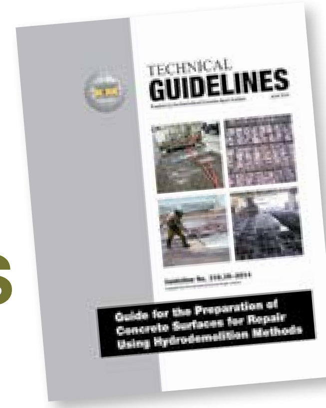
INTRODUCTION TO ICRI TECHNICAL GUIDELINE NO. 310.3R–2014,

GUIDE FOR THE PREPARATION OF CONCRETE SURFACES FOR REPAIR USING HYDRODEMOLITION METHODS



BY PAT WINKLER

ICRI Technical Guideline No. 310.3R–2014, "Guide for the Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods," was recently revised and updated. The guideline, originally produced in 2004, provides a detailed discussion of the hydrodemolition process, including advantages and limitations. The guideline's primary focus is on the use of hydrodemolition for the removal of concrete for concrete repair. The guideline provides a description of equipment, applications, safety procedures, methods of water control and treatment, and cleanup of debris. It also discusses surface preparation and coating removal.

Various sections of the guideline have been revised to provide new or updated information. Updated sections include microcracking, limitations, scarification, the hydrodemolition process and considerations for use, and wastewater treatment and recycling.

Fig. 1: Surface prepared using hydrodemolition has a rough, irregular profile with protruding aggregate essential for creating a mechanical bond

Fig. 2: Hydrodemolition can expose and clean reinforcing steel

The use of hydrodemolition continues to grow as a preferred method to remove concrete and perform surface preparation. Should OSHA further restrict the level of silica permitted in the work area (that is, from sandblasting and other concrete removal operations), as is currently being discussed, hydrodemolition can be used to reduce worker exposure.

Hydrodemolition uses high-pressure water jets to remove deteriorated and sound concrete. It provides a rough surface for excellent bonding of repair materials (Fig. 1). Hydrodemolition can be used for horizontal, vertical, overhead, and underwater concrete removals, and surface preparation on reinforced and nonreinforced structures. Hydrodemolition applications include scarification, partial- and full-depth concrete removal, and coating removal.

A typical hydrodemolition system consists of a support trailer or vehicle, high-pressure pump(s), a robotic unit to perform the demolition, and high-pressure hoses to connect the pump(s) to the robot. Hand lances are available to remove concrete in areas inaccessible to the robot and are also covered in the guideline.

Hydrodemolition will remove concrete from around reinforcing steel, expansion joint hardware, anchorages, conduits, shear connectors, and shear studs. These items are undamaged and cleaned during the hydrodemolition process (Fig. 2).

The benefits of hydrodemolition can be placed into two groups: structural benefits which improve the quality of the repair, and environmental benefits which improve the quality of the workplace.

The primary structural benefit from hydrodemolition is the elimination of microcracking, or microfracturing (bruising) of the concrete substrate, typically caused by impact removal methods such as handheld concrete breakers (Fig. 3 and 4).

Other structural benefits include:

- Selective removal of lower-strength and deteriorated concrete;
- A rough, irregular surface profile (typically meeting or exceeding concrete surface profile

[CSP] 10, as defined in ICRI 310.2R[1]) for bonding to repair material;
- Bond strengths that equal or exceed the tensile strength of the substrate concrete (based on pulloff tests per ASTM C1583/C1583M[2] and ICRI 210.3R[3]);
- Minimal structural vibration;
- Cleaning of reinforcement, eliminating the need for a second step of surface preparation; and
- Undamaged reinforcing and other embedded elements.

Environmental benefits include:
- Transmitted sound and vibration is significantly reduced through the structure;
- Increased speed of concrete removal can reduce construction time;
- Silica dust is minimized; and
- Soft-tissue injuries are reduced.

Limitations when using hydrodemolition include the following:
- The process consumes a significant amount of potable water;
- Wastewater must be contained and treated;
- Water may leak into occupied space;
- Potential for blow-through (unanticipated full-depth removal); and
- Freezing temperatures may create hazardous conditions.

The guideline discusses the various limitations in detail and provides additional insight into other factors that may affect the use of hydrodemolition.

Many factors affect the speed and quality of concrete removal when using hydrodemolition, including:
- Concrete strength;
- Uniformity of concrete;
- Aggregate size;
- Type of aggregate;
- Previous repairs with dissimilar strength material;
- Deterioration, delamination, and cracking;
- Size and spacing of reinforcing steel or other embedded items;
- Surface hardeners; and
- Previous rotomilling of the surface.

Each of these factors is fully discussed in the guideline.

Prior to selecting hydrodemolition for a particular repair project, one needs to consider various job-site and repair conditions. These conditions may influence the cost and practicality of using the hydrodemolition method and include:
- Mobilization and setup;
- Potential increase in repair quantity;
- Reinforcing steel size and concrete cover;
- Potential for full-depth blow-through;
- Extent of previous repairs;

