Precast Concrete Panels for Rapid Pavement Repair

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Closing a major interstate highway for extended periods of time for pavement rehabilitation is becoming increasingly difficult. As a result, night paving is becoming a routine practice for most highway agencies facing rehabilitation on major routes. However, concrete pavement rehabilitation often requires significantly more time than an overnight repair can provide. Conventional repairs to I-25 north of Denver, Colorado were estimated to require a minimum of 48 hours to complete, requiring closure of the facility. Closing this major interstate for this length of time would have created significant traffic congestion and was judged unacceptable. Therefore, a rehabilitation method requiring only an 12-hour closure of the interstate was evaluated. This research describes the use of precast concrete panels to replace the deteriorated concrete pavement in lieu of conventional cast-in-place techniques or asphalt concrete patches. Results of the experiment indicate that not only can the process be completed in the time frame desired, it can be used where non-uniform cross sections exist, installed in adverse weather conditions and at a cost that is lower than competing techniques and saves significantly on user costs. After this research was completed several additional locations have used the precast process with success.

Keywords: Concrete pavement repair, precast pavement panels, rapid pavement repair

Introduction

Rehabilitation of roadways is rapidly replacing original construction as the primary mode of construction activity for most public agencies. Rapid repair of these facilities is becoming increasingly important as reduction of traffic congestion becomes a higher priority (Mohsen, et al, 1998, Merritt, et al, 2001). Therefore, methods for expediting rehabilitation time have been suggested to minimize this congestion. Michigan (Buck, et al, 2003), Texas (Elkins, 1979), and Colorado (Public Works, 2001) have experimented with the use of precast concrete panels for expediting the rehabilitation of Portland concrete pavement.

Objective

The objective of this research was to demonstrate whether repairing concrete pavement using precast concrete panels could be accomplished successfully in under twelve hours. The first trial pavement was on US287 north of Ft. Collins, Colorado. The success of this small-scale trial lead to further evaluation on a high traffic segment of I-25 north of Denver. This pavement consisted of ten inches of plain concrete over twelve inches of aggregate base course. Traffic was between 23,000 to 60,000 vehicles per day with 10 percent heavy trucks. A condition survey conducted prior to rehabilitation indicated that over 500 thirty by twelve foot panels existed with at least three full depth longitudinal cracks and significant spalling. As the concrete continued to deteriorate around the cracks it was typical for loose concrete pieces to dislodge under traffic and
become airborne. Rapid repair of the slabs became a high priority as these hazards became more common.

**Experiment**

This experiment was conducted on US287 north of Ft. Collins, Colorado near the intersection with Larimer County Road 19. The trial pavement had repeated pavement failures due to an unstable base course.

The proposed pavement section was on a super elevated curve of approximately 4 percent. This location was chosen to test the feasibility of placing precast panels over unlevel substrates in addition to:

1. a complete panel of the same shape and size as the original with matching transverse and longitudinal joints,
2. a smaller portion of a panel,
3. an irregularly shaped panel.

Constraints for constructing the precast panels were:

1. Maintaining two-way traffic
2. 8 hour time limitation for conducting work
3. Acceptable ride required
4. All debris to be removed during the 8 hour work period
5. Base repair had to occur prior to the pre-cast slab placement
6. Widths of joints could not exceed ½ inch for longitudinal joints and 5/8 inch for transverse joints

Typical panels were 12 feet by 12 feet by 10 inches thick. Connection of the panels to the existing pavement was with fiberglass joint ties measuring ¼ inch thick by 5 inches wide by 36 inches long as shown in the detail in Figure 1.
Figure 1: Precast Panel Details
Preconstruction

In order to minimize construction time, obstacles were identified that could be addressed before panel installation including:

1. The size of the panel to be precast was accurately measured in advance so the panels could be cast to within plus-minus 1/4 inch.

