ACCELERATED SLAB REPLACEMENT USING TEMPORARY PRECAST PANELS AND SELF-CONSOLIDATING CONCRETE (SCC)

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PROJECT TEAM

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Slab Replacement Challenges

- Short window for nighttime lane closures, (9 hrs.)
- Contractors’ production/night for slab replacements is generally very low (Survey: 25-50 cu. yd.).
- Results: long MOT & project completion times, as well as high cost to the Department.
- To increase contractor production, the concrete mix is often designed to achieve lane-opening strength in shorter times – (by designing mixes with excessive cement & accelerator contents.)
  
  This often leads to premature slab cracking
PROJECT OBJECTIVE

- To develop a method, using temporary/reusable precast panels and SCC mix to accelerate construction of replacement slabs in concrete pavement rehabilitation projects.
TASKS

1. Develop SCC mix design with high workability & early strength.

2. Design & construct precast panels for quick installation in & removal from replacement slab pit.

3. Demonstrate robustness of panels under truck loading.


5. Demonstrate improvement in accelerating slab replacement process.

SCC MIX

SCC Mix Requirements:

- Use of HRWR, workability retainer, and accelerator, and large aggregate (grade 57) in Mix.
- Achieve High slump flow > 20” (50 cm) & maintain it for 60 minutes with no segregation.
- Achieve strength of 2,200 psi at lane opening time (6 hrs.)

Slump flow test
## SCC final mix design

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Mix lb/yd.(^3) (kg/m(^3))</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>830 (492)</td>
<td>Type I/II cement used – AASHTO M85</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>1625 (964)</td>
<td>Limestone grade size 57</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>1224 (726)</td>
<td>Silica sand</td>
</tr>
<tr>
<td>Mix Water</td>
<td>280 (166)</td>
<td>Mix water adjusted to aggregate moisture and water content in the accelerator admixture</td>
</tr>
<tr>
<td>W/C</td>
<td>0.34</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admixtures</th>
<th>fl Oz/yd.(^3) (mL/m(^3))</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workability Retainer</td>
<td>42 (1,242)</td>
<td>ASTM C 494/C 494M, Type S, specific performance admixture</td>
</tr>
<tr>
<td>HRWR - Polycarboxylate</td>
<td>50 (1,479)</td>
<td>ASTM C 494, Type A, water-reducing, and Type F, high-range water-reducing admixture</td>
</tr>
<tr>
<td>Accelerator</td>
<td>473 (13,987)</td>
<td>ASTM C 494 Type C, accelerating, and Type E, water-reducing and accelerating, and admixture.</td>
</tr>
<tr>
<td>Water Reducer &amp; Retarder</td>
<td>42 (1,242)</td>
<td>ASTM C 494/C 494M, Type A, water-reducing, Type B, retarding, and Type D, water-reducing and retarding admixture</td>
</tr>
</tbody>
</table>
### Workability Retention

#### Slump Flow and T-20 Test results

<table>
<thead>
<tr>
<th>Time Min</th>
<th>B1</th>
<th></th>
<th></th>
<th>B2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slump Flow (mm)</td>
<td>T-20 (sec)</td>
<td>Slump Flow (mm)</td>
<td>T-20 (sec)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 *</td>
<td>20 (480)</td>
<td>9</td>
<td>22 (550)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>28 (710)</td>
<td>2</td>
<td>----</td>
<td>----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>----</td>
<td>----</td>
<td>24 (600)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>29 (737)</td>
<td>2</td>
<td>----</td>
<td>----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>----</td>
<td>----</td>
<td>27 (675)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>28 (700)</td>
<td>2</td>
<td>----</td>
<td>----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>----</td>
<td>----</td>
<td>29 (725)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>26 (648)</td>
<td>3</td>
<td>----</td>
<td>----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>22 (546)</td>
<td>4</td>
<td>----</td>
<td>----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>15 (380)</td>
<td>&gt;10</td>
<td>29 (725)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* This test was performed after 6 minutes from adding accelerator and remixing
Compressive Strength

All trial SCC batches prepared in FAMU-FSU lab and at two commercial batch plants consistently produced concrete with a 6-hour compressive strengths that exceeded 2,200 psi required by the FDOT for lane opening to traffic.
Temporary & Reusable Precast Panels

- Two precast panel sizes are specified in this method:
  - 6’ x 12’ x T
  - 4’ x 12’ x T
  
  \((T = \text{average thickness of slabs determined from project core samples})\)

- The two panel sizes will fit standard replacement-pit sizes:
  - 6’ x 12’, 8’ x 12’, 10’ x 12’ and 12’ x12’

- FDOT Design plans need specify above standard dimensions for distressed areas to be removed - to allow use of specified precast panels.

