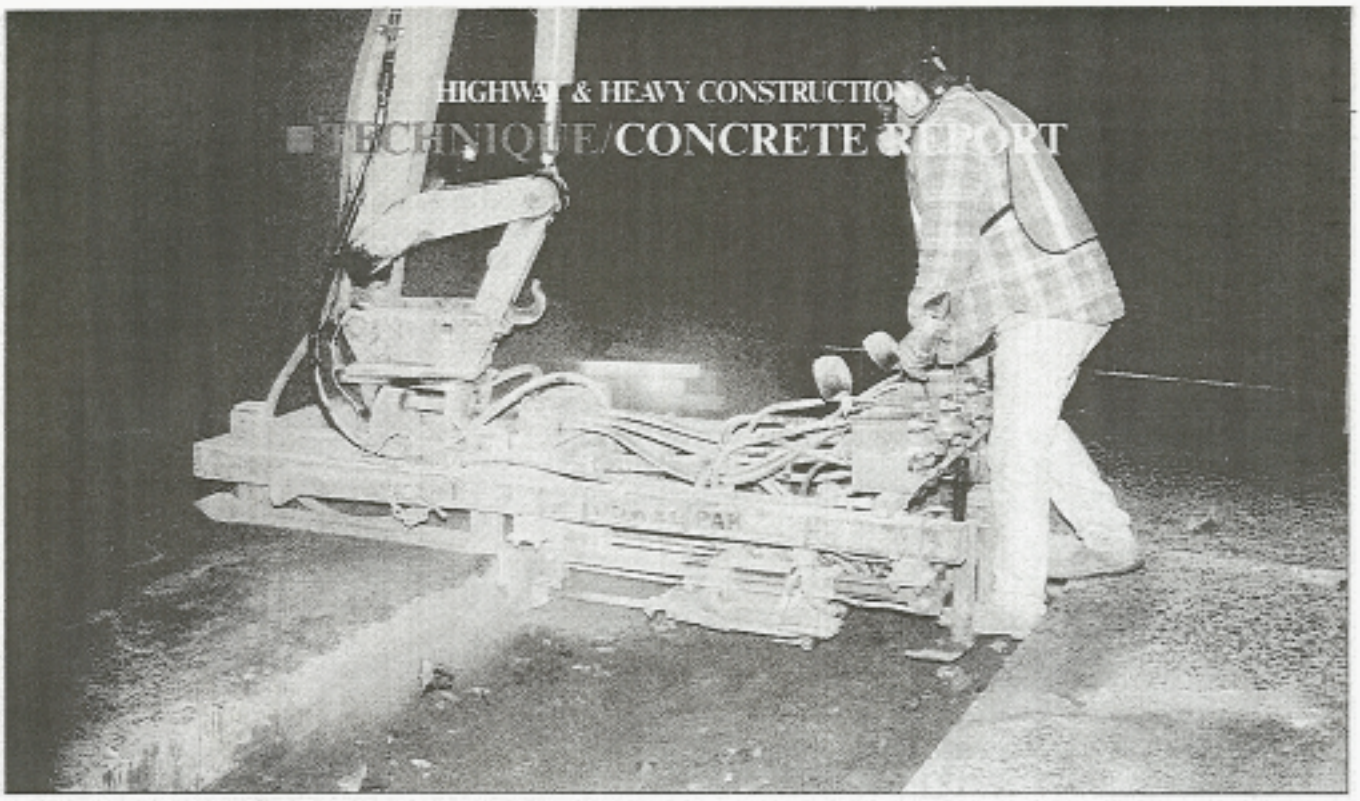


Three-gang hydraulic drill is mounted on backhoe boom. The rig is easily positioned to drill 24 holes 9 in. deep in about 10 min.

When Slab Replacement Resembles A Production Line

Overnight closures, high-speed gang drills and HES concrete enable extensive repairs in one season instead of two

By Thomas L. Klemens, P.E.

Faster concrete pavement repairs, done correctly, are what heavy construction teams look for to succeed in the highway maintenance market. Two articles on concrete repairs follow; the third story details how a 38-ft.-wide concrete slab was paved in one pass over an asphalt base.

Concrete slabs are replaced overnight on the Long Island Expressway in an assembly line process using high-speed gang drills, tightly-fitted dowels and fast-setting concrete. Repairs are expedited by closing 5½ miles of the expressway in one direction and diverting traffic onto access roads from 10 p.m. until 6 a.m.

"Traffic volumes being a major, major problem, we have to do it right the first time," says NYSDOT civil engineer John W. Bugler. "We just can't get back out there and close the road down again.

