

Field Study of Air Content Stability in the Slipform Paving Process

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applied pavement TECHNOLOGIES
providing engineering solutions to improve pavement performance

Why is Air Entrained in Concrete?

- An entrained air-void system is essential to protect paving concrete against F-T damage
- Microscopic spherical air bubbles are entrained in concrete through the use of AEA
- Although the volume of the air is important, the size and spacing of the bubbles is more important
 - Critical spacing factor is thought to be between 0.008 in (0.200 mm) and 0.010 in (0.250 mm)

Saturation and Freeze-Thaw Damage

Resistance to Frost (%)

Degree of Saturation (%)

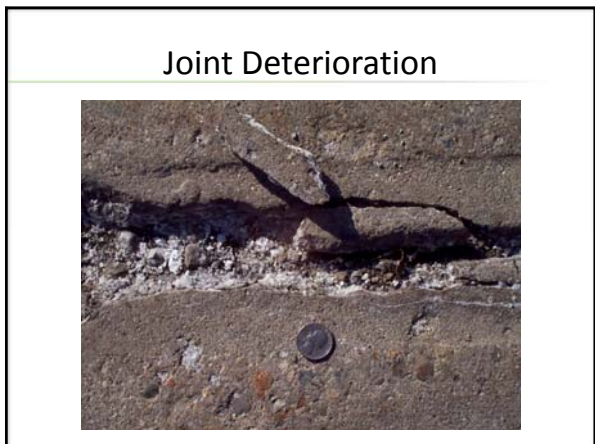
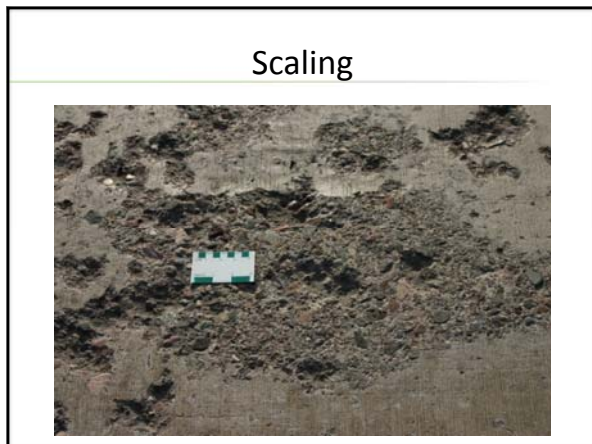
Good Durability

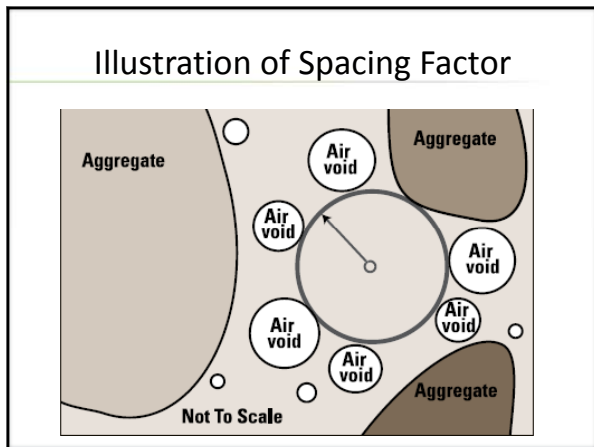
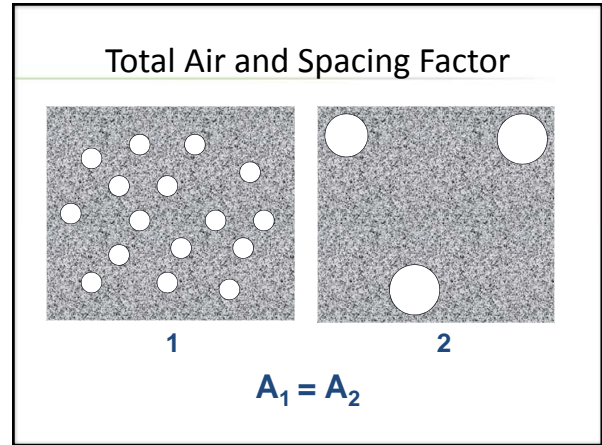
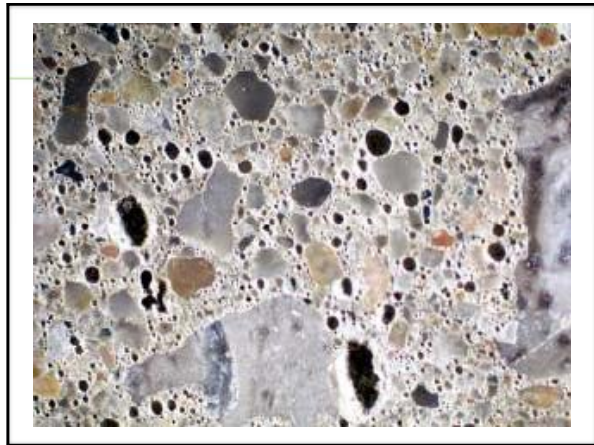
Poor Durability

