SO YOU'RE GOING TO USE HYDRODEMOLITION ON YOUR NEXT PARKING GARAGE REPAIR PROJECT?

BY SCOTT HARRISON

The hydrodemolition method uses high pressure water jets, typically 20,000 to 40,000 psi (138 to 276 MPa), to remove areas of deteriorated and sound concrete as part of a concrete restoration project (Fig. 1). The hydrodemolition method provides numerous advantages over the use of conventional pneumatic hammer (handheld concrete breaker) demolition, including:

Fig. 1: Hydrodemolition of a garage floor slab

Fig. 2: Hydrodemolition provides superior surface preparation of existing concrete and reinforcing steel surfaces

- Lower noise transmission and vibration through the concrete structure into adjacent areas and floors of a building. Typically, there is little noise on the floors directly above where hydrodemolition is being performed compared to pneumatic hammer demolition, where noise can still be an issue ten (10) floors above the work area. Low noise transmission is critical in buildings with 24-hour occupancy, such as hospitals, hotels, and multi-family residential properties;
- Produces minimal dust. Dust is difficult to control in a pneumatic hammer project and can create a hazard to workers;
- Provides a superior existing concrete surface and reinforcing steel preparation, without the need for sandblasting (Fig. 2). It also does not result in "micro-cracking" of the existing substrate and surrounding sound concrete;
- Does not damage embedded reinforcing steel, sound metal conduit, steel members, steel studs, and other embedded metal items; and
- Faster production. Production rates will vary with different equipment set-ups and existing concrete compressive strength, but a good rule of thumb for a wall to wall concrete slab removal, at 4 in (102 mm) partial depth cut, is 100 to 160 sf (9.3 to 14.9 m^2) per hour.

However, hydrodemolition also provides several challenges compared to conventional demolition methods, including:

- Uses a significant amount of water (50 to 100 gallons/minute [189 to 378 liters/minute]) for typical partial depth (4 in [102 mm]) and full depth (8 in [203 mm]) concrete slab removal;
- The wastewater produced from hydrodemolition must be collected, settled, filtered, treated and

pumped into a sanitary system (Fig. 3). Most jurisdictions will require a wastewater disposal permit, recording of discharge amounts, and testing of the discharged water to confirm that the suspended solids and pH levels of the treated water meet the jurisdiction requirements. Additionally, some jurisdictions may limit the amount of water that can be discharged into the sanitary system on a daily basis;

- For phased work areas, more extensive protection is required, including full height solid (typically wood) partitions and water dams (Fig. 4) to keep water within the work areas, as well as noise reduction measures, such as insulating blankets;
- Requires temporary disconnection and/or plugging of the existing drainage system;

Fig. 4: Sealed skirt dam installed at perimeter of work area

Fig. 5: Single unit small hydrodemolition pump set-up

Fig. 6: Hydrodemolition robot

Fig. 3: Hydrodemolition waste water must be collected, settled, filtered, and treated

- Requires more space for the hydrodemolition pump equipment (Fig. 5 and 6), water collection, and wastewater treatment;
- Debris clean-up is more difficult;
- Electrical or fire control systems are exposed to water and humidity; and
- Pneumatic hammer demolition will still be required in locations that hydrodemolition cannot reach or be performed due to logistics (occupied space/water sensitive areas), or to remove concrete shadows under the reinforcing bars.

In 2003, The Occupational Safety and Health Administration (OSHA) began working on amending the current standards for occupational exposure to respirable crystalline silica. These changes were approved on March 24, 2016. The amendment includes a new permissible exposure limit, calculated as an 8-hour time-weighted average, of 50 micrograms of respirable crystalline silica per cubic meter of air (50 $\mu g/m^3$). This change will also require additional provisions for employee protection that will help control exposure, such as respiratory protection, medical surveillance, hazard communication, and record keeping. Depending on how and when OSHA starts to enforce these new standards and how the legal system works through the process, hydrodemolition could soon become the preferred and least expensive method for concrete demolition.