"We've adopted a method developed by Jen Simonsen (of the Michigan DOT) and made some significant improvements," said Bugler.

Triple the concrete placed

Productivity has gone from placing 20 cu. yd. of concrete in seven patches a night, when the process was begun 10 years ago, to placing 60 cu. yd. on an average shift this year. The increase in productivity is so dramatic, it has cut the present rehabilitation project from two construction seasons to one.

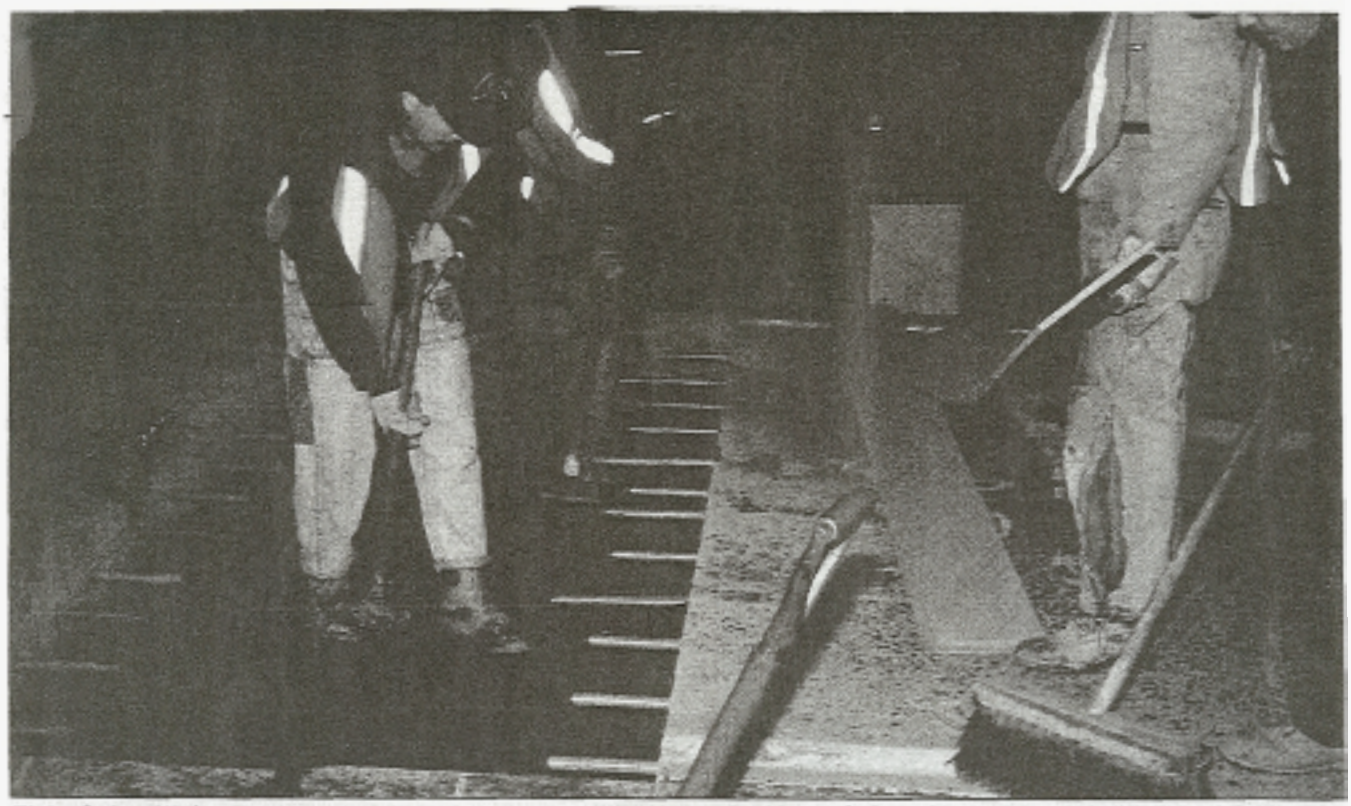
The NYSDOT/Long Island method now takes advantage of six special items combined in an effective process for rapidly replacing fractured, buckled or otherwise unsuitable concrete slabs. They include:

- New York dry bar method, using tight-fitting epoxy-coated dowels placed without the need for epoxy mortar
- Rapid slab removal which also leaves the base virtually undisturbed by first sawing and then using thumb-bucket-equipped backhoes
- High-speed hydraulic gang drills for accuracy and productivity
- Accelerated set concrete, allowing full traffic after overnight repairs
- Meter-equipped ready-mix trucks with dry ingredients from a batch plant and water added at the site
- Temporary timber raft platforms, enabling the contractor to use the first two and last four hours of the shift more productively

The patching and repair problem surfaced in 1979 when Bugler began looking into joint re-sealing on the Long Island Expressway and other rigid pavements. At that time, asphalt was used as a patching material to repair blow-up explosions along the expressway. Due to seasonal changes of heating and cooling, the slab system expanded into the asphalt patch areas but did not pull back again, leaving larger and larger open joints along the roadway. That led to further differential movement between the lanes and other problems.

