PERFORMANCE ENGINEERED MIXTURES (PEM) FOR CONCRETE PAVEMENTS

DELIVERING CONCRETE TO SURVIVE THE ENVIRONMENT

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What should we measure to get **Good Concrete**?

1. **Shrinkage** - To reduce preventable cracking
2. **Transport (permeability)** - To reduce transport of aggressive unwanted fluids in order to survive the environment
3. **Freeze/thaw durability** - To reduce expansive damage to the concrete pavement
4. **Aggregate Stability** - To eliminate reactive aggregate that destroys concrete pavements
5. **Workability** - To improve concrete placement that impacts concrete durability & improves rideability.
6. **Strength** - To ensure concrete pavement carries intended vehicle loads without failure
Some New Test Methods for PEM

- Tests for those critical properties
  - VKelly (Workability)
  - Box (Workability)
  - Resistivity / Formation Factor (Transport) factor
  - Bucket / Sorptivity
  - Dual ring (Shrinkage)
  - SAM (Cold Weather Resistance)
<table>
<thead>
<tr>
<th>How do we measure?</th>
<th>Shrinkage</th>
<th>Transport</th>
<th>Freeze/Thaw Durability</th>
<th>Aggregate Stability</th>
<th>Workability</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paste content</td>
<td>w/cm ratio</td>
<td>ASR</td>
<td>Box Test V-Kelly</td>
<td>Flexural &amp; Compress</td>
<td></td>
<td></td>
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<tr>
<td>Drying shrinkage</td>
<td>Air content</td>
<td>D-Cracking</td>
<td></td>
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<tr>
<td>Dual Ring</td>
<td>SAM</td>
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<tr>
<td></td>
<td>CaOxyschloride (LT-DSC)</td>
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</tbody>
</table>

Mix Design

- ✓
- ✓
- ✓
- ✓

QC/Acceptance

- ✓
- ✓
- ✓
- ✓
Update on the SAM Test

Tyler Ley
digital gauge

different bleeder valve

Six clamps!
AASHTO Test Method

• The SAM is now an AASHTO provisional test method!

• AASHTO TP 118

• Precision and Bias will be demonstrated at the Iowa DOT later this spring. (PEM-FHWA)
** Controlled Air Pressure Extender **  
aka CAPE

**Step 1** (14.5 psi)
**Step 2** (30 psi)
**Step 3** (45 psi)
SAM modifications

• The SAM can be completed in 8-10 minutes with the air pump

• If you use the CAPE then it can be completed in 4-6 minutes

• An all metal body gauge is under development
Super Air Meter Test

1. **FILL**, consolidate, and level with a plate
   a. 3 equal lifts – 25 rods each lift
2. Strike bucket with rubber mallet after each lift
3. **CLEAN** rim of the bucket & O-ring on lid thoroughly
4. Zero gauge
5. Place & clamp lid
6. **FILL** SAM with water through petcock
   a. Tilt meter while filling with water
   b. Allow all air bubbles to leave
   c. Close both valves while filling
7. **BEGIN** SAM test & follow directions on gauge
   a. Inflate to 14.5 psi & equalize
   b. Inflate to 30.0 psi & equalize
   c. Inflate to 45.0 psi & equalize
   +/- 0.05 psi tolerance on each pressure
8. **PURGE**, open petcocks
9. **REPEAT** **Step 6**
   a. Inflate to 14.5 psi & equalize
   b. Inflate to 30.0 psi & equalize
   c. Inflate to 45.0 psi & equalize
   +/- 0.05 psi tolerance on each pressure

Test should be completed in 12 min.

Refer to superairmeter.com & AASHTO TP 118

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The following states have a SAM

- Michigan (20+)
- Kansas (6)
- Utah
- Colorado (2)
- Iowa (2)
- Illinois (5)
- Indiana (2)
- Wisconsin (12)
- Massachusetts
- Idaho (2)
- Tennessee
- Pennsylvania
- Missouri (2)
- N. Carolina (3)
- N. Dakota
- Oklahoma (9)
- Nebraska (3)
- Ohio (3)
- Minnesota (2)
- Texas (2)
- FHWA (4)
- Georgia
- New Jersey
- New York (20+)
- South Dakota
- Mississippi
- Manitoba (3)
- Ontario (2)
What have we done in the lab?

• Completed 220 laboratory testing for typical pavement and bridge deck concrete

• Investigated w/cm from 0.35 to 0.53

• Different AEAs, admixture combinations, with and with out fly ash, different temperatures
SAM vs spacing factor

94% agreement
SAM vs spacing factor

70% agreement w/ 0.20 limit
84% agreement w/ 0.25 limit
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May the Force be with you!!!!
DELIVERING CONCRETE TO SURVIVE THE ENVIRONMENT

• The framework is in place
• Now we are focused on the details of confirmation and implementation
• *Let’s continue Iowa leadership in the PEM endeavor. Gain some familiarity with the SAM this season!*

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