For now, hydrodemolition is still typically a more expensive demolition method versus pneumatic hammer demolition for isolated concrete slab repairs. However, hydrodemolition may actually be a less expensive demolition method on garage projects that have:

- Large quantities of "wall-to-wall" partial depth slab removal;
- Deeper slab repairs with heavy concentration of reinforcing steel bars, such as mat slabs;
- Fast paced schedule requirements;
- Large work phase areas; and
- More allowable demolition time for using hydrodemolition versus pneumatic hammer demolition.

ISSUES TO CONSIDER BEFORE EMBARKING ON A HYDRODEMOLITION PROJECT

1. Experience Counts

a. Work with a hydrodemolition subcontractor that has extensive experience on your type of project. Check references from other contractors, owners, and engineers.

Fig. 7: Varying depth of concrete removal due to improper bar placement

b. Request resumes and references for the proposed team members for the project and confirm they have adequate experience on your type of project.

c. Request information related to the expected downtime of the hydrodemolition equipment planned for use and confirm that the hydrodemolition subcontractor has adequate in-house mechanics to maintain the equipment. Confirm that there is back up equipment to minimize downtime for repairs.

d. Confirm that the engineer on the project has experience with hydrodemolition projects.

2. Logistics

a. Confirm what the hydrodemolition subcontractor is expecting you to provide to them: fuel, water, distance to water source, water source and discharge line tie-ins, space limits for equipment, noise controls, phase size/work space, and protection.

b. Confirm with the owner who is allowed to stop the demolition work due to noise complaints and communicate this to the hydrodemolition subcontractor.

c. Obtain existing concrete compressive strength results from the engineer.

3. Depth of Cut

a. Agree on the expected "average" depth of cut for the repairs. This is typically clear in the engineers' specification, but sometimes the engineer will only state ¾ in (19 mm) clearance under the reinforcing steel.

b. Request a unit price for ½ or 1 in (13 or 25 mm) of additional depth of cut that may be necessary based on improper placement of the reinforcing steel (Fig. 7) or varying slab thickness. Take into account that if the cut is deeper, the amount of new concrete going back could be more than was included in your contract unit price, so you may want to clarify this in your bid to the engineer/owner.

c. Confirm the engineers' expectations on when full depth repair is required based on the depth of cut. On flat slabs, rule of thumb for most engineers is if 2/3 of the slab thickness is removed, then a full depth repair is required.

d. Understand that continued adjustment of the hydrodemolition robot will be required to maintain a consistent depth of cut. The mock-up is mainly for information purposes, as the existing concrete strength and matrix will most likely differ from location to location. Additional adjustments, such as nozzle angles, may be required to provide the required depth of cut.

4. Water Control and Treatment

a. Controlling the water to keep it within your work area and get it to the settlement area is crucial. This will require disconnection of existing deck drains on elevated slabs, plugging drains on the lowest level, installation of perimeter dams, and pumping of the water.

b. Confirm discharge, treatment, and testing requirements.

c. Obtain a price from the hydrodemolition subcontractor to perform the water control and treatment work.

d. Due to the environmental liabilities (state, local and federal) for this part of the work, be sure that you understand all of the aspects so that you can be sure that the hydrodemolition subcontractor is complying with all state, local, and federal requirements.

5. Clean-up and Removal of Debris

a. Removal of the water and slurry from the demolished surface is required as soon as possible. Do not allow the hydrodemolition slurry to dry on prepared surfaces. High pressure water jetting or sandblasting will most likely be required to remove the dried slurry.

b. The hydrodemolition debris is a sloppy, slurry mess. Use sloped areas of the garage slabs or ramps to store and let gravity help de-water the debris.

c. Mix the wetter hydrodemoliton debris with dryer debris to help reduce water. At times, you may want to add cement to help stiffen the debris.

6. Electrical and Fire Alarm Conduit in Slabs

a. Confirm if and what type of conduit is embedded in the concrete slabs. Sound metal conduit will not be damaged by hydrodemolition (Fig. 8); however, PVC/plastic conduit will be destroyed. Additionally, severely deteriorated metal conduit will allow water to be injected into the conduit.

