PROJECT PROFILE

Mn/DOT District 6 Tests Centrifugally Cast Concrete Pipe in Problem Area

"Our district is faced with thousands of deteriorated centerline roadway pipes," says Ruth Betcher, P.E., hydraulics engineer for the Minnesota Department of Transportation's (Mn/DOT) District 6, "and replacing all that pipe is cost prohibitive—and also, citizens don't welcome detours!" And by deteriorated, Betcher means *extremely* deteriorated. "We see a lot of large-scale rust, holes in the entire perimeter, and pipe separation in long sections of metal pipe," she explains. "We also see pipe separation between sections of reinforced concrete pipe. We have to correct these—otherwise, the risk of roadway or culvert failure is too high."

Currently, Mn/DOT uses cured-in-place pipe (CIPP) and HDPE pipe relining extensively because they are trenchless methods that don't disrupt traffic. But both methods have disadvantages that keep Betcher on the lookout for other solutions.

CIPP, for example, can be expensive, especially for larger-diameter pipe. "In our experience," explains Betcher, "the cost of CIPP liners increases exponentially as the size of pipe increases, due to the weight of the liners and the need for expensive subcontracted machinery." On the plus side, CIPP doesn't substantially reduce the inner diameter of pipe and doesn't require a large staging area.

HDPE *does* somewhat reduce hydraulic capacity, because the inserted HDPE pipes are 4 to 8 inches smaller in diameter than existing pipe. "Our design calculations indicate that actual capacity isn't significantly reduced," says Betcher. "The bigger problem is public per-

ception." That's because many Mn/DOT culverts are intentionally designed to hold back some water during peak events; when landowners see the resulting ponding, together with a visibly smaller pipe, they tend to be concerned. Decreased diameter also increases outlet velocity, which can damage downstream landscapes. More significantly, HDPE requires at least 25 feet of clear area for staging, which can stop traffic or damage property. On the plus side, HDPE relining is relatively inexpensive, and costs stay proportional as pipe diameter increases.

So, are there any pipe relining methods that are cost-effective, don't reduce pipe diameter, and don't require trenching or large staging areas?

Testing a New Solution

Betcher recently conducted tests of a new pipe rehabilitation solution called centrifugally cast concrete pipe, also known as CCCP or CentriPipe. Using equipment and engineered mortar provided by AP/M Permaform, District 6 relined 80 feet of badly deteriorated 36-inch corrugated metal pipe (CMP). The pipe was severely rusted, with holes in the floor and an interior section of 33-inch pipe that had separated.

CCCP uses a spinning nozzle, inserted into pipe and retracted by a winch, to spray mortar onto pipe interiors. By varying the retraction speed and spin rate, very precise thicknesses can be applied. If fiber-reinforced engineered mortar is used, the result is a smooth, structurally sound inner pipe. Because the new pipe is bonded to the original steel or concrete pipe and needs to be only a few inches thick, pipe diameter isn't significantly reduced.

CCCP isn't exactly new; it's been used in manhole restoration since the mid-1990s and is now widely accepted for that purpose. Chicago, for example, is using CCCP and engineered mortar to systematically rehabilitate all of the city's deteriorating brick manholes. But using CCCP in *horizontal* pipe is new; initial testing and results are promising and should result in greatly expanded use of CCCP.

When used in horizontal pipe, the spin caster is pulled through the pipe on a skid. In the Mn/DOT test pipe, after cleaning, the CMP floor was so uneven that some mortar had to be laid to provide a smooth skidding surface. The mortar used is mixed on site and includes high-density polypropylene reinforcing fibers and other additives. It can be sprayed, cast, or gravity-flowed, and progresses to final set in as little as four hours.

For this test, two passes were made on successive days, laying down a 3/4-inch layer of mortar each time, plus a final pass with a curing compound. Each pass took less than two hours, and after the first pass some spot repairs were made to fill voids caused by deteriorated pipe invert. The final result was, essentially, a new, smooth, structurally sound, 1 1/2-inch thick concrete pipe, bonded with the original CMP.

Costing information currently relies on estimates, because CCCP has not yet seen large-scale use on horizontal pipe. But preliminary estimates suggest that costs per foot will be somewhere between that of HDPE and CIPP, at least in smaller-diameter pipe. For larger-diameter pipe, cost per foot is likely to be significantly less than CIPP.

Staging area requirements are less than HDPE, and comparable to CIPP.

"This was a challenging test project," says Betcher, due to badly deteriorated pipe, shallow depth that exposes the pipe to freeze/thaw cycles, and heavy loading from farm equipment. Initial results are good, and Betcher says that CentriPipe's combination of cost effectiveness, reasonable staging area requirements, and minimal pipe diameter reduction is very promising. This is one new idea that may well find a place in Mn/DOT's suite of pipe rehabilitation solutions.