# Hydrodemolition:
## A Preservation Strategy for Concrete Bridges in the United States

**by Edward Liberati, Hydro-Technologies Inc. and Patrick Martens, consultant**

Hydrodemolition uses a controlled, high-pressure water jet to safely and selectively remove portions of reinforced concrete from a bridge while leaving the reinforcing steel and surrounding concrete intact. It was developed in Europe in the 1970s as an alternative to jackhammers and has become an acceptable method of removing concrete throughout the world.

In the United States, hydrodemolition is predominantly used to remove concrete from bridge decks in preparation for a new concrete overlay. It can also be used to remove concrete from bridge abutments, piers, walls, and rails and to do full-depth deck removals.

Other uses of hydrodemolition to remove concrete from reinforced concrete structures include tunnels, factories, piers, dams, defense facilities, and even amusement park rides. Logistics, costs, and feasibility are important considerations for the use of hydrodemolition on these special projects.

Department of transportation specifications—such as those in Pennsylvania, Indiana, Kentucky, Ohio, Arkansas, and many more—are valuable resources when considering the use of hydrodemolition.

Hydrodemolition robot working on a bridge deck. All Photos: Edward Liberati.

### Equipment and Process Overview

Equipment consists of a hydrodemolition robot, a pump unit, and cleanup equipment. The robot is computerized, self-propelled, and remote-controlled and has many safety features. To meet various project needs, there are hydrodemolition robots designed to cut horizontally, vertically, and overhead.

The hydrodemolition process begins when potable water is delivered from a hydrant or a tanker to the pump unit, where it is pressurized and the flow rate can be controlled. The high-pressure water is then delivered through hoses to the hydrodemolition robot, where it exits a secured nozzle and impacts the concrete surface. The computerized robot controls the movements of the water jet so the stream exposure time on the concrete surface is consistent over the removal area. A steel shell and skirting around the robot’s cutting head that houses the water jet allows this operation to be performed safely.

While hydrodemolition work is underway, cleanup of all rubble created from the operation is required. Cleanup of the concrete debris and excess runoff water is performed with water pumps and vacuum-collection equipment. The vacuum-collection equipment can quickly cleanup all water and wet debris remaining on the deck.

As a final method of deck preparation before the placement of the overlay, the contractor performs a final high-pressure water blast and soaks the deck surface with water until it is at a point at which it will not dry out. Once the deck surface is saturated, the contractor covers it with plastic. This covering locks in the moisture, eliminates the need for bonding grouts, and prevents deck contamination from construction equipment.

### Fast-Track Hydrodemolition

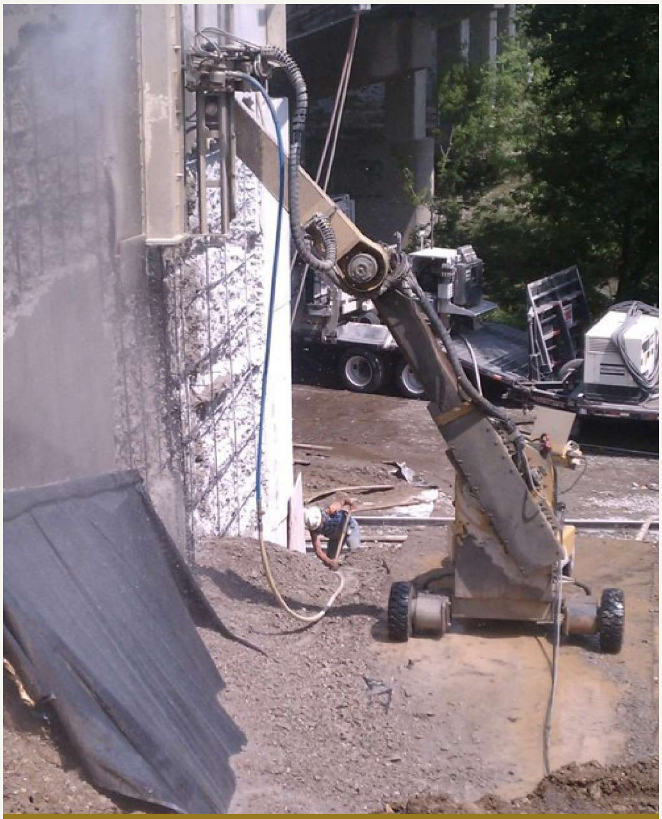
Fast-track hydrodemolition (FTH) is a technique used to prepare a bridge deck for a new latex-modified concrete

Full-depth deck concrete removal. Note the very clean condition of the reinforcement.