Putting it into action

This year, J.D. Posillico, Farmingdale, N.Y., installed as many as 350 full-depth repairs on the Long Island Expressway using the NYSDOT/Long Island method. That method currently limits full depth slab replacement to



Tight-fitting 1⅛-in. diameter expoxy-coated dowels are tapped into the 30-mm holes. The exposed ends are lightly greased, and hemasote joint fillers are provided at each joint.

sections a maximum of 12 ft. long.

The 9-in. slab is first sawcut full depth, parallel to and at least 1 ft. from the transverse joint. A Vermeer CC-135 then cuts the slab into 2- to 3-ft. pieces. Those are removed by a Dynahoe 490 tractor-loader-backhoe equipped with a thumb bucket. That is much faster than using hand tools such as air hammers for removal, and leaves the base relatively undisturbed. A K91T tamper from MBW is used to recompact the base as needed.

Holes for dowels are then drilled using a hydraulic three-gang drill. Made by Tamrock, the Dowel **Pak** DP3 is mounted on the backhoe boom and powered by the Dynahoe's hydraulic system. It is easily moved from one patch to the next and can rotate 360 degrees, facilitating easy alignment. **Ganging** the drills enables the operator to drill three holes on 1-ft. centers with one setup. The 24 holes for the slab patch are drilled in about 10 minutes.

"Bugler was instrumental in identifying key aspects of the patching process that were relevant to the design of the drilling machine," said Jeff Schmaling, manager of Tamrock's tools department. The main concerns were: size of the holes, accuracy of alignment, and speed.

The hydraulic drills operate at about 4000 blows per minute and provide an impact of about 30 ft. lb./blow, compared to approximately 145 ft. lb./blow for the pneumatic drills. That eliminated much of the spalling around the holes and reduced the likelihood of internal micro-cracking. Tamrock's drills also have an independent rotation mechanism, Schmaling said, which results in very round holes of uniform size.

Switching to hydraulic drills also enabled the use of metric-size bits. The use of 30-millimeter drill steel ensures a snug fit, leaving only about 1/50 inch of looseness — virtually no looseness at all — around the epoxy-coated 1⅛-in. diameter dowels. The 18-in. dowels are inserted 9 in. into the existing slab, and are tapped into place.

A compressor mounted in place of the bucket supplies air to keep the holes clean, and provides extra weight to counterbalance the gang drill.

The hydraulic high-speed drills with easy alignment capabilities were first used in 1985, and were subsequently specified by NYSDOT Region 10 beginning in 1986. Bugler reports that the concrete bid item price dropped from almost $900/cu. yd. in 1985 to $529/cu. yd. in 1988 (1988 adjusted prices). He attributes much of that drop to increased productivity brought about by use of high-speed hydraulic drills.

Two-stage concrete mixing

The concrete itself posed another productivity challenge. In order to get the high early strength required for overnight repairs, a mix was designed to use calcium chloride to accelerate hydration of the cement. After the initial set — about 30 min. — strength gain begins almost immediately.

Each cubic yard of concrete consists of 1449 lb. of 1-in. stone, 1320 lb. of fine aggregate, 38.6 gal. of water, 826

PROJECT PROFILE

Project: Concrete Repair & Asphalt Concrete Resurfacing on Route I-495
Location: Islandia, Long Island, N.Y.
Contractor: J.D. Posillico, Inc.
Designer: N.Y. State Department of Transportation
Consulting Engineer: Greenman-Pedersen, Inc.
Contract Cost: $8.3 million

"We have one of the best contractors on Long Island on this job. They will always try to do things right the first time."
—L. Burke.

Members of the construction team, from left to right:
Peter Scalamandre—Vice Pres., Seville Central Mix
Bob Fleischmann—State Rep., NYSDOT, Region 10
Mike Alessi—Night Superintendent, J.D. Posillico
John Bugler—NYSDOT, Region 10
Larry Burke—Resident Engineer, Greenman-Pedersen, Inc.

