Implementing New Concrete Tests

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What is the dream?
What is the dream?

Concrete that is economical, consistent, and long lasting with minimal maintenance.
Why are we talking about this?

• The heart of the PEM effort is early age test methods to predict the long term performance of concrete.

• If we don’t try to implement these tests then nothing will change.
What gets measured gets managed.

- Peter Drucker
When was the last time that we did this?
When was the last time that we did this?

• Air meter (Klein and Walker, 1949)
  68 years

• Rapid Chloride Permeability Test (Whiting, 1981)
  36 years
Why should I do this?

Does the test measure something I care about?
Do my current tests tell me everything I need to know?
Do I have the resources to make changes?
Does this fit into my priorities?
What are your steps to implement?

**Convince yourself**
Convince others
Try the test
Shadow specification
Specification on a few projects
Daily practice

Set a goal and get started.
What are your steps to implement?

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- Convince others
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- Specification on a few projects
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**Set a goal and get started.**

**Ask questions**

**Communicate what you are finding**

**Find out what works for you**
What are your steps to implement?

**Convince yourself**
- Convince others
- Try the test
- Shadow specification
- Specification on a few projects
- Daily practice

**Set a goal and get started.**

**Ask questions**
- Communicate what you are finding
- Find out what works for you

**Set a goal and get started.**
What are our steps to implement?

Establish that the test meets a need and is useful
Standardize the test
Find critical performance limits
Establish test variability
Recommend a specification
Make changes based on comments
Super Air Meter (AASHTO TP 118)
What Do You Want in an Air-Void System?

- Volume of air provided is the same for both.
- Case B has a better air void distribution.
What Do You Want in an Air-Void System?

- Volume of air provided is the same for both.
- Case B has a better air void distribution.
Ley et al., 2017
Discussion

The SAM Number tells you about the bubble size distribution in fresh concrete and the total air does not do this.
68 mixtures show a 88% agreement.
Over 227 lab mixtures from two different research groups
88% agreement

Ley et al., 2017

Spacing Factor [μm]

SAM Number

Low quality air void system agreement

0.008” spacing factor

High quality air void system agreement

OSU Lab Data

FHWA Lab Data

ACI 201.2R
13 DOTs over 270 field mixtures
81% agreement

YES!

NO
Discussion

The SAM Number correlates to performance in rapid freeze thaw testing.

A SAM Number of 0.20 correlates to a spacing factor of 0.008” for 497 concrete mixtures completed by 13 different DOTs and two research groups.

88% agreement in lab
81% agreement in the field
How variable is the test?

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Parameter</th>
<th>COV</th>
<th>Time to complete the test</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAM</td>
<td>SAM Number(^1)</td>
<td>15.2%</td>
<td>10 min</td>
</tr>
<tr>
<td>ASTM C457</td>
<td>Spacing Factor(^2)</td>
<td>20.1%</td>
<td>7 days</td>
</tr>
<tr>
<td>ASTM C666</td>
<td>Durability Factor(^3)</td>
<td>22.7%</td>
<td>3.5 months</td>
</tr>
</tbody>
</table>

\(^1\)Assumes a SAM Number of 0.32 and a standard deviation of 0.049

\(^2\)From ASTM C457

\(^3\)From ASTM C666 with a durability factor of 75 and Method B

170 SAM comparisons were used to determine this.
<table>
<thead>
<tr>
<th></th>
<th>Average Value</th>
<th>68% of the Data Will Be in This Range</th>
<th>96% of the Data Will Be in This Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Compressive strength (psi)</td>
<td>5000</td>
<td>5500</td>
<td>4500</td>
</tr>
<tr>
<td>Air meter (%)</td>
<td>6</td>
<td>6.4</td>
<td>5.6</td>
</tr>
<tr>
<td>SAM</td>
<td>0.20</td>
<td>0.23</td>
<td>0.17</td>
</tr>
<tr>
<td>Spacing factor (in)</td>
<td>0.008</td>
<td>0.010</td>
<td>0.006</td>
</tr>
<tr>
<td>Freeze Thaw (DF)</td>
<td>70</td>
<td>86</td>
<td>54</td>
</tr>
</tbody>
</table>

One standard deviation:

Two standard deviations:
Recommended SAM Specification

**Mixture Design**

- SAM Number ≤ 0.20
- Air content > 4%

**Field**

<table>
<thead>
<tr>
<th>SAM Number</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.25</td>
<td>Accept the concrete</td>
</tr>
<tr>
<td>0.25 - 0.30</td>
<td>Increase air content on next truck, accept the concrete</td>
</tr>
<tr>
<td>&gt; 0.30</td>
<td>Reject the concrete</td>
</tr>
</tbody>
</table>

Air content > 4%
Discussion

If the producer designs the SAM Number to be at 0.20 at their working air content then they will have < 2% chance of getting a failing test in the field.

By allowing actions at different SAM Numbers then the producer can bring their materials back within specification before getting them rejected.

The rejection limit is determined by freeze thaw testing (ASTM C 666).
States that have plans to shadow specify the SAM

• Michigan
• Minnesota
• Idaho
• Oklahoma
• Colorado
• Wisconsin
The future!

A new water content test for fresh concrete.

- Testing time is ~ 10 min
- Accurate to 0.015 w/cm in the lab
- It is automated
- We have investigated > 150 concrete mixtures in the lab
- Minnesota DOT is acquiring a Beta version
All our dreams can come true if we have the courage to pursue them.
Walt Disney

Set a goal and get started.
Questions?

www.tylerley.com

Please subscribe to my concrete YouTube channel!

Go here!
Improvements to the SAM

• Reinforced Gauge
• Shotgun
• Lower durometer O-ring
Reinforced Gauge

Shotgun
New O-ring
Pooled Fund members can get their equipment updated at the link below

https://goo.gl/forms/ug0GkUEjdkNI4fhj1
Why should I do this?

Does the test measure something I care about?
Do my current tests tell me everything I need to know?
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Does this fit into my priorities?

Are you sure?
Percent agreement

SAM Number

spacing factor = 0.008"

Ley et al., 2017