There is a critical saturation that makes concrete susceptible to repeated F-T

After CEB 1957

Fundamental Premise
If it is not saturated it will not develop damage

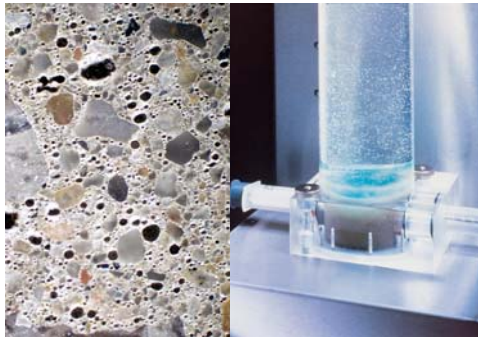




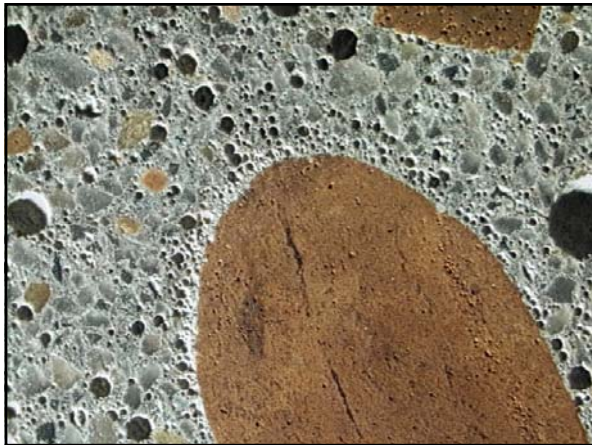
How is Air Measured?

- 🔍 Air content of fresh concrete is most often measured using the pressure meter
 - Measures total air content, and not the air-void system characteristics
 - Some use the AVA to assess air-void system parameters in fresh concrete – mixed results
- 🔍 Air-void system parameters in hardened concrete are estimated using stereomicroscopy (ASTM C457)
 - Automated methods exist

Air-Void Analyzer



Air-Void System Analysis



Pressure Meter

- 🔍 Familiar
- 🔍 Valid for normal density aggregate
- 🔍 Gives only total air content; no details of air void system
 - Some concerns exist regarding the ability of pressure meter to pick up the smallest air bubbles



Air Entraining Admixtures

- 🔍 AEA are surfactants that work at the air-water interface, reducing surface tension and thus forming stable bubbles upon agitation
- 🔍 The AEA do not create air bubbles, agitation creates the bubbles that are stabilized by the AEA



Vinsol® Resin Air Entraining Admixture

- 🔍 Traditionally, this is the most common AEA
- 🔍 Create very stable bubbles
- 🔍 Attracted to cement grains, fixating the bubble while creating a calcium salt hydration shell



Synthetic Detergent Air Entraining Admixtures

- 🔍 Synthetic detergents are becoming more common
- 🔍 Not necessarily attracted to cement grains
- 🔍 Not compatible with some HRWRA
- 🔍 Can easily be overdosed
 - Can “build air” if mixing continues



Construction Factors

- 🔍 Mixer type and duration have an impact on the creation of the air bubbles
 - Sufficient mixing must occur to mobilize most of the AEA (typically 1 minute)
 - Additional mixing will reduce air content
 - Retempering can result in air void clustering



Construction Factors

- 🔍 For a given concrete plant, the ability to entrain air in concrete is impacted by many variables
 - Temperature
 - Alkalinity
 - Presence of activated carbon (fly ash)
 - Other admixtures
- 🔍 Air is typically lost when concrete is transported and placed



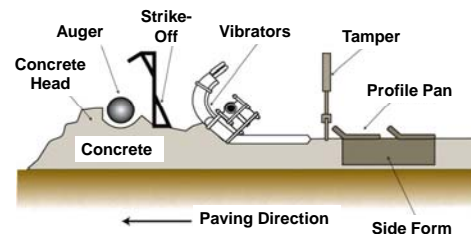
Questions Requiring Answers

- 🔍 What air content and air-void system parameters are required to protect concrete against F-T damage?
- 🔍 What Mechanisms lead to air void instability?
 - Particularly for synthetic detergent AEA which might not form a hydration shell
 - Incompatibilities with different cements, fly ash, and/or HRWRA (MRWRA?)
- 🔍 How is air void clustering and “building air” prevented?



Questions Requiring Answers?

- 🔍 What is the impact of mixer type on the creation of the air-void system?
 - Know we can get total air content, but is an adequate air-void system created in each mixer
- 🔍 What is the impact of slipform paver type on air loss through paver?
 - How much is the paver and how much is the mix?



New WisDOT Project

- 🔍 Variables considered include paver type, plant type, AEA type, coarse aggregate type
 - Variables not considered include cement type, fly ash type, WR type
- 🔍 Currently trying to identify projects and contractors to work with this summer to conduct field work
 - Looking for 12 projects



Air Entraining Admixture		Vinsol Resin		Non-Vinsol Resin	
Coarse Aggregate Source		Gravel	Limestone	Gravel	Limestone
Paver	Plant				
G&Z S850	Rexcon		X		X
	Erie-Strayer		X		X
GHP 2600	Rexcon		X		X
	Erie-Strayer				
GHP 2800	Rexcon	X		X	
	Erie-Strayer				
Rexcon Town and Country	Rexcon	X	X	X	X
	Erie-Strayer				

Fieldwork

- 🔍 Should be initiated in May 2011
- 🔍 Will include field monitoring of air content and unit weight before and after the paver and cylinders will be made for future analysis
 - CP Tech Center, Purdue, and Michigan Tech also want to piggy-back material sampling from the plant as part of another project
- 🔍 Cores will be extracted from the finished pavement for analysis



Summary

- 🔍 Lots of unknowns exist regarding the creation and stability of the air-void system
- 🔍 New WisDOT project will address some of the unknowns with respect to impact of the concrete plant and paver
- 🔍 Need to find 12 potential projects for fieldwork this summer

