



## REMR TECHNICAL NOTE CS-MR-2.1

CONCRETE SURFACE PREPARATION  
PRIOR TO REPAIR

Prepared surface ready for patching

PURPOSE: To provide guidance for preparing concrete surfaces for repair.

BACKGROUND: Surface preparation is one of the primary considerations when executing a repair requiring bonding of a material to concrete. Inadequate surface preparation can cause the most expensive and innovative repair materials and techniques to fail. There are many reasons why a repair may fail prematurely. With care and adequate preparation, however, the chances for success are excellent.

MAJOR CAUSES OF CRACKING, DEBONDING AND BREAKDOWN OF LOAD CARRYING CAPACITY:

1. Stresses: At the interface between concrete and repair material, stresses develop because of service loads, and because of differences in thermal, shrinkage and elastic properties of the two materials. Ultimately, these stresses can cause cracking and debonding of the repair material.
2. Unsound Concrete: Bonding a repair material to unsound concrete can result in failure of the repair below the interface. Insufficient removal depth or technique-induced microcracking may result in unsound concrete

remaining in the prepared surface. A layer of microcracking can result from an impacting technique, such as milling or jackhammering.

3. Foreign Agents: Presence of grease, oil, efflorescence, laitance, dirt, protective coatings or other surface coatings on the concrete can result in failure of the repair.

4. Varying Thickness of Repair: Extreme nonuniformity in the profile of a prepared surface can result in cracking of the repair material. As the thickness of the repair material varies along the profile, so does the change in thickness from drying, autogenous, and thermal shrinkage. Stress concentrations occur in places where the profile changes and are greatest at the boundaries of depressions and high points located in the profile. If stresses are of sufficient magnitude, cracking will occur. In a similar manner, feathered edges at the boundary of a repair are prone to debond (caused by extreme differences in relative shrinkage between the body of the repair and its edges).

5. Moisture: Surface moisture and temperature requirements for a surface are dependent on the repair material to be employed. Polymer materials generally require an extremely dry surface, while latex materials require a saturated surface for proper bonding. When applying a moisture barrier, it is important that the moisture movement not be out of the concrete during curing. (The direction of movement is a function of the ambient temperature and humidity.) If a barrier coating is applied to a concrete surface when the moisture movement is out of the concrete, moisture vapor will form at the interface and tend to lift the coating off the concrete surface. Under these conditions surface blisters may form, causing the coating to fail.

6. Reinforcing Steel Failure: Reinforcement steel must have adequate cross-section for capacity, as well as clearance, to allow for proper consolidation and bond of repair material around the bars. Surfaces must be free of materials that would result in a poor bond.

#### EVALUATION OF SURFACE PREPARATION:

1. Surface Soundness: A visual inspection of the aggregates at the prepared concrete surface can give an indication of the soundness of concrete. Aggregates sheared at the surface indicate sound concrete. Aggregates pulled from the surface, leaving only an imprint, indicate unsound concrete. Fractured paste and aggregates indicate unsound concrete that includes microcracking. The concrete can be further evaluated by impacting the surface with a hammer or hammering a chisel or screwdriver into the surface and observing the results on the large aggregate and the ease with which the mortar can be removed.

2. Delamination: Impacting the concrete surface with a hammer or dragging a chain across the surface is a means of locating areas of delamination remaining beneath the surface. Sound concrete makes a clear, high-pitched ring. Unsound concrete makes a dull, drum-like sound.

3. Strength: The tensile strength of the concrete surface can be determined with a pull-out test. An acceptable tensile strength for most repairs is 200 psi or greater. For more reliable data, a minimum of three tests should be conducted. The test: A 2-in.-diam-core barrel is used to drill 1 in. into

the concrete, and a pipe cap is bonded to the core (Ref a). A hydraulic jack with a donut ram is used to apply load.

4. Surface Profile: Visual inspection can be used to evaluate the uniformity of the concrete surface profile. Removal depth, peaks, and dips in the surface profile can be measured with a ruler and a straight edge. Removal depth should not be less than the specified depth. For patching, resurfacing, and overlay repairs with cementitious materials, it is important to note all significant peaks and dips in the prepared surface. For most barrier coatings, it is important to note (1) peaks greater than 1/16-in. and (2) holes greater than 1/8-in. (Ref a). Noted peaks should be removed, and dips should be patched prior to placement of the repair material. Acid etching of floors produces the lowest profile and the roughness of 200-grain sandpaper (Ref b). Acid etching is not a preferred method (Ref a) because it is difficult to control; however, for thin coating systems such as clear urethane, etching may be necessary. Steel shot blasting produces a fine-to-coarse profile, except in a heavy grease environment (Ref b). Mechanical abrading is suitable for removing fins and projections.

