

# Working Beneath the Surface:

**Milwaukee Utilizes Evasive  
Repair Techniques for Vital Sewers**



Along the surface, everyday life continues as usual; residents commute to work, businesses open up shop and pedestrians traverse the sidewalks. But underneath the streets, it's not business as usual.

In Wisconsin, the Milwaukee Metropolitan Sewerage District (MMSD) is in the midst of a large-scale rebuilding program — the Central Metropolitan Interceptor Sewer Improvement Project. Involving more than 50 miles of sewer to repair or replace, the project is one of the largest the district has undertaken.

But while the work is large scale, the district is employing methods that have the least amount of impact on residents. One of the methods, shotcreting, involves using sprayed concrete to reline failing sewer pipes below the streets without digging up the old pipe.

Minimally intrusive techniques are vital for MMSD officials. "Working with businesses, municipalities and state agencies, we've carefully scheduled work to minimize disruption," said Kevin Shafer, executive director of the MMSD. "In addition, new technologies have allowed us to rehabilitate sewers without having to close streets, bring in excavators and dig trenches to replace the pipe."

In one section of town, MMSD turned to a new shotcrete technology as part of its sewer rehabilitation program.

## Shotlining

Shotcrete Technologies Inc. of Idaho Springs, Colo., has been in business for over 25 years developing new shotcrete applications. The company has developed a system for lining/repairing all types of culverts, pipes, shafts and tunnels from 18 in. ID to 144 in. (12 ft) ID. This new process is quick, non-disruptive (i.e. no excavation, traffic stoppage) and less expensive than conventional techniques.

The company's system, dubbed "Shotlining" is a one-step operation that constructs a new, permanent "in-situ" lining using a fiber-reinforced cementitious mix that will develop a compressive strength of 6,000 psi or greater in seven days. The resulting lining is more acid and abrasion resistant and more impermeable than ordinary concrete. The pipe/culvert is ready for use within hours of application.

The custom designed "Shotliner" spinning robot is operated via remote control with cameras and can travel several hundred feet at a time — around corners, down inclines and up declines. The spinner unit, as well as all of the other equipment, fits through a 3-ft manhole, so no excavation is needed.

## Putting the System to the Test

Shotcrete Technologies, subcontracting for Affholder Inc., performed the rehabilitation of a 9,000 lf of 60-in. ID sewer line for MMSD. Employing the Shotlining system, a ½-in. thick monolithic structural cementitious lining was applied with a 5,000- to 7,000-rpm spinner head. The material is a high-strength, non-shrink mortar lining with high water impermeability and a bacterial inhibitor.

The project took place from November of 2005 through January 2006 with many sub-zero days. An average of 300 lf per day was completed — with a record day of 500 lf. Twelve manholes from 30 to 80 ft in depth were also rehabilitated.

"We started out on-site testing in Milwaukee using a calcium-aluminate cement mix. We were not successful using this material for wet shotcrete. In spite of using various retarders, we were never able to control the consistency of the mix, i.e. the set time," said Kristian Loevlie of Shotcrete Technologies.