Concrete is placed at 95 to 100 degrees F. *The calcium chloride additive combined with heated mix water results in about a 30-minute setting time.*

The water/cement ratio is controlled using water meters on the trucks

Water meters *are mounted on the ready-mix trucks, allowing the heated water to be added to the mix at the site. The concrete must be placed within 30 minutes of mixing. At 50 gpm, the meters are accurate to 1/100 gal.*

lb. of Type III cement and 20.65 oz. of W.R. Grace's Daravair air entrainment. The calcium chloride is provided as a standard solution containing 29 percent anhydrous calcium chloride. It contains 2 percent pure anhydrous calcium chloride by weight, which is about 5.33 gal./cu. yd. of concrete.

Originally, mobile mixer trucks were used for blending and placing the concrete at the site, but those were slow. The Long Island concrete suppliers wanted to supply concrete in transit-mix trucks, but the fast-setting concrete made that impossible. So Bugler, working with the DOT's Albany Materials Bureau and Lenny Cowan and Mike Wagner of the Region 10 materials unit, developed a way to use drum mix trucks to supply the material.

Sand and stone are loaded first into truck mixers at the batch plant. Then the truck is backed up a 15 percent incline under a separate hopper holding the Type III cement, enabling the cement to slide in over the aggregates. Layering materials keeps most cement out of contact with the moisture in the aggregates during transit.

The mix water is added at the jobsite. The amount needed is determined by subtracting the moisture in the aggregates and water in the calcium chloride solution. The water/cement ratio is controlled using water meters on the trucks.

Concrete supplier Peter Scalamandre of Seville Central Mix, Bethpage, N.Y., installed water meters on his trucks at Buglers suggestion. The trucks have 1- or 2-in. piping and Badger meters, which deliver up to 50 gpm at an accuracy of 1/100 gal.

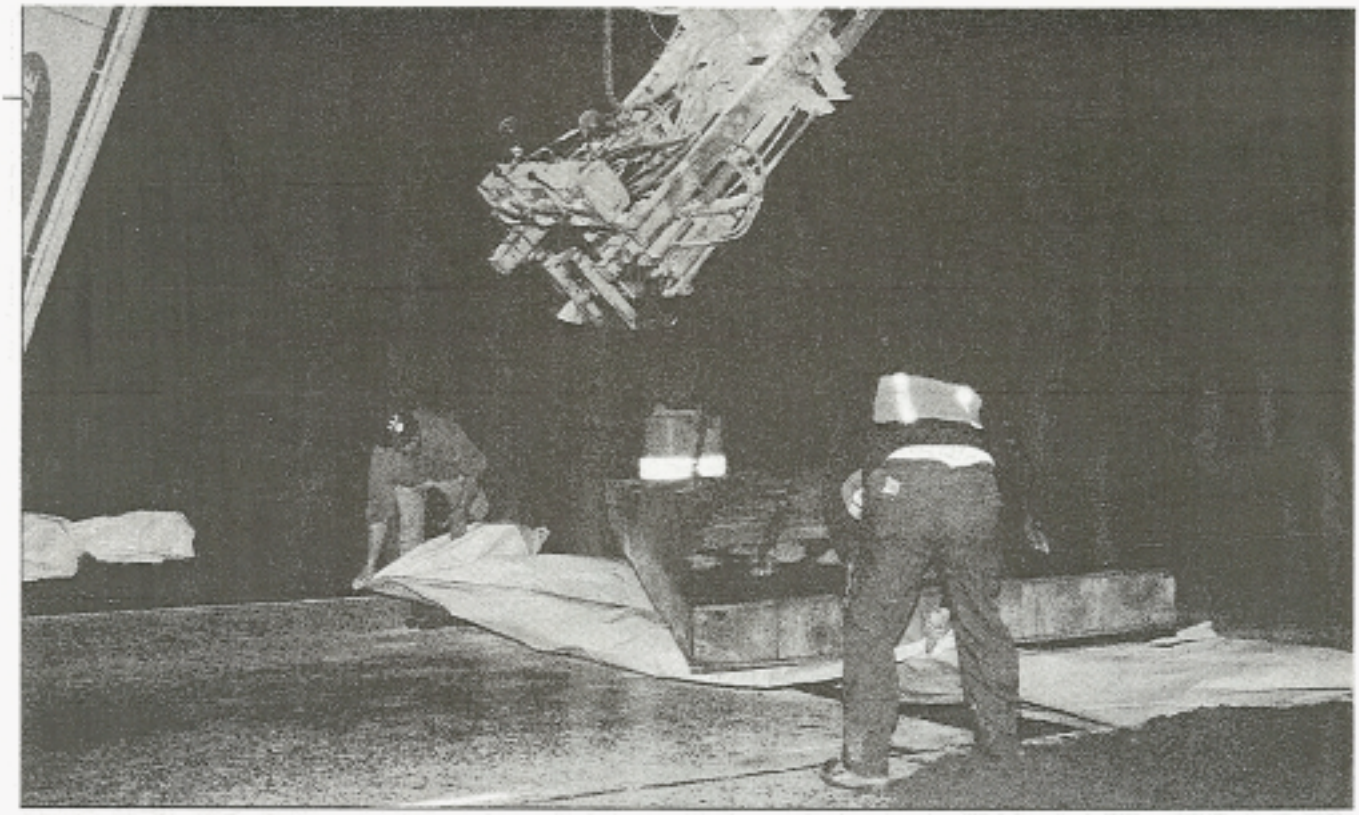
Bugler realized that the concrete temperature was also critical and decided to try raising the water temperature. That resulted in a higher temperature of concrete which further sped the set. Concrete is now placed at 95 to 100 degrees F. A chart indicates the required water temperature based on the temperature of the aggregate and cement, and Scalamandre has installed a large tank at the plant to heat the water.

