DEPLOYABLE CONCRETE TECHNOLOGIES FOR PAVEMENTS

By
Angel L Correa
FHWA Resource Center, Atlanta

PRESENTED AT THE "VIRGINIA CONCRETE PAVEMENT CONFERENCE"
Richmond, VA
March 6, 2008

Notice
- This presentation is presented by the FHWA in the interest of technology exchange.
- The US Government does not endorse products or manufacturers.
- Trade or manufacturers’ names may appear in this presentation only because they are considered essential to the object of this presentation.

DISCUSSION TOPICS
- EQUIPMENT AND CONSTRUCTION
- QUALITY CONTROL
- DESIGN
- SOFTWARE
- WIDE PCCP SLABS

DOWEL BAR INSERTER
GSI
GOMACO Smoothness Indicator
“Revolution in Profiling”

GSI taking readings behind a Paver

GSI
GOMACO Smoothness Indicator
**PI Comparison (GSI & Cox)**

Top Trace: Cox Profigraph  
Bottom Trace: GSI

**STRINGLESS PAVING**

**Goals**

A. Control of slipform paving train without stringline  
   1. X-Y-Z axis control  
   2. Meet smoothness criteria

B. Control of as many as 4 companion machines  
   1. Placer Spreader (s), Texture / Cure machine (s)  
   2. Redundancy with back-up in case of failure

**Control System**

- Note GPS receiver No 1  
- Laser Receiver (tracking) mounted on paver

**Control System**

- Laser kept within 500 ft of paver (1000 ft range)  
- Left to Right: Computer, Sensor I/O's, Monitor, Foreground: Keyboard
Elliptical Dowels

American Highway Technology

Why Consider Elliptical Shapes

- Reduce Bearing Stress
- Engineer Dowel Spacing
- Reduce Cost

Dowel Bar Test Results

<table>
<thead>
<tr>
<th>Dowel Bar Description</th>
<th>Concrete Bearing Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25 inch round steel</td>
<td>2,048 psi, (1.23 sq in)</td>
</tr>
<tr>
<td>1.5 inch round steel</td>
<td>1,568 psi, (1.77 sq in)</td>
</tr>
<tr>
<td>Large elliptical steel</td>
<td>1,147 psi, (2.08 sq in)</td>
</tr>
<tr>
<td>Medium elliptical steel</td>
<td>1,611 psi, (1.43 sq in)</td>
</tr>
</tbody>
</table>

DISCUSSION TOPICS

- EQUIPMENT AND CONSTRUCTION
- QUALITY CONTROL
- DESIGN
- SOFTWARE
- WIDE PCCP SLABS

LOCATION OF DOWEL BARS
MIT SCAN

Developed by Magnetic Imaging Tools, GmbH
Based on the principles of pulse induction

Advantages
- Works on fresh or hardened concrete
- Real-time, automated data analysis
- Very accurate
- Reliable
- Efficient (1-2 min per joint)

---

Dowels placed in baskets

The current software does not analyze dowels placed in baskets that are uncut

Good quantitative results can be obtained if the basket is cut

- Approximate results with general calibration
- More accurate results with calibration to specific basket type
- For accurately placed bars (placed within typical placement tolerance) the error is less than +/- 5 mm.

---

Dowels Placed in a Basket

Basket not cut
Basket cut
When the maturity reaches this value, we can reliably say that the in-place strength is 550psi (FLEX ASTM C1074)

Laboratory Calibration  
Field Monitoring

When the maturity reaches this value, we can reliably say that the in-place strength is 550psi (FLEX ASTM C1074)

Reestablishing Maturity Curve

Factors Affecting Maturity
- Cement
- Fly Ash
- Admixtures
- W/C ratio
- Mix type
- Aggregate gradation

Air Void Analyzer (AVA)

An apparatus that measures the air-void characteristics of fresh concrete

A 2002 Focus Technology

Spacing Factor

More control of air-void characteristics in fresh concrete

Quantify the air-void structure in the field

Rapid QC/QA testing, useful for concrete placed in extreme climates

Air Void Analyzer allows …
AVA Equipment

How the AVA works

A cement mortar sample is placed in the analysis liquid. They are stirred together.

The air bubbles contained in the mortar are released.

Large bubbles rise to the surface faster than small ones.

AVA Limitations

Equipment is sensitive to vibration.
Testing needs to be performed in a quiet environment, like a permanent structure.

Small sample size

Air characteristics are calculated based on assumed volume fractions. Sample excludes aggregate larger than 6 mm (0.24 in).

DISCUSSION TOPICS

- EQUIPMENT AND CONSTRUCTION
- QUALITY CONTROL
- DESIGN
- SOFTWARE
- WIDE PCCP SLABS

Limitations: Huge Extrapolation

Pavement Thickness

AXLE LOAD REPETITIONS

WWW.TRB.ORG/MEPDG
DISCUSSION TOPICS

- EQUIPMENT AND CONSTRUCTION
- QUALITY CONTROL
- DESIGN
- SOFTWARE
- WIDE PCCP SLABS

What is it?

- High PERformance Concrete PAVing
- An integrated computer system that analyzes material, environmental, design, and construction variables
What are typical uses?

Predict responses in cold and hot weather paving
Predict potential strength gain for tight closures and opening to traffic
Determine effects of design parameters on stress development
  - Joint spacing, thickness, base type
  - Determine optimal mix characteristics
  - Forensic studies – crack development

DISCUSSION TOPICS

- EQUIPMENT AND CONSTRUCTION
- QUALITY CONTROL
- DESIGN
- SOFTWARE
- WIDE PCCP SLABS

JCP Stress and Strength Development

Scenario #1
Cracking should not occur

Scenario #2
Cracking may occur

WIDENED LANES
## CRC WIDENED LANE
(50,000 ADT  30% TRUCKS  90% RELIABILITY)

<table>
<thead>
<tr>
<th>THICKNESS</th>
<th>% STEEL</th>
<th>YRS TO FAILURE 12 FT WIDE</th>
<th>YRS TO FAILURE 13 FT WIDE</th>
<th>ESAL'S 12 FT WIDE</th>
<th>ESAL'S 13 FT WIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.70</td>
<td>14.3</td>
<td>30.3</td>
<td>76 MILLION</td>
<td>191 MILLION</td>
</tr>
<tr>
<td>12</td>
<td>0.70</td>
<td>26.3</td>
<td>40+</td>
<td>175 MILLION</td>
<td>281 MILLION</td>
</tr>
<tr>
<td>10</td>
<td>0.65</td>
<td>12.3</td>
<td>26.3</td>
<td>64 MILLION</td>
<td>159 MILLION</td>
</tr>
<tr>
<td>12</td>
<td>0.65</td>
<td>24.3</td>
<td>40+</td>
<td>145 MILLION</td>
<td>281 MILLION</td>
</tr>
</tbody>
</table>

Thank You!