Fig. 8: Sound metal conduit undamaged from hydrodemolition

b. Have an electrical/fire alarm subcontractor, preferably ones that are familiar with the building/garage, survey the system and make recommendations for installing temporary or permanent surface mounted feeds for critical items, such as elevators, exhaust fans, and emergency circuits.

c. Turn off electrical systems in the work areas to the greatest extent possible, prior to the start of demolition.

d. Do not perform hydrodemolition over locations where large electrical feeds or duct banks are located.

e. Monitor electrical rooms to confirm that water does not travel through conduits into electrical breaker boxes.

f. Determine who will install temporary lighting, and remove existing lights and other fixtures that could be damaged from demolition work. Temporary lighting is typically installed prior to the start of demolition, as wading through water and debris makes this task much more difficult after the start of demolition.

g. Bag, cover, protect, or remove fixtures that have to remain in place during the work, to minimize possible damage from water and debris.

7. Safety

a. Follow general local, state, and federal safety regulations.

b. Make sure all personnel have personal protection equipment (PPE). This should include parking management company personnel and others than may be in the garage during the use of demolition equipment.

c. Install full height wood partitions at perimeter of the work areas, at least on the level being demolished and the level below.

d. Place proper signage at the perimeter of work areas to notify people of dangerous work conditions and loud noise.

e. Block off doorways and elevators within the work areas or provide protected access ways (sub phases) if continued access is required.

f. Provide debris netting around hydrodemolition robot work area if other work is being performed within a work area.

g. Protect high pressure water lines that may traverse from the work area through public areas.

8. Repair Quantities

a. For localized slab repairs, the hydrodemolition method will typically result in more full depth repairs than pneumatic hammer demolition. This is good and bad: good because the lower strength/deteriorated concrete is removed, and bad because it will result in an increased project cost.

b. An engineer with experience in hydrodemolition will typically increase the partial depth and full depth slab repair quantities for hydrodemolition versus pneumatic hammer demolition, on the same project.

LIMITATIONS

Hydrodemolition is not typically cost-effective or appropriate for full depth, complete (wall to wall) concrete slab demolition. Other demolition methods, such as pneumatic crushing (munching) or hoe ram demolition, can be cost-effective and are typically less noisy than full depth hydrodemolition.

Additionally, the use of hydrodemolition is typically not appropriate for:

- Slabs above occupied spaces;
- Slabs above areas with finishes that cannot be protected and are susceptible to water damage;
- Slabs above locations that house electrical or mechanical equipment that cannot be effectively protected from water;
- Areas that cannot be effectively supported/shored during demolition; and
- Post tensioned slabs. It is difficult to work around the post tension tendons and anchorages, the tendon sheathing is damaged, and the high pressure water is typically injected into the strands.

CONCLUSION

Hydrodemolition is a highly effective method for the removal of deteriorated and sound concrete as part of a concrete restoration project. Hydrodemolition may become the preferred concrete demolition method at some point in the near future depending on how OSHA enforces the respirable crystalline silica exposure limits and protection requirements. Understanding the complexities of the hydrodemolition process and teaming with a qualified hydrodemolition subcontractor will help you meet the goal of having a successful and profitable project.

REFERENCES

1. OSHA Fact Sheet, "OSHA's Crystalline Silica Rule: Construction", Occupational Safety and Health Administration – U.S. Department of Labor, March 2016, 2 pp.

Scott B. Harrison, P.E. *is a Senior Associate with Construction Insight Inc. in Alexandria, Virginia. He graduated as a civil/structural engineer from Virginia Tech and has over 30 years of experience in the evaluation and restoration of existing structures, with an emphasis in concrete restoration. He has been involved with over 100 hydrodemolition projects, either as an engineer or contractor, performing his first project in 1988. He is an active member of ICRI and currently serves as a member of the Board of Directors, chairs the Publications Committee, and is a member of the Education and Guide Specifications Committees. Scott has published several articles for the Concrete Repair Bulletin and other trade magazines, and has provided presentations at several ICRI and ASCE local and national seminars. He is a licensed professional engineer in Virginia, Maryland, District of Columbia, and Delaware.*