire broom to remove laitance and score the surface. Then it should be wet cured for 3 days. Don't use curing compounds as they can interfere with bonding.

If the slab is being repaired with a bonded overlay, then techniques developed for the pavement industry are typically appropriate. Bonding of two-course floors is difficult. Without close attention to detail, the bond won't be successful.

Slabs on grade and pavements now can be cleaned fast with high-production, self-propelled cold-milling equipment and improved blasting techniques. The type of coarse aggregate in the existing pavement usually dictates the least costly way to prepare a surface.

Most agencies specify the surface cleaning method and minimum depth of surface removal. The Corps of Engineers requires removal of at least 1/4 inch from the surface by scarification followed by high-pressure water flushing and air blowing. The Portland Cement Association (PCA) recommends that the surface be scarified to remove unsound concrete and cleaned by sandblasting or other means.

Bonding medium

The most practical and economical bonding agents are sand-cement and water-cement grouts. Epoxy resin grouts specially formulated for each application also are on the market. ACI 503 details the use and specification of epoxies for bonding fresh to hardened concrete.

The bonding sand-cement grouts usually consist of 1 part cement, 1 part sand, and enough water (about 1/2 part) to form a creamy consistency. The sand should pass the No. 30 sieve. Proportion water-cement bonding grouts at the rate of 1 bag of cement to 6 to 7 gallons of water. Some project specifications permit a water-cement grout with a water-cement ratio of 0.62. This allows the grout to be sprayed on the surface to a depth of about 1/16 inch.

Epoxy resins and their hardeners or curing agents are co-reactants in a chemical reaction that allows the material to harden. The proportioning of the resin and hardener is extremely important; they must be mixed thoroughly to produce a homogenous mixture. This ensures a complete reaction. Epoxy resins can be formulated for different temperatures and for dry or damp surfaces. The ability to be used on a damp surface is sometimes an advantage.

Regardless of the bonding medium, a minimum bond strength is required. Based on laboratory and field tests, Felt (Ref. 4) concludes that bond strengths greater than 400 psi may be achieved, but that strengths of 200 psi or less may be adequate. The bond strength of 200 psi is generally used as a guide in designing bonding media.

Bonding procedure

After preparing the surface, the contractor need only decide if the concrete should be dry or damp before brooming or brushing the bonding medium into place. Most agencies recommend a damp surface free of water, especially in hot, windy weather.

Protect the bonding medium from drying above and below. Hot, windy weather dries the bonding medium from above. From below, porous aggregates or concrete can absorb enough water to prevent complete hydration. This produces a weak bond interface or the porous surface can absorb enough epoxy to starve the glue line.

Apply the grout immediately before placing the new concrete. Place only as much grout as can be covered with fresh concrete before the grout dries. The amount of grout varies with weather, equipment, and crew. After applying the bonding medium, place the concrete as usual.

Curing

Start curing as soon as possible after placing the fresh concrete. Use wet burlap, wet sand, plastic sheets, curing paper, tarpaulins, curing compounds, or a combination.

Moisture and temperature both affect the curing of bonded concrete. Differential shrinkage, thermal movements, or moisture gradients can cause enough stress to break the bond during the curing period. This is especially important when the new concrete has different properties (modulus of elasticity, coefficient of thermal expansion, shrinkage strains) than the underlying concrete.

References

1. Hutchinson, R. L., "Resurfacing with Portland Cement Concrete," NCHRP 99, Transportation Research Board, December 1982.

2. "Use of Epoxy Compound with Concrete," ACI 503R-80, Manual of Concrete Practice, American Concrete Institute, P.O. Box 19150, Detroit, Michigan 48219, 1986.

3. "Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive," ACI 503.2-79, Manual of Concrete Practice, American Concrete Institute, 1986.

4. Felt, E. J., "Resurfacing and Patching Concrete Pavement with Bonded Concrete," Highway Research Board Proceedings, Vol. 35, Highway Research Board, National Research Council, Washington, DC, pages 444-69, 1956.

5. Kosmatka, S. and W. Panarese, "Design and Control of Concrete Mixtures," 14th Edition, Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077.

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