Mix and place quickly

At the site, the mixer turns 20 revolutions to blend the dry ingredients. As the drum continues to rotate, 50 gal. of water is added. The calcium chloride, which is pre-measured and carried in a 42-gal. pressure tank on the truck, is added as water and rotation continue. The average total water per load is nearly 200 gal. Mixing is complete after 130 revolutions, and the concrete must be placed within 30 minutes.

Hemasote ½ in. thick is placed at each joint. The concrete is placed with standard mesh at mid-slab depth. Derez Contracting, Syosset, N.Y., pours and finishes an average slab patch in five to 10 minutes.

After the surface is finished and cur-



Temporary pavement platforms enable the contractor to remove concrete and drill holes as the shift finishes. The temporary platforms do not impede high-speed traffic. They are quickly removed at the beginning of the next shift, and concrete can be placed before new excavations are ready.

ing compound applied, a sheet of plastic is placed on top and covered with 2-in. Dow Styrofoam insulation panels. That keeps heat, which can reach 180 degrees, and moisture in the slab.

Concrete compressive strength had to be 2000 psi and rising before the patch could be opened to traffic. Initially, the DOT's Tom O'Connor broke test cylinders in a nearby lab to determine concrete strength. A correlation was developed between the test breaks and the slab's temperature rise, which was monitored. When the patches reached the predetermined temperature, about 150 deg., Posillico's crews removed the covering and traffic was permitted.

Making time count

Shortly after 2 a.m., the final concrete for the night has been poured. But the contractor is able to continue working thanks to another Bugler innovation, temporary pavement platforms.

He designed lift-out timber raft platforms with recessed lift rings. The platforms are solid to ensure subbase stability and safety to the high-speed traffic passing over them. They are also tight fitting which keeps most rainwater out. The platforms enable the contractor to remove additional slabs and drill dowel holes while the patches cure and before the roadway opens at 6 a.m.

"Now it's a very short time between closing the road and when the contractor can pour his first patch," said Bugler. The crew no longer has to wait 30 minutes or more for the initial excavations. That innovation alone has reportedly increased the contractor's daily productivity by *20* percent.

Posillico made seven timber platforms for this job. All are 11 ft. 9 in. wide, the same as the full slab. The lengths are standard, with three at 6 ft., two at 4% ft. and two at 9 ft.

Mike Alessi, night superintendent, directed Posillico's patching crew of 30 working five to six 8-hr. nights a week on this job.

The basic system has been evolving on Long Island for nearly 10 years. Bugler credits many people for the system's success—especially the DOT's Albany Materials Bureau, "whose support contributed significantly to our high degree of success." □

ACTION EXPRESS

Additional information is available by circling the appropriate Reader Service Numbers in this issue.

185 Concrete saw
186 Concrete additives
187 Hydraulic gang drill
188 Tractor-loader-backhoe
189 N.Y. dry bar method

Other States Point the Way

Bugler's improvements result from his study of repair methods used in other jurisdictions. An inverted "T" method, used in Virgina and tried in New York, was effective but very labor intensive. It called for the removal of a portion of the ruptured portion of the pavement slab and 6 in. of subbase, with additional removal of the subbase for 9 in. underneath the remaining slabs. The entire opening was then filled with concrete.

That was revised to include dowels for a load transfer mechanism instead of the inverted "T." The dowels were held in place by an epoxy mortar. Material requirements were reduced but it was still very labor-intensive.

Another method, from Michigan, used bars placed loosely in holes drilled by high-speed pneumatic drills, which had greatly improved productivity. But the load transfer method was not completely effective, and drilling lead to some facial fracturing and possible microfracturing within the concrete.