Joint Durability Where Next?

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The problem?

- Some joints are deteriorating faster than we would like

Outline

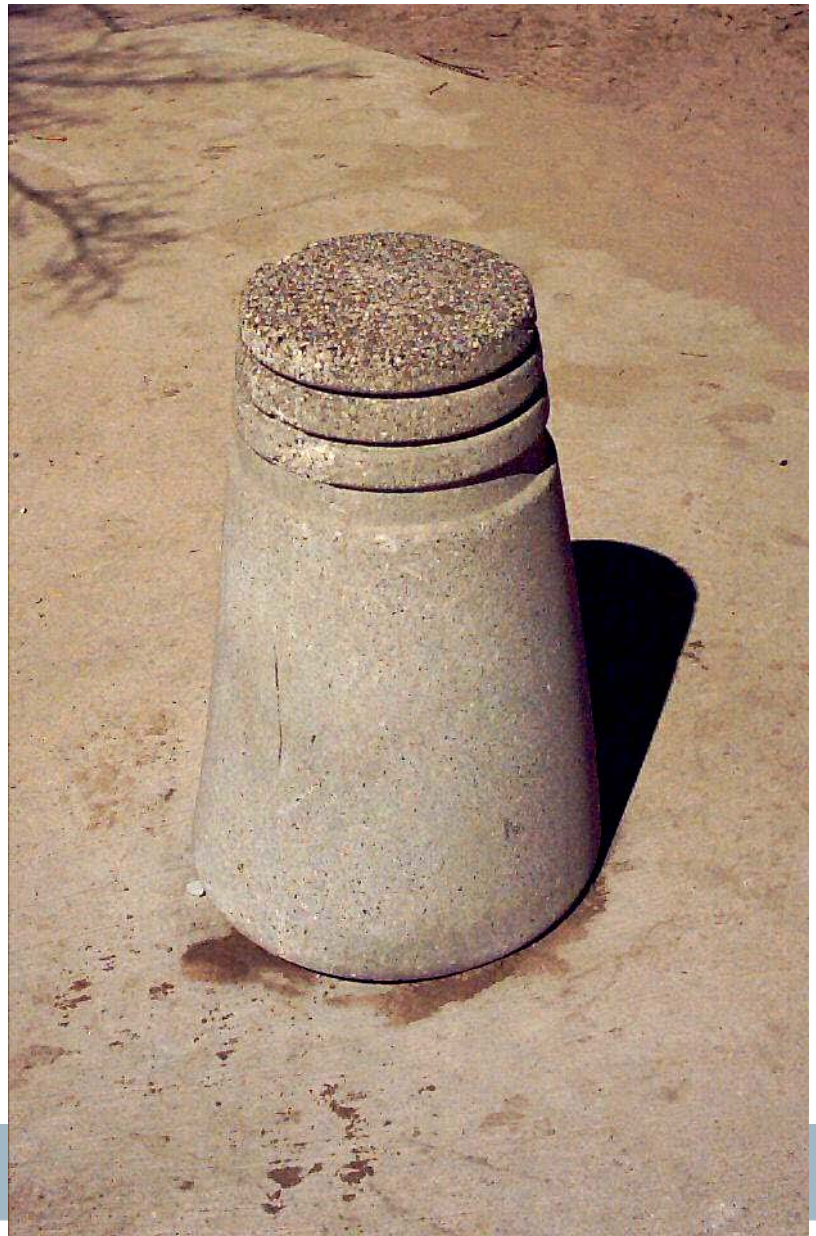
- Mechanisms of Failure
- Why Now, What’s New?
- Current Recommendations
- What we don’t know
- Education needed

What Do We Know?

