Joint Durability
Where Next?

Peter Taylor
The problem?

• Some joints are deteriorating faster than we would like
Outline

• Mechanisms of Failure
• Why Now, What’s New?
• Current Recommendations
• What we don’t know
• Education needed
What Do We Know?
Saturation
Saturation

• Damage occurs where the concrete does not dry out
The Symptoms

- Shadowing
- Thin flakes
Saturation

- Microcracking/Shadowing
Saturation

- Bottom-Up Moisture
Saturation

• Tunneling – water trapped in saw-cut
Saturation

• Top-Down
Purdue Work

• Depends on degree of saturation
Salts increase saturation
Purdue Work

• Some salts prevent drying

Drying of Concrete With Salt Solutions

• One-sided condition, 50 +/- 2% RH, 23 +/- 1°C
• Lower or no water loss or gain with higher salt concentrations
• Drying behavior explained by differences in solution and environmental RH

Spragg et al 2010
Salts can cause chemical attack

• Rates and amount are limited though
Incremental Cracking
Incremental Cracking
The Symptoms

• Not typical freezing and thawing
Interfacial Zone
What’s new?
Questions

- Why now?
  - Salting / Brines
  - Marginal air in situ
  - Marginal w/cm
Questions

- Why in some joints
  - Batch variability
  - Drainage
  - Salt treatment
  - Hand placed
Ames, IA

- Non-distressed joint
  - Spacing factor: 0.007in
  - w/cm: 0.40 to 0.45
- Distressed joint
  - Spacing factor: 0.005in
  - w/cm: 0.42 - 0.47
I-275, Two Sites, Varying Performance

- Site 2 - showing deterioration at joint
- Site 4 - not exhibiting deterioration at joint
Summary

• Site 2
  – Poor air-void system
  – Alkali-silica reaction with fine aggregate particles and related cracks extending into hardened paste, but only within the top inch
  – Low paste density, high chloride ingress

• Site 4
  – Adequate air-void system
  – Alkali-silica reaction with fine aggregate particles, but without cracks extending into hardened paste
  – Higher paste density, lower chloride ingress
So...

- The game has changed
  - Water has to be prevented from saturating the concrete
  - Permeability of the concrete should be as low as practical
  - The air void system in the in-place concrete must be adequate
Design

- Drainage
  - Avoid bathtubs
- Drainage
  - Make sure surface water can get away
- Drainage
  - Prevent ground water from getting in
Seal?

- Avoid joint details with reservoirs
- Maintain them
Unsealed Joints
46% cracked panels

Sealed Joints
5% cracked panels

T. Burnham, Mn/DOT 2011
The Mixture

• 5% minimum **behind the paver**
• 0.40 max w/cm
• Use appropriate SCMs
Why 0.4?

➢ Keep the water out

- Connectivity of capillaries increases with higher $w/cm$
Workmanship

- Curing (poly-alpha-methylstyrene)
- Consider topical surface sealants
- Choose salts carefully
- Maintain drainage systems
Repairs

- Depends on damage
- Need NDT

A. Damage in top third
B. Damage below the saw-cut
C. Damage from the bottom
D. Full depth damage
Help

- Local visits
- Education (RMC & PCA grants)
- Specifications