SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Performance Engineered Concrete Pavement Mixtures

Peer-to Peer Technical Exchange
Burlington, Vermont

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U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

- Background
- Team Members
- Specification Basics
  - Provisional Specification
  - Detailed Commentary
- Next Steps
- Conclusion

Background

- MAP-21
  - FHWA emphasis on performance
  - Linking investments to outcomes
- Industry & Agencies desire better performance
  - Optimized mixture design
  - Improved durability
  - Sustainability

Background

- Innovative new test methods related to performance
- Several being balloted by AASHTO
- Tell the contractor what performance is needed
- Hold industry accountable to meet performance

Background

- Expert Task Group formed in 2013
  - Academia, Industry, SHAs
- Determined the specification should include
  - Strength
  - Cracking
  - Freeze-Thaw resistance
  - Aggregate Stability
  - Workability

Team Members for This Task

- Peter Taylor
- Tom Cackler
- Tom Van Dam
- Jason Weiss
- Tyler Ley
- Michael Praul
- Cecil Jones

Specification Basics

- "Menu" specification
- Not an off the shelf drop in
- Select from what you want to satisfy the needs you have
- Intended to work for SHAs and local agencies
- Intended to respect organizational traditions while offering performance options

Specification Basics

Section	Property	Specified Test	Specified Value	Mixture Qualification	Acceptance	Selection Details	Special Notes
6.3 Concrete Strength							
6.4 Reducing Unwanted Slab Warping and Cracking Due to Shrinkage (If Cracking is a Concern)							
6.5 Durability of Hydrated Cement Paste for Freeze-Thaw Durab							
6.6 Transport Properties							
6.7 Aggregate Stability							
6.8 Workability							

Specification Basics - Strength

Section 6.3

Section	Property	Specified Test	Specified Value		Mixture Qualification	Acceptance	Selection Details	Special Notes
6.3 Concrete Strength								
6.3.1	Flexural Strength	AASHTO T 97	4.1 MPa	600 psi	Yes	Yes	Choose either or both	
6.3.2	Compressive Strength	AASHTO T 22	24 MPa	3500 psi	Yes	Yes		

Specification Basics – Warping and Cracking

Section 6.4

Section	Property	Specified Test	Specified Value	Mixture Qualification	Acceptance	Selection Details	Special Notes
6.4 Reducing Unwanted Slab Warping and Cracking Due to Shrinkage (If Cracking is a Concern)							
6.4.1.1	Volume of Paste		25%		Yes	No	Choose only one	
6.4.1.2	Unrestrained Volume Change	ASTM C157	420 με	at 28 day	Yes	No		Curing Conditions
6.4.2.1	Unrestrained Volume Change	ASTM C157	360, 420, 480 με	at 91 days	Yes	No		
6.4.2.2	Restrained Shrinkage	AASHTO T 334	crack free	at 180 days	Yes	No		
6.4.2.3	Restrained Shrinkage	AASHTO TP XXX	σ < 60% f'r	at 7 days	Yes	No		Dual ring test is currently under consideration as an AASHTO Provisional Test Method
6.4.2.4	Probability of Cracking	Appendix X1	5, 20, 50%	as specified	Yes	No		
Commentary	Quality control check	~	~	~	No	Yes		Variation controlled with mixture proportion observation or F Factor and Porosity Measures

Specification Basics – Paste Durability

Section 6.5

Section		Property	Specified Test	Specified Value		Mixture Qualification	Acceptance	Selection Details		Special Notes
6.5 Durability of Hydrated Cement Paste for Freeze-Thaw Durability										
	6.5.1.1	Water to Cementitious Ratio	~	0.45	~	Yes	Yes	Choose Either 6.5.1.1 or 6.5.2.1		
	6.5.1.2	Fresh Air Content	AASHTO T 152, T196, TP 118	5 to 8	%	Yes	Yes		Choose only one	
	6.5.1.3	Fresh Air Content/SAM	AASHTO T 152, T196, TP 118	≥ 4% Air; SAM ≤ 0.2	%, psi	Yes	Yes			
	6.5.2.1	Time of Critical Saturation	"Bucket Test" Specification	30	Years	Yes	No	Note 1	Note 2	Variation controlled with mixture proportion observation or F Factor and Porosity Measures
	6.5.3.1	Deicing Salt Damage	~	35%	SCM	Yes	Yes	Choose one		Are calcium or magnesium chloride used
	6.5.3.2	Deicing Salt Damage	AASHTO M 224	~	Topical Treatment	Yes	Yes			Are calcium or magnesium chloride used, use specified sealers
	6.5.4.1	Calcium Oxychloride Limit	Test sent to AASHTO	< 0.15g CaOXY/g paste		Yes	No			Are calcium or magnesium chloride used

Specification Basics – Transport Properties

Section 6.6

Section		Property	Specified Test	Specified Value		Mixture Qualification	Acceptance	Selection Details	Special Notes
6.6 Transport Properties									
	6.6.1.1	Water to Cementitious Ratio	~	≤ 0.45 or ≤ 0.50	~	Yes	Yes	Choose Only One	The required maximum water to cementitious ratio is selected base on freeze-thaw conditions.
	6.6.1.2	Formation Factor	Table 1	≥ 500 or ≥ 1000	~	Yes	Yes		Based on freeze-thaw conditions. Other criteria could be selected
	6.6.2.1	Ionic Penetration, F Factor	Appendix X2	25 mm at 30 year		Yes, F	through ρ		Determined using guidance provided in Appendix X2.

Specification Basics – Aggregate Stability

Section 6.7

Section	Property	Specified Test	Specified Value		Mixture Qualification	Acceptance	Selection Details		Special N
6.7 Aggregate Stability									
6.7.1	D Cracking	AASHTO T 161, ASTM C 1646	~	~	Yes	No			
6.7.2	Alkali Aggregate Reactivity	AASHTO PP 65	~	~	Yes	No			

Specification Basics – Workability

Section 6.8

Section	Property	Specified Test	Specified Value	Mixture Qualification	Acceptance	Selection Details		Special Notes
6.8 Workability								
6.8.1	Box Test	Appendix X3	<6.25 mm, < 30% Surf. Void		No			
6.8.2	Modified V-Kelly Test	Appendix X4	15-30 mm per root seconds		No			

Specification Basics

- Specification describes process and choices
- Includes acceptance requirements
- Includes quality control provisions
  - Contractor submits quality management plan
  - Some minimum requirements listed

Specification Basics

- Appendices for new and emerging test methods
  - Cracking and volume change
  - Formation factor and pore solution resistivity
  - Box test
  - V-Kelly test
  - Transport and pore structure
  - Commentary

Specification Basics

- Commentary (60 pages)
  - Detailed discussion of each section
  - References for more detailed background

Next Steps

- AASHTO Subcommittee on Materials balloting as a Provisional Standard
  - Will be dynamic for several cycles
- Lead states assisting in demonstration and shadowing on existing projects
- FHWA Mobile Concrete Trailer demonstrating new equipment and test methods
- Workshops to introduce concepts

Next Steps

- Provisional Standards can be modified as new methods are developed, and as we learn from early adopters

Conclusion

- Why do this?
  - Agency can custom design mixtures to meet the needs that exist
  - Research produced new test methods
  - Allows for better risk allocation
  - Allows for innovation
  - Shares responsibility for performance with industry

Thank You