3. The panels were cast 1 inch thinner than the surrounding pavement so polyurethane foam could be injected underneath to level the panels. This was a water blown formulation of high density polyurethane.

4. The total sequence of panel installation was reviewed and duties at 15 minute intervals were identified.

5. Backup sequences were identified in case events did not go as planned, for example asphalt concrete was utilized as an alternate patch material.

Trial Installation

Several trial precast panels were installed on US287 for the first trial. However, one objective of this trial was to determine if the trial panels could be installed within a twelve hour period. Therefore, although the entire trial installation occurred from November 30, 2000 to December 7, 2000, the major activities required for installation of a single panel are summarized in Table 1 to show that installation within the twelve hour period is possible.

Table 1: Major Activities and Time Requirements

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Cumulative Hrs</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-30</td>
<td>0630</td>
<td>0</td>
<td>Traffic Control Established</td>
</tr>
<tr>
<td></td>
<td>0700</td>
<td>0.50</td>
<td>Saw Cutting</td>
</tr>
<tr>
<td></td>
<td>0745</td>
<td>1.25</td>
<td>Removed Old Slab</td>
</tr>
<tr>
<td>1000</td>
<td>3.50</td>
<td></td>
<td>Placed New Precast Slab</td>
</tr>
<tr>
<td>1030</td>
<td>4.00</td>
<td></td>
<td>Polyurethane Installation</td>
</tr>
<tr>
<td>1230</td>
<td>6.00</td>
<td></td>
<td>Final Leveling Completed</td>
</tr>
<tr>
<td>1500</td>
<td>8.50</td>
<td></td>
<td>Finished Cleaning Joints</td>
</tr>
<tr>
<td>12-1</td>
<td>1130</td>
<td>8.50</td>
<td>Traffic Control Established</td>
</tr>
<tr>
<td>1300</td>
<td>10.00</td>
<td></td>
<td>Dried Joints and Filled with Sealer</td>
</tr>
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Performance After Six Years

The precast panels have been in service for six years and are performing very well. There is no evidence of cracking or other distress in the precast panels. The fiberglass joint ties have remained in place, required only routine crack sealing, and show no evidence of distress. Ride quality when transitioning the panels is excellent. The only disadvantage of the process, to date, is due to the presence of crack filler in the perimeter joints and in the fiberglass ties which make the panels more obvious to motorists. Figure 2 shows the appearance after six years including corner cracks in the original pavement that were present at the time of panel installation.
Figure 2: Appearance of Trial Panels After Six Years
Costs

An analysis was conducted to compare the relative costs of the precast panel repair technique and conventional cast-in-place repair and asphalt patching. Table 2 is a summary of the approximate costs for these procedures for projects using 12 foot by 15 foot concrete slabs 10 inches thick.

Table 2: Cost Comparison for Three Concrete Pavement Repair Techniques

<table>
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<tr>
<th>Summary Cost per Square Foot</th>
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<tbody>
<tr>
<td>Cast-in-Place Concrete</td>
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<tr>
<td>Pre-cast Concrete</td>
</tr>
<tr>
<td>Asphalt Concrete</td>
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Although the initial cost of the precast concrete panels is significantly higher than competing methods, considering the advantages of long term performance and the relatively short time
required for installation, this method of rehabilitation of concrete pavements should be considered.

Conclusions

1. Precast concrete slabs are effective as a repair technique for high traffic pavements when rapid repair is desirable and closing the facility for periods beyond twelve hours is not feasible.

2. Polyurethane foam was effective for lifting the precast panels into position initially and has remained in position for six years on the trial project.

3. Although the initial cost of the precast panels was three to four times the cost per unit area of asphalt patches and two to four times the cost of cast in place concrete, cost of this technique would decrease as experience is gained and more contractors are familiar with the process.

4. User costs associated with lane closures on high traffic roadways are significant and should be considered when rehabilitation strategies are selected. Precast concrete panels would help to significantly reduce this user cost.

References


