INSTALLATION OF PRECAST CONCRETE PAVEMENT PANELS ON TH 62

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State Project 2775-12
PROJECT PURPOSE

On Tuesday, June 21, 2005, a test project involving the installation of precast concrete pavement panels was conducted on a pavement rehabilitation project on TH 62 between I-35W and TH 55 in the southeast metro (SP 2775-12). The purpose of this test project was to evaluate the use of precast pavement panels to reduce construction time.

TEST LOCATION

The test segment included installation of 18 precast pavement panels on the outside lane of eastbound TH 62 near 40th Avenue. The repair segment included a continuous 218’ stretch of pavement 12’ wide.

PRECAST UNITS

The panels were fabricated at Wieser Concrete in Maiden Rock Wisconsin and stamped with Mn/DOT certification at the plant. These panels are part of the Super-Slab system developed by Fort Miller Company, Inc. of Schuylerville, New York.

Eighteen (18) precast pavement units were installed on this project. Each precast unit was 12’x12’ with a depth of 9-¼” in. The units include top and bottom reinforcement mats with #13 bars spaced at 6” O.C. transversely and 36” O.C. longitudinally. The units also included 1 ½” diameter dowel bars (18-inch epoxy) spaced at 12-inches in the wheel paths.

A typical panel consisted of a male end (with dowel bars extruding) and a female end (to accept the adjacent dowels bars).

The concrete mixtures for the panels conform to Mn/DOT 3W36 mix with a minimum compressive strength of 3900 psi and 28 days.

The panels were cast with lifting hooks installed as per the manufacturer recommendations.
CONSTRUCTION

The construction sequence for this operation generally consists of removing the old concrete pavement, fine grading the base, placement of the precast panels, grouting the panels, and sealing the joints.

On Monday, June 20th, the existing concrete pavement was removed using conventional methods. Since the precast panel depth was 9 ¼" in depth and the existing pavement was approximately 8", existing base had to be excavated to account for the difference. Following removal, a fine graded crushed limestone (stone dust) was installed as a level pad. Heavy rains on the afternoon of the 20\textsuperscript{th} prevented the contractor from finishing the fine grading.

On Tuesday, June 21\textsuperscript{st}, the fine grade crushed limestone (stone dust) was re-worked and compacted with a small vibratory roller. A leveling screed was mobilized by the manufacturer to meet the required tolerance of 1/10 inch difference between the base depth and precast unit depth. The screed traveled along rails on the adjacent pavement section to obtain a consistent depth. The elevations of the rails were set using a survey level.

Leveling the stone dust required several passes of the screed. This process appeared to be somewhat time consuming, beginning at 7:30 am and ending at around 12:30 pm. In speaking with Mn/DOT staff involved with this project, other more efficient pieces of equipment exist for this type of work. However, it was not cost effective for the manufacturer to mobilize the larger piece of equipment to this location due to the small repair quantity on this project.

Prior to placing the first precast panel, the stone dust was dampened with a fine spray of water to facilitate subsequent grouting of the slabs. Dowel bars were drilled and grouted into the adjacent concrete slab at the west termini.

The precast panels were not tied to the adjacent 12 foot lane. The adjacent concrete lane had joint spacing longer than the precast panel lengths of 12 feet. Instead, the two lanes with “float” next to each other, with a 1” maximum contraction joint sealed with an approved grout, backer-rod at a depth of 2”, and a highway joint sealer near the surface.
**Placement of the Panels**

The first 3 panels were delivered on a truck at approximately 12:45 pm and placement began at approximately 1:15 pm.

Installation generally consisted of picking the panels from the truck and sequentially placing them together progressing to the east. The female end of the panel was placed over the male end and moved into place carefully to limit cracking/spalling of the panel end.

The units were separated from each other by a bond breaker. A small piece of foam separated the units to prevent damage when sliding the panels together.

As panel placement continued, measurements were taken to identify the exact location to saw-cut the existing concrete pavement at the east termination point. It was important to properly measure the saw cut location in order to achieve a tight-fit when matching the existing concrete pavement section.

The termination point was saw-cut and dowel bars are drilled and grouted into the adjacent slab. The final slab had female connections at both ends, slipping over the dowels on the adjoining precast and existing concrete slabs. Placement of the precast slabs concluded at approximately 5:30 pm, with an average placement time of approximately 14 minutes per panel.
Grouting the Panels

Following placement of the final panel, the joints slots (dowel bar openings) were grouted with a fast setting grout. The grout had a set-time of approximately 10 minutes. Specification required that this grout obtain a compressive strength of 2,500 psi within 8 hours or prior to opening to traffic.

The grout was pumped into a dowel slot until it extruded from the second grout hole in the same slot. Dowel grouting occurred at a rate of approximately 2 panels/hour. However, as the contractor becomes more familiar with this procedure, it is expected that this production rate could significantly increase.

Following joint grouting, bedding grout was added through the injection ports located along the longitudinal edges of the slab. The grout was pumped under the slab until it extruded from the vent hole on the opposite side of the slab. During this process, the grout needed to be injected slowly to eliminate lifting of the slab. Bedding grouting occurred at a rate of approximately 4 panels/hour.

Additional construction activities performed the following day included sealing the joints and placing bituminous patch material in the shoulder adjacent to the precast slabs.

TIMELINE COMPARISON

The installation of the precast panels was not the controlling operation for this project. Since there was no incentive or sense of urgency for the contractor to finish this operation as quickly as possible, the total process for replacing these panels was approximately 4 days (Day 1 - Set Barrier, Day 2 - Removals and Stone Dust Placement, Day 3 - Place Panels and Grout, Day 4 - Seal Joints and Shoulder Repairs). Comparatively, a standard Type D-1 repair with high early strength concrete would be open to traffic in amount the same timeline, assuming a 3 day cure.