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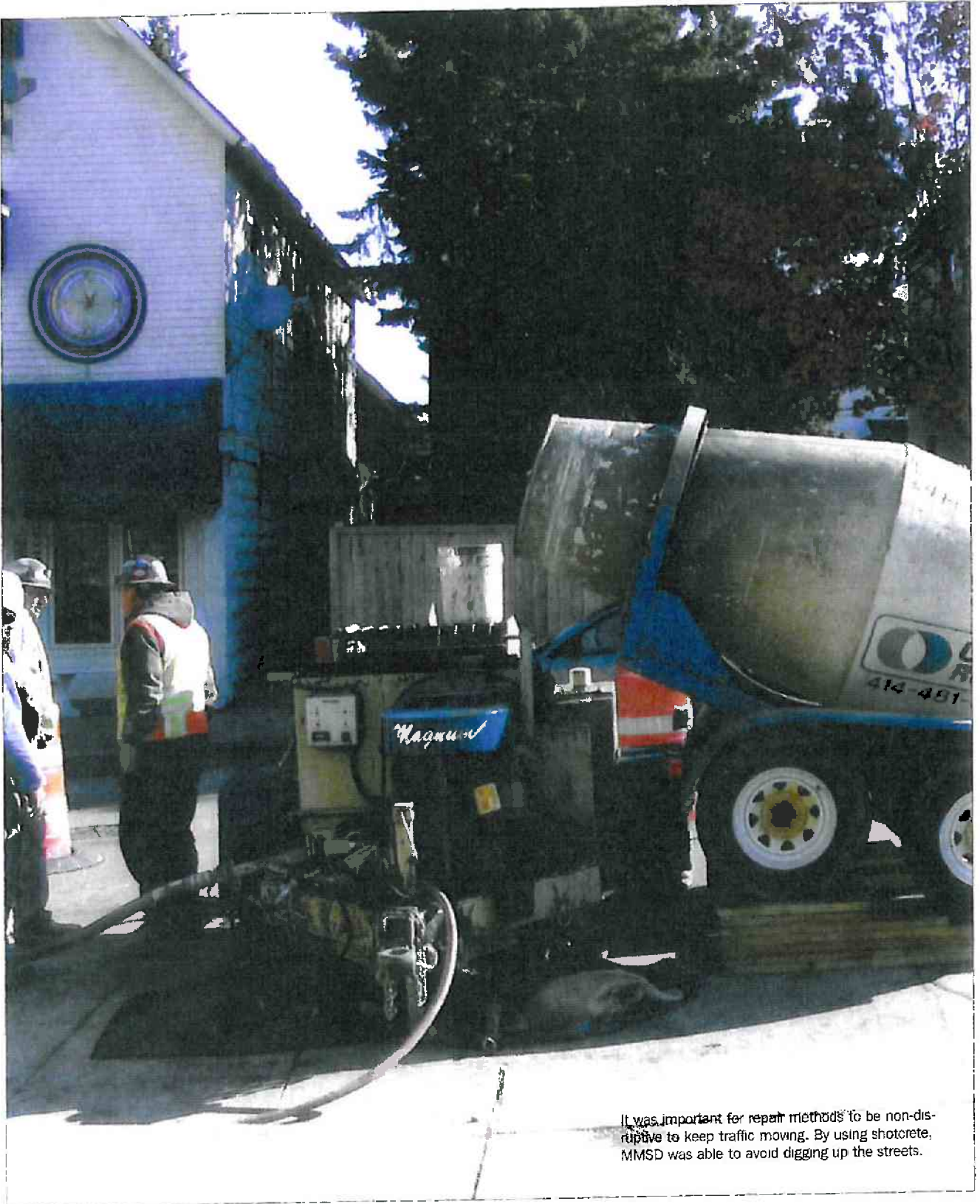
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"Eventually we settled on our proprietary mix, which is a non-shrink, waterproof mix of sand, cement, Pozzolon and KFA. With this mix we were able to continuously apply a minimum ½-in. thickness at a speed of 6,000 rpm, and do up to 500 lf per day."

Before the Shotlining could commence every morning, the Affholder crew pressure-washed, plugged inlets and prepared footage that was to be lined with the repair material that day. Shotlining normally commenced by 10 a.m.

## Delivery System

A continuous supply of material was key to the success of the operation. The proprietary mix was bagged and delivered to the site by Quickcrete in Milwaukee. On the surface, we mobilized two 1-cu yd remixers that delivered the material to an Allentown Magnum piston pump with a 1 ½-in. hose to provide the necessary steady stream of mortar. A 250-cfm compressor was the only air requirement.



It was important for repair methods to be non-disruptive to keep traffic moving. By using shotcrete, MMSD was able to avoid digging up the streets.





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The underground gear that all fit through the 3-ft ID manhole openings included the Shotline spraying setup, nozzle, sled, winch and unique spinning head mounted on the sled. A five-man crew handled the process from mixing to final application. The winch speed was set based on the ID of the pipe, the overall desired thickness and the material volume pumped per minute.

The cohesiveness of the mix, and the high velocity of the application resulted in almost no rebound. In the case of some water in the invert, often a ½ in. or more, crews included cellulose in the mix so the in-place mix would not be affected or washed out by water.

Lateral pipes/inlets were of no concern because during spraying, shotcrete builds up around the opening and does not bond unless the material is sprayed perpendicular to the surface. If not sprayed with the proper angle, the mix will end up as gravel to be washed away. This repair method eliminates the need for re-opening laterals and the risk of leaks between the main and laterals.


Major challenges included freezing weather, black water days and the learning curve on a new technical application for the owner, engineers and general contractor.

On the last day of rehabilitation, crews handshot a chamber at 6th Street and shot-lined nine manholes. An MMSD inspector was on site every day and Rust/Harza engineering oversaw and inspected the unique project. The videotaped results were approved and accepted.




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