- Maintain a 1.5” gap between panels & surrounding concrete to facilitate panel installation & removal.
Notes:
- Precast pales may also be fabricated in precast plants reinforced &/or pretensioned, and delivered to contractor’s yard for use.
- Light weight concrete may also be an option.
Precast Panel Design Features

*Backer rod gasket glued to sides to facilitate panel installation & removal*

*Bottom of panel has recessed strips for better grip & stability*
Demonstration of the precast panels and SCC mix was conducted in a dedicated pavement test track south of Jacksonville.
Slab Replacement Process

- Remove deteriorated section
- Drill holes for new dowel bars then cover holes with tape
Construction of replacement slab pit at Track to house two 6’ x 12’ panels

Recycled concrete leveling course

Use leveling course to adjust surface elevation of precast panels (If necessary). Goal: ≤1/4” elevation difference with surrounding.
Other Leveling Course Materials

- Builders Sand
- Geosynthetic Mats

No need to remove leveling course – *Becomes part of base for replacement slab*
PANEL INSTALLATION

Backer rod lubricated to facilitated lowering the panel inside the pit

Installation of 2\textsuperscript{nd} Panel

Panel Installation: 10 minutes

Panel Removal: 5 minutes
Load Testing Precast Panels

60,000 lb pump truck was used to load the precast panels – No panel shifting or displacement observed
Pit preparation for concrete placement

Epoxy injection of dowel holes in adjacent concrete

Anchor dowel bars in epoxied holes
SCC Casting of 12’ x 12’ x 8” replacement Slab

Placement completed in 2 minutes

IMPORTANT: Maintain mixer in agitation mode until load is discharged completely
Truck Loading of Replacement Slab

- The replacement slab was loaded six hours after SCC placement.
- A 25,000 lb truck made 100 passes on the replacement slab.
- No cracks were observed
Core Samples From Slab – No Segregation
CONSTRUCTION GUIDELINES

First Night
1. Remove bad slab section – (use standard dimensions)
2. Drill new dowel holes
3. Cover holes with tape
4. Add leveling course (if needed)
5. Install 1 or 2 precast panel(s)
6. Repeat (1-6) for next 40 to 50 bad sections

Second Night
1. Remove precast panels
2. Transport panels to next project segment
3. Inject epoxy and anchor dowel in adjacent concrete
4. Pour SCC mix in pit
5. Apply surface vibration & leveling
6. Repeat (1-6) to Complete placement of 40 – 50 slabs

Continue this Construction Sequence for duration of project
CONCLUSIONS

1. Precast panels were highly resilient during handling, installation & removal.

2. Panels were structurally sound and stable under truck loads.

3. SCC Mix retained high slump flow for nearly 60 min. for rapid discharge & shorter slab placement time.

4. SCC mix proved adaptable to batch plant production, truck transportation and multiple discharges w/o segregation.

5. SCC exceeded the 2,200 psi FDOT strength requirement for lane opening.
Use of temporary/reusable precast panels and SCC mix for slab replacement provides the following benefits:

- Increased contractor productivity. (30%)
- Reduced (MOT) days.
- Shorter project completion time.
- Cost savings to DOT from lower bid prices.
- Reduced premature slab cracking - more time will be allowed for curing by using more forgiving concrete mixes which will exceed the required lane-opening strength.

CONTRACTOR CAN MAXIMIZE BENEFITS BY USING MORE EFFICIENT EQUIPMENT AND SMARTER TECHNIQUES.
AKNOWLEDGEMENTS

- Florida DOT Sponsored the project
  Project Manager – Mike Bergin

- Industry Support
  - Argos – Jacksonville
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  - BASF Corporation
  - Dayton Superior
  - Concrete Specialist Inc.
QUESTIONS?