Update on the SAM and the Box Test

Tyler Ley
Outline

1. Super Air Meter
2. The Box Test
Six clamps!

digital gauge

different bleeder valve
AASHTO Test Method

• The SAM is now an AASHTO provisional test method!

• AASHTO TP 118

• Thanks to the help of Larry Sutter of Michigan Tech, Mic Syslo, and Wally Heyen of Nebraska Department of Roads
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
The following states have a SAM

- Michigan (5)
- Kansas (6)
- Utah
- Colorado (2)
- Iowa (2)
- Illinois (5)
- Indiana (2)
- Wisconsin (4)
- 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
- South Dakota
- Mississippi
- Iowa (2)
- 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 specific surface

89% agreement
SAM vs rapid freeze thaw

80% agreement w/ 0.20 limit
89% agreement w/ 0.25 limit
Spacing factor vs rapid freeze thaw

69% agreement
Discussion

• A SAM number of 0.20 shows 94% agreement with laboratory spacing factor limit of 0.008”
• The same limit shows 89% agreement with specific surface limit of 600 in\(^{-1}\)
• For the freeze thaw data there is better agreement for a SAM number of 0.25 (89%) then for a SAM number of 0.20 (80%)
• The SAM number had a better correlation with freeze thaw results then the spacing factor
What have we done in the field?

• Visited eight field sites in Oklahoma and sampled 60 different mixtures
• Gathered 90 field mixtures from Colorado, Utah, Nebraska, Minnesota, N. Dakota, Iowa, FHWA
  – 30% bridges, 67% pavements, 3% other
• We have another 50 mixes from Michigan and FHWA mobile concrete lab that will be added soon
SAM vs spacing factor

70% agreement w/ 0.20 limit
84% agreement w/ 0.25 limit
Discussion

• A SAM limit of 0.25 shows 84% agreement while the SAM limit of 0.20 shows 70% agreement

• The field data is more variable then the lab data
How do we choose a SAM limit?

• We run fresh and hardened air tests as a surrogate for freeze thaw durability.
• This suggests that we should choose a SAM limit based on the freeze thaw testing.
• While a SAM limit of 0.25 may be a better predictor of freeze thaw performance, a limit of 0.20 is conservative.
• Maybe we use the 0.20 as an accept limit and the 0.25 as an action limit?
Proposed SAM limit

• If SAM number is less than 0.20 then accept the concrete
• If SAM number is between 0.20 and 0.25 then request the air be increased on the next load
• If the SAM number is greater than 0.25 then there is concern about freeze thaw durability
• Total air content must be above 5%
How can this group help?

• Get a SAM and start using it
• **Share your data and send a cylinder and we will do hardened air-void analysis**
• We will make all of the data public
• If you have already promised me data then provide it!

www.superairmeter.com
Other Work

• We are holding a SAM robin at Oklahoma State this winter.
• All experienced SAM users are invited!
• We will check calibration of meters and have operators pass a proficiency exam
• We will have ready mix concrete brought into our lab and everyone will sample at the same time.
The Box Test

• A simple test that examines:
  – Response to vibration
  – Filling ability of the grout (avoid internal voids)
  – Ability of the slip formed concrete to hold a sharp edge (cohesiveness)

• The slump test can not tell us this!
Box Test

• Add 9.5” of unconsolidated concrete to the box
• A 1” diameter stinger vibrator is inserted into the center of the box over a three count and then removed over a three count
• The edges of the box are then removed and inspected for honey combing or edge slumping
<table>
<thead>
<tr>
<th>Box Test Ranking Scale</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>4 4 4 4</td>
<td>3 3 3 3</td>
</tr>
<tr>
<td>Over 50% overall surface voids.</td>
<td>30-50% overall surface voids.</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>2 2 2 2</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td>10-30% overall surface voids.</td>
<td>Less than 10% overall surface voids.</td>
</tr>
</tbody>
</table>
Visual Ranking

- Instead of just eyeballing the amount of surface voids we have started using a more systematic procedure.
- You use plexi glass with circles printed on it and hold it up to the surface and examine each circle to see if there is a void.
• By counting the dots where there are voids then you can quickly estimate the amount of surface voids.
• This is like doing a point count on a hardened air sample.
• We are still perfecting the technique.
Red circles = void
Orange circles = mortar

28 dots total
8 dots with voids
8/28 = 28% voids

This takes about 30 seconds per side
www.optimizedgraded.com
What’s Next?

• Finalize the details of the point count to estimate the surface voids
• Eleven states have been given a Box Test and vibrators to try out
• We have a new YouTube video on how to run the box test.
• Develop an AASHTO Provisional Test Method!!!!

www.optimizedgraded.com
Questions???
Tyler.ley@okstate.edu
www.tylerley.com

May the Force be with you!!!!