CP ROAD MAP

shaping the future of **concrete pavement**

Mix Design and Analysis Track State Feedback

I-2015

Mixtures that are consistently long-lasting, constructible, and cost efficient

Track 1. Mix Design Analysis

Goal: Mixtures that are sustainable and consistently long-lasting, constructible, and cost-efficient

Subtrack: Tests

- **Acceptance**
- **Uniformity**
- **Materials**
  - **Aggregates**: ASR; Dust; Grading; CTE; D-Cracking; Moisture content
  - **Cement**: Chemistry; PSD
  - **SCM**: Chemistry; LOI; Glass content; PSD
  - **Admixture**: Function; Side effects
- **Mixture**
  - **Fresh**: Rheology (Workability); Stiffening; Setting; Proportions
  - **Hardened**: Strength gain; Permeability; Shrinkage; Proportions; ASR; CTE

PCC Mix Design Laboratory Testing & Equipment

Subtrack: Models

- **Effects of Mix Proportioning**
  - **Parameters**
    - Aggregates: Grading; Dust; Shape; Texture; Proportion
    - Cements: Chemistry; PSD; Proportion
    - SCM: Chemistry; PSD; Proportion
    - Water: Proportion
    - Admixtures: Proportion
  - **Effects**
    - Fresh properties: Rheology; Stiffening; Air content
    - Hardened properties: Strength gain; Permeability; Shrinkage; ASR
- **Effects of Materials Interactions**
  - Fresh properties
  - Hardened properties
  - Incompatibility

PCC Mix Design Modeling

Subtrack: Specifications

- **Guide Sheets (Instructions for specific people)**: Structural designer; Specifier; Mix proportion lab; Plant operator; Test lab; Contractor
- **Guide Specifications (Guidelines on balancing priorities)**: Risk and reward; Cost and quality; Project scope and testing costs; Innovation and Comfort

PCC Mix Design System Development & Integration

Subtrack: Communication

- **Field Trials**: Demonstrate tests; Demonstrate models; Validate models; Demonstrate specs
- **Tech Transfer**: Tests; Models; Specifications; Training; Workshops; ...

PCC Mix Design Evaluation & Implementation

Which tasks do we want first?

The States have voted…

Nine of them anyway

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1. **What are the things you wish you could measure in a concrete mixture?**

- Properties to predict durability (5)
- Water content and w/cm (3)
- Rheology (3)
- Air entrainment at the paver (2)
- Curing (2)
- Its emotional state of being (2)
- In-place strength test method
- Real time evaporation rates
- Incompatibility

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2. What are the causes of materials / mix related failures that you experience?

- Durability related to air void system (5)
- Incompatibilities (2)
- Freeze-thaw
- D-Cracking
- Late ettringite formation
- Excessive aggregate absorption
- Excessive deicers/anti-icers
- Excessive alkali
- ASR

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2. What are the causes of materials / mix related failures that you experience?

- Gap graded aggregates (2)
- Improper/inadequate curing (2)
- Cracking (2)
- Unapproved materials
- High cement contents
- Poor construction practices
- Aggregate and concrete handling
- Poor finishing
- Hot weather/cold weather construction
- Low strength

3. Would you use a guide specification if one were prepared?

- Yes (3)
- Yes, if ... (3)
- Maybe (3)
- Probably not

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4. What should be the two greatest priorities for the mix track?

- Tests and models to predict long-term performance based upon construction data (3)
- Tests for acceptance and uniformity (3)
- Permeability (2)
- Minimum cementitious materials content? (2)
- Fast and reliable test for freeze-thaw durability
- Correlation of laboratory testing with field performance
- ASR
- How much air is really necessary?

4. What should be the two greatest priorities for the mix track?

- Quick delivery & thorough coverage
- Drop use strength for acceptance of “good” concrete
- Guidelines for different classes of concrete mixtures relative the application
- Define what we expect in terms of durability
- Work should be balanced between concrete structures and concrete pavements
- Standard mix design procedure
- Acceptable variability

5. What immediate tasks or actions should we do to address those priorities?

- Testing equipment and methods (2)
- Good tests and models
- Education and outreach
- Understand the current state of the industry in terms of production versus quality
- Understand sustainability parameters
- Equipment user groups
- Procedures

Review of Current Work (RIP)

- Quality 9
- Models 8
- Air void system 6
- Durability 4
- Mix proportions 4
- Cracking 2
- Corrosion 1
- Sustainability 1
- Rheology 1

Summary

- Good tests and models
  - Predict potential durability (air void system)
  - Confirm mix proportions
  - Workability
- Correlate tests with performance
- Guide Specification
  - Necessary parameters and limits
  - Decision tools
- Now!
- Not just pavements