If replacing the panels was the controlling operation, it is anticipated that this timeline could be significantly reduced. It would be reasonable to assume that the contractor could set barrier and perform removals in one day, set and grout panels the next day, open to traffic, and seal the joints and repair the shoulders at night.

On a smaller repair type application, it is possible that the precast system could be open to open to traffic within one day. Smaller areas may not require installing precast barrier to protect the work zone. For example, a single panel could be removed and re-placed with a precast panel during the day, the lane could then be open to rush hour traffic, and the joints and shoulder could be sealed at night.
COST ANALYSIS

The cost of the precast panels was compared to a typical D-1 repair for which would have occurred under “normal” rehabilitation procedures at this location. The unit costs were derived from the low bid contractor. The cost analysis compares just the items related to pavement rehabilitation. Items such as traffic control (use of barrier and attenuator), diamond grinding, and striping were not included in this analysis. Listed below is a cost breakdown based on a length of 216 feet and a width of 12 feet. A more detailed breakdown can be seen in Appendix A.

<table>
<thead>
<tr>
<th>Repair Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precast Panels</td>
<td>$165,805</td>
</tr>
<tr>
<td>Type D-1 Repair</td>
<td>$21,656</td>
</tr>
</tbody>
</table>

This analysis assumes that the contractor includes the costs associated with having the manufacturer on-site during construction and at the pre-construction meeting (as required by special provision). The engineers estimate per panel was $5,760, the low bid was $9,040, and the second bidder bid $8,000 per panel.

As shown above, the cost of the precast panels is substantially more than a typical D-1 repair. With such a large discrepancy in costs, the use of precast panels should be weighed carefully versus the time and cost saving associated with user delay.

The above analysis does not consider a life-cycle cost analysis. It is recommended that the durability of these panels be evaluated versus the standard C and D repairs being performed concurrently along the corridor.

DAMAGED PANELS

Following placement of the panels, a couple of hairline cracks were identified in the 14th panel placed. The crack extended from a dowel slot to a pick-hole in the slab. The crack appeared near the crane legs. The contractor elected to use a 35 ton crane to place 8 tons panels. Although the contractor did provide pads for the crane legs, it is possible that the weight of the crane near the slab corner may have contributed to the crack.

According to the special provision, cracked panels were to be removed and replaced at no cost to the department. On a time-sensitive project, it may not be practical to remove a crack panel if a “spare” panel is not available.

It is anticipated that this crack will be held together fairly tightly due to the reinforcement mats in these slabs. In consultation with Mn/DOT’s Concrete Unit, the cracked slab was allowed to remain in-place as per Mn/DOT Specification 1503.

Guidance for repairing damaged/cracked panels may want to be included in future specifications.
CONSTRUCTION ZONE / SAFETY ANALYSIS

Construction Zone
The space requirements for construction vehicles of this project were similar to those of a conventional repair project. The wide outside shoulder allowed ample room for panel delivery trucks and the crane to operate safely away from traffic.

On projects with narrow shoulders, special consideration should be given to delivery of panels. Long stretches of repair may pose potential issues for unloading the slabs from the trucks.

Safety Analysis
At the precast panel installation area, temporary precast concrete barrier was installed to protect the workers from the adjacent traffic lanes. The other standard Mn/DOT repairs (e.g. Type C or Type D) on this project were constructed with only barrels separating traffic from the travel lanes.

When compared to a standard C or D repair, the precast panel repair required more time and manpower to prepare the base. Workers were required to set, level and survey the rails for the screed. Approximately 3 or more workers were required to fine-grade the base material with the equipment provided. Workers were consistently against the barrier when fine grading and setting rails.

On a smaller type repair (one to two panel replacement), the safety risks to workers for a precast panel system would probably be similar to those of a standard D repair. Both repairs would likely be performed with just barrels protecting the workers from traffic.

- With the precast operation, workers will be adjacent to traffic for longer periods of time during the stone dust grading process, but would likely be protected by the crane during the panel placement process. Workers are also exposed to traffic during the grouting procedures.

- On a D repair, workers would be more exposed to traffic during the concrete placement and finishing process compared to the placing precast panels.
CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Although the costs of pre-fabricated concrete pavement panels are substantially higher than standard DOT repairs, the elimination of cure time can significantly reduce lane closure time and reduce traffic impacts. User-costs need to be carefully considered when selecting this type of rehabilitation strategy.

2. Work zone safety needs to be considered when using this type of rehabilitation. On a project-by-project basis, the project engineer should carefully weigh the safety measures of using barrier versus the time factor involved with opening the lane to traffic.

3. The production rates on this project may not necessarily reflect the production rates on projects that require rapid turn around. This operation was not on the critical project path. In addition, the contractor had a learning curve with installing this new system.

4. It is possible that on a smaller repair area, a precast repair could be made during the day or night, and re-opened to traffic before the next rush hour. This would involve opening the lane to traffic before the joints were sealed and shoulder repaired. A subsequent “off-peak” lane closure would be required to complete this work.

Recommendations

1. To reduce grading time of the stone dust, the pre-fabricated panels may want to be constructed with a depth slightly less than the depth of the existing slab.

2. The special provisions may want to include additional guidelines and/or flexibility for the project engineer to address cracked or damaged panels. Guidance on how to address non-conformance to specification on special items such as grout strength and stone dust gradations may want to be added.

3. Continue to monitor the long range durability of these precast panels versus the type C and type D repairs performed on this project.

ATTACHMENTS

APPENDIX A  Cost Breakdown
APPENDIX B  Precast Concrete Pavement Panel Details (3 Sheets)
APPENDIX C  Precast Concrete Pavement Panel Special Provisions