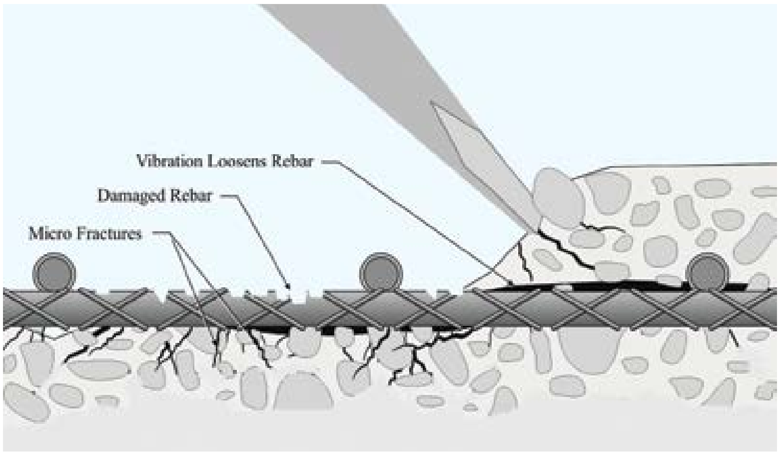


Fig. 3: Microcracking of concrete substrate caused by handheld concrete breakers

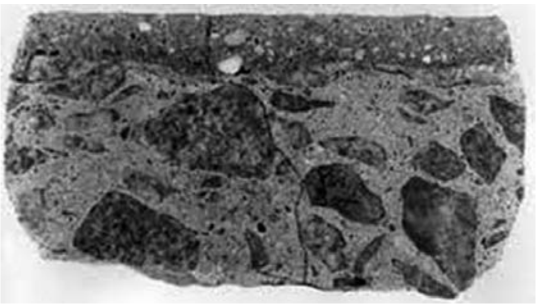


Fig. 4: Microcracking of concrete substrate below repair material

- Occupied areas adjacent to or under the repair area;
- Shoring requirements;
- Equipment location;
- Available water sources;
- Post-tensioned structures;
- Conduit and embedded metal items;
- Noise limitations;
- Protection of lighting, sprinkler, and other services;
- Cold temperatures;
- Shielding;
- Wastewater collection, treatment, and disposal; and
- Debris cleanup and disposal.

Again, all of these considerations are fully discussed in the guideline.

Hydrodemolition debris consists of wet sand, aggregate, and chips and chunks of concrete. Removal of the debris should occur quickly. This will help to avoid the material resolidifying and adhering to the surface, making cleanup more difficult. Tools used for cleanup include fire hoses, pressure washers, compressed air, sweepers, skid-steer loaders, vacuum trucks, and manual labor. Cleanup methods will depend on whether the reinforcing steel is exposed. If the reinforcing bar is not exposed, cleanup equipment such as skid-steer loaders and vacuum units may be driven on the surface to assist the cleanup. If the reinforcing bar is exposed, heavy equipment cannot be used. Pressure washers, air wands, and vacuum equipment (Fig. 5) provide the best solution for cleanup.

Often, the concern over wastewater collection and disposal discourages the use of hydrodemolition. When properly planned, wastewater is easily managed. The wastewater (slurry water) contains suspended particles (ranging up to 15,000 ppm of total suspended solids [TSS]) and typically has a pH of 11 to 12.5. The wastewater is collected and treated to reduce the TSS and pH to acceptable levels prior to discharge. Treatment generally requires a settling system followed by the addition of a neutralizing material (Fig. 6).

Fig. 5: Small track unit used to vacuum debris

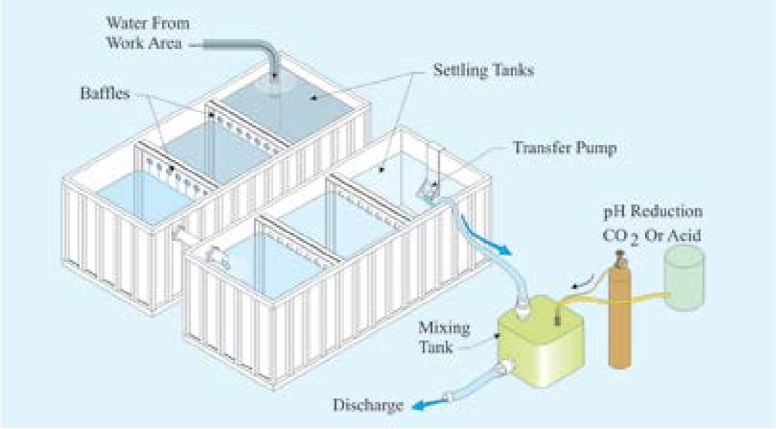


Fig. 6: Typical wastewater treatment system

Fig. 7: Wastewater treatment system

With the proper equipment, the wastewater may be recycled through the hydrodemolition equipment. Portable water filtration units are available to separate the slurry from the water and adjust the pH (Fig. 7). This equipment can reduce the suspended particles to less than 20 ppm and a pH of 6 to 9. This and similar wastewater processing equipment allow for the recycling as well as disposal of the wastewater.

Effective concrete removal and proper surface preparation are key elements to a successful repair project. A surface prepared using hydrodemolition is typically rough, irregular, and provides an excellent mechanical bond with the repair material. Hydrodemolition does not create microcracks in the concrete surface. Noise transmission through the structure is greatly reduced compared to mechanical methods. Exposed reinforcing steel is cleaned and not damaged by hydrodemolition. Dust and the danger of silicosis are reduced.

The revised and updated ICRI Technical Guideline No. 310.3R–2014 on hydrodemolition covers the aforementioned items in much more detail. If you are contemplating the use of hydrodemolition and want to know about the benefits and limitations of this process, this guideline will be very beneficial.

REFERENCES

1. ICRI Technical Guideline 310.2R-2013, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair," International Concrete Repair Institute, Rosemont, IL, 2013, 48 pp.

2. ASTM C1583/C1583M, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pulloff Method)," ASTM International, West Conshohocken, PA, 2013, 5 pp.

3. ICRI Technical Guideline 210.3R-2013, "Guide for Using In-Situ Tensile Pulloff Tests to Evaluate Bond of Concrete Surface Materials," International Concrete Repair Institute, Rosemont, IL, 2013, 20 pp.

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