Examples of Using Test Methods to Quantify Workability Properties

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New Orleans
Outline

- Why Am I Taking Measurements?
- Workability Range
- Testing and applying results to practice
  - Novel methods
  - Industry methods
Why Am I Taking Measurements?

- What is the purpose of the data I generate?
- Is it to compare different materials in the same mixture?
- Is it for jobsite quality control?
- Is it to compare the relative performance between two concrete mixtures?
- Is it to develop a new method?
Testing needs to matter, it should not just generate numbers
Stiff Concrete

- Placement is typically heavily dependent upon equipment.
  - Block, Paver, SRW production
  - Hollow core production
  - Paving
- More concerned with extrusion than flow for placement.
- Compaction energy requirement is important.
- Many times used without formwork.
  - Must resist “edge slump”
  - Are all 1-in. (25-mm) slumps the same?
Stiff Concrete Placement Challenges

- Low-slump concrete can be difficult and slow to extrude
- Surface appearance after extrusion
  - Often requires re-work for bugholes/tearing
- Wet mixes can result in edge slump
- Intense vibration can negatively affect air-void structure
Goal: Quantify rheology of low-slump mixtures

- Equipment – L Box
  - customized, high-energy vibrator
- Fill vertical portion and consolidate
- Vibration on for 10 sec.
  - measure drop and run
- Volume Flow = cc/sec
Conventional Stiff Concrete

Concrete Volume Flow with Vibration

Volume Flow

Slump (in.)
Comparison of Concrete Volume Flow with Navitas 33

Data Comparison
Moderate Workability Range

Low  Medium  Flowing

Is slump enough?
A slump measurement may provide some indication of the relative ease of placement and screeding.

- But what about mixtures with the same slump?

What about bull floating, straight edging and finishing? How do we measure properties related to these techniques?
Workability need transitions from a bulk to a surface property
Slab on Grade – Novel Method and Custom Equipment
Quantify “Finishing”

- Concrete slab
- 1/4 in. deep indentations
Quantify “Finishing”

- Position “finishing machine”
- Determine number of strokes to close indentations?
Finishing Comparison

Plain Concrete vs. Admixture-Treated Concrete

Plain Concrete = 100% Effort to Finish

PolyHeed-Treated Concrete
Total Work Required as % of Reference

Concrete Age After Mixing (h) “Finishing Window”

- 2.5: 65%
- 3: 35%
- 3.5: 45%
- 4: 50%
Transition from high slump to SCC is a gray Zone

Recommend measuring the spread as well as the slump for all mixtures with slumps greater than 8 inches (200-mm).
The Gray Zone

![Diagram showing slump flow and slump with annotations for 9-inches and 2-inches.](image-url)
Testing SCC

- Fluidity
  - Slump Flow (C 1611)
- Passing Ability
  - J-Ring (C 1621)
- Stability
  - VSI (C 1611) - optional
  - Column segregation (C 1610)
  - Rapid penetration

Chairman: Mark A. Bury
Secretary: John Schemmel
Slump Flow
Visual Stability Index

0

1

2

3

J Daczko BASF Construction Chemicals
Establishing the Correct QC Parameters

![Graph showing Segregation Factor (%) vs. Slump Flow (in.) for Mix 1 and Mix 2. The graph indicates an increasing trend in segregation factor with increasing slump flow for both mixes.](image_url)
Conclusions

- Many test methods exist for quantifying some aspect of workability.
- First priority is to be clear on how the test values are to be used.
- Many times new methods can be developed to help us measure an important practical property.
- Combining multiple tests provide us with a more thorough view of a mixtures characteristics.