Vertical hydrodemolition of a bridge hammer-head pier.

overlay. It is the most commonly used hydrodemolition method in the United States. The FTH approach expedites the work, minimizes lane closure times, and provides a good surface for a high-quality concrete deck overlay that lasts for many years.

This process has numerous advantages for deck rehabilitation and restoration. Upon proper calibration of the robot, the FTH process takes advantage of a concept referred to as *selective removal;* the water jet traverses the deck surface selectively removing only weakened deck concrete in a single pass. The computer-calibrated equipment removes not only large and obvious areas of delamination but also areas with microfractures that are less evident. These microfractures could be the result of corrosion, past jackhammer work, or milling. It is imperative to ensure that no microcracks remain because they could later create a potential for delamination in the underlying deck.



Vertical hydrodemolition of a turnback bridge abutment.

The FTH process also etches the sound concrete that is left in place to provide a roughened and bondable surface for the new latex-modified concrete overlay. The weaker cement matrix and fine aggregates are washed away during the hydrodemolition process, exposing the angular faces of the coarse aggregate that provide mechanical interlock for the overlay. That bond is enhanced by the increased surface area available from the coarse aggregate and the general roughness from the process. With only a sound, roughened concrete deck surface remaining after the FTH process, a monolithic application of the new latex-modified concrete provides a dense structural repair that acts integrally with the remaining deck concrete.

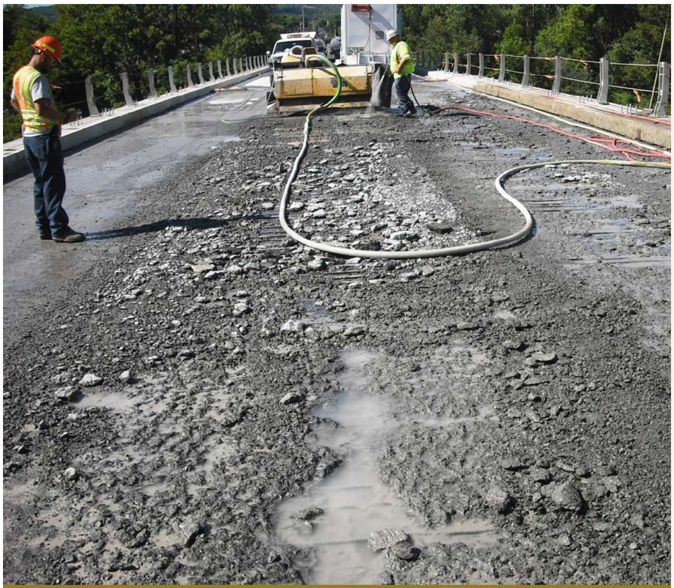
## Hydrodemolition Advantages

When compared with jackhammering, hydrodemolition has many advantages. Hydrodemolition does not damage the existing reinforcing steel; in fact, it cleans the steel and removes chloride-ion concentrations. It also will not cause vibrations to the existing bridge deck steel or promote debonding of the otherwise firmly embedded portion of the bars.

With conventional concrete removal techniques using jackhammers, clearance around reinforcing steel must be provided for bonding of the new concrete. In contrast, the use of hydrodemolition, when combined with latex-modified concrete, may allow owners to waive the rebar clearance requirements in their specification, as long as the remaining concrete is found to be sound and no debonding of reinforcing steel with the existing interface is present. Thus, the use of FTH greatly reduces the required amount of concrete material removed from a bridge deck when compared to jackhammering.

## Conclusion

In the United States, the use of hydrodemolition to



Hydrodemolition equipment performing fast-track hydrodemolition on a bridge deck.

Fast-track hydrodemolition surface showing selective removal of deteriorated concrete areas. The process provides a clean, etched, and bondable surface ready for an overlay.

selectively remove deteriorated concrete from bridge decks has become a popular technique to minimize the concrete removal required and more quickly address bridge deck needs. The success of the system has been validated through the thousands of installations across the United States. When combined with latex-modified concrete, the FTH surface preparation has the potential to deliver upward of 30 years of added service life to the bridge deck. Transportation agencies are finding that FTH is an efficient way to rehabilitate and preserve bridge decks quickly and cost effectively, while minimizing traffic disruptions.

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*Edward Liberati is the chief engineer with Hydro-Technologies in Jeffersonville, Ind. Patrick Martens is an independent consultant with Bridge Preservation and Inspection Services in Jefferson City, Mo.*