Saturation

Saturation

- Damage occurs where the concrete does not dry out



The Symptoms

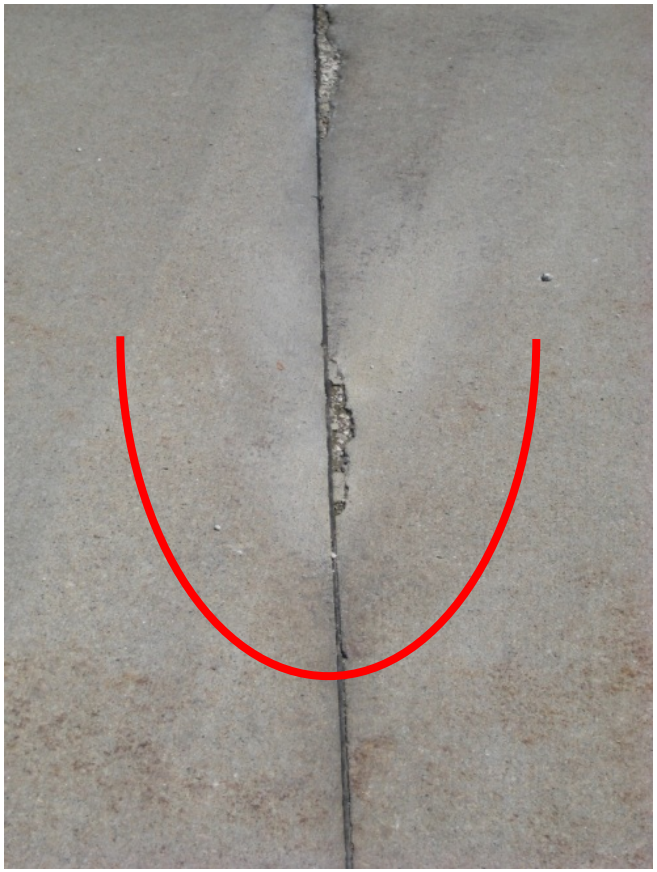
- Shadowing
- Thin flakes

Saturation

- Microcracking/Shadowing

Saturation

- Bottom-Up Moisture



Saturation

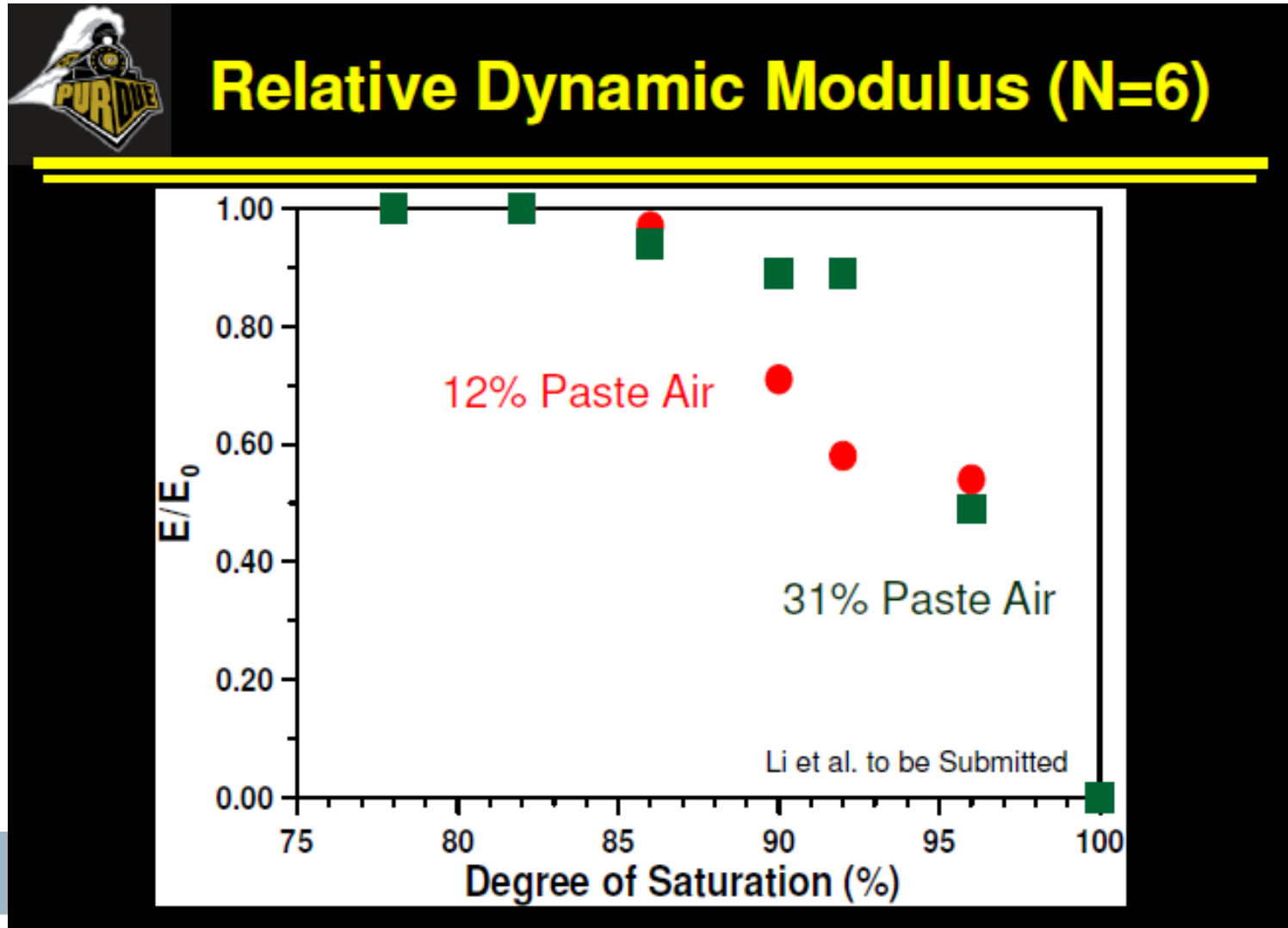
- Tunneling – water trapped in saw-cut

Saturation

- Top-Down

Purdue Work

- Depends on degree of saturation



Jason Weiss

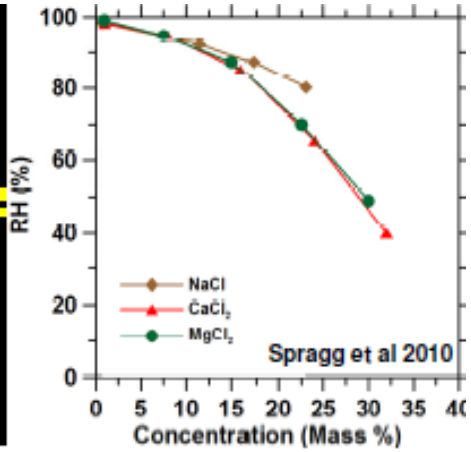
Salts increase saturation