5. Edges of Repair Area: For patching and resurfacing repairs, edges at repair boundary should be saw cut and chipped to produce edges normal to the concrete surface, a minimum of 1-in. deep. Feathered edges are not acceptable.

6. Deleterious Materials: The presence of laitance is indicated if a white powder is produced by scraping the surface with a steel blade. Oil, wax, or grease is present if water droplets bead on the surface. Other determinations will require chemical analysis of surface samples. Protective coatings, efflorescence, laitance, oil, wax, grease and other penetrating contaminants must be removed from the surface. Detergents and emulsifying agents are recommended for removal of oil and grease. Do not use abrasive blasting or solvents as these methods drive contaminants farther into the concrete surface (Ref b).

7. Cleanness: The surface can be checked for any residues by wiping it with a dark cloth or sticking adhesive tape to it and then examining the tape. Air blasting, water cleaning, scrubbing, sweeping, or vacuuming are acceptable methods for cleaning surfaces. If air blasting is used, the air must be free of all oil (ASTM D 4285).

8. Moisture Condition: For a barrier application, there should be no free water on the surface (Ref a). Surface moisture can be checked by pulling your fingers across the surface. If moisture is picked up, the surface is too wet. Another method is to drag an absorbent paper across the surface: if the paper darkens, there is too much water. Also, moisture meters that can quantitatively measure surface moisture are available. Capillary moisture can be checked by taping a transparent polyethylene sheet to the repair surface for the length of time required for the barrier system to cure (Ref d). If condensation occurs on the underside of the plastic sheet, the concrete needs further drying. Project and material specifications give a minimum time that the moisture condition must be maintained prior to placement of the concrete coating.

9. Temperature Condition. Surface temperature must be recorded, especially when the ambient temperature is near that of the manufacturer's recommended limit for placement. A standard or electronic digital thermometer can be used to measure the temperature at the concrete surface. Project and material specifications recommend a placement temperature range.

EVALUATION OF CONDITION OF REINFORCING STEEL:

1. Clearance: If more than half of the perimeter of a reinforcing bar is exposed for as much as 12 in., the bar should be completely exposed (ACI 546.1R-80) (Ref e). The minimum clearance between the exposed bar and the concrete should be three-fourths inch or the maximum size aggregate plus one-fourth inch, whichever is greater. This recommendation does not apply if the closeness of adjacent reinforcing makes this clearance impossible.

2. Placement: Quantity, size, and location of reinforcement must comply with specifications. Reinforcing bars that protrude out-of-plane with adjacent bars to the extent that their structural effectiveness will be reduced and any reinforcement whose location will result in inadequate concrete cover must be relocated. Reinforcing bars must be securely tied and supported to maintain their location during concrete placement.

3. Effective Cross-Sectional Area: If damage to reinforcing bars has reduced the effective cross-sectional area by more than 20 percent, additional reinforcement should be added. Splicing and lap lengths of added reinforcing must comply with ACI 318-83 (Ref f). Chipping hammers used to remove concrete from around reinforcing bars should be no heavier than 15 lb.

4. Deleterious Materials: Materials such as oil, wax, grease, and other contaminants must be removed. Do not use abrasive blasting or solvents (Ref g) as these methods will drive grease and oil farther into the steel surface. Detergents or emulsifying agents are recommended for removal of these materials.

5. Cleanness: Wire brushing, abrasive blasting, and water jet blasting can be used to clean reinforcement of dirt, surface residues, and loosely adhered rust. Dry sandblasting is preferred, but this method requires special equipment to protect the operator from respiratory health hazards.

- REFERENCES:
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- e. ACI Committee 318. 1983. "Building Code Requirements for Reinforced Concrete," ACI 318-83 American Concrete Institute, Detroit, MI.
- f. Aldinger, T. I. and Fultz, B. S. 1989 (May). "Keys to Successfully Preparing Concrete for Coating," Journal of Protective Coatings & Linings, Vol 6, No. 5, pp 34-40.