Instrumentation and Monitoring of Precast Prestressed Concrete Pavement

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Organization

- Background
- Casting/Fabrication
- Construction
- In-service Performance
- Summary Observations

Pavement Design

- Comprises three panel types: joint, base, and anchor panels
Precast Sections

- Divided into four - 250' sections
- Each 250' section was post-tensioned together

Instrumentation

- Strandmeter
- Vibrating Wire Gage
- Thermocouples
- Instrumented Rebar
Typical Panel Design & Instrumentation Layout

- Precast Panels are 10’ by 38’
- Pre-tensioned in the transverse direction and post-tensioned longitudinally after installation

Casting
Construction

Curing and Hydration

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<th>Time Elapsed (Hours)</th>
<th>Microstrain</th>
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<tr>
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<td>-800</td>
</tr>
<tr>
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<tr>
<td>70</td>
<td>600</td>
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</tbody>
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- **Amb. Temp.**
- **Steam Temp.**
- **Therm. Temp.**
- **T7 and T8**

Steam Curing of First Half of Panel
Steam Curing of Second Half
Steam Off
Steam Off

Joint Panel Plan
Inside Shoulder
Outside Shoulder

Stress Transfer
Average Post-tensioning concrete strain in the panels

* Prestressing force lost in PT ducts = 61.8 lb/ft/duct

Post-Tension Strands
- 0.6" Diameter
- 7-wire Low Relaxation Strands
- Uncoated
- Stressed to 80% of ultimate (U. = 270 ksi)
Daily Service Performance of a Typical Joint Panel (A32)

Service Performance for Week Long Period

**Trends**
- Increase in relative temp. = 11 °C
- Increase in relative strain = 68 mstrain

\[ \frac{68}{11} = 6.2 \]

(Close to CTE_{	ext{Concrete}} as assumed of 6.0)
Seasonal Service Performance of a Typical Base Panel (B2)

In the Seasonal Service Performance of a Typical Base Panel (B2) section, the document illustrates various temperature and strain measurements. The graphs show the mean daily ambient temperature, mean daily temperature from B2, and the mean daily concrete strain from R2, R5, and a theoretical curve. The temperature values range from -350°C to 56°C, and the strain values range from -350 to 500 µstrain.

Pavement Response to Traffic Loadings

The Pavement Response to Traffic Loadings section displays the strain response over time. The graph shows the strain on B4 Rebar 5 with a peak of 4.5 µstrain and a range of 1 - 4 µstrain. The strain values are measured in time (minutes), with a scale ranging from 0 to 35 minutes.
Individual Vehicle Induced Strains

Service Observations – Joint Panel
Service Observations - Cracking

Possible Causes of Cracking

- Thermal cracking from high temperature swings during fabrication process
- Curling causing longitudinal cracking
- Epoxy was allowed to cure before PT
Weather Related Issues

• Summer heat waves were problematic for sensitive circuitry.
  - Addition of a shade roof
  - Larger heat sinks, with strategically placed fans
  - Military grade parts since exceeding Max. Junction Temp.

Weather Related Issues

• Water and Lightning won’t stay away
  - Condensation and leakage due to worn seals
  - Corrosion
  - Addition of circuit protection diodes in line and on regulators
  - Path to ground
Summary Observations

- Overall the project provided useful insights on the performance of precast pavement system
- Need to avoid thermal shock during early age
- Fabrication/alignment issues to be addressed
- Joint performance can be improved
- As-built post-tensioning stress location dependent
- Friction plays a role – incorporate in design
- Thermal strains single-most significant loading
- Cracking could be minimized through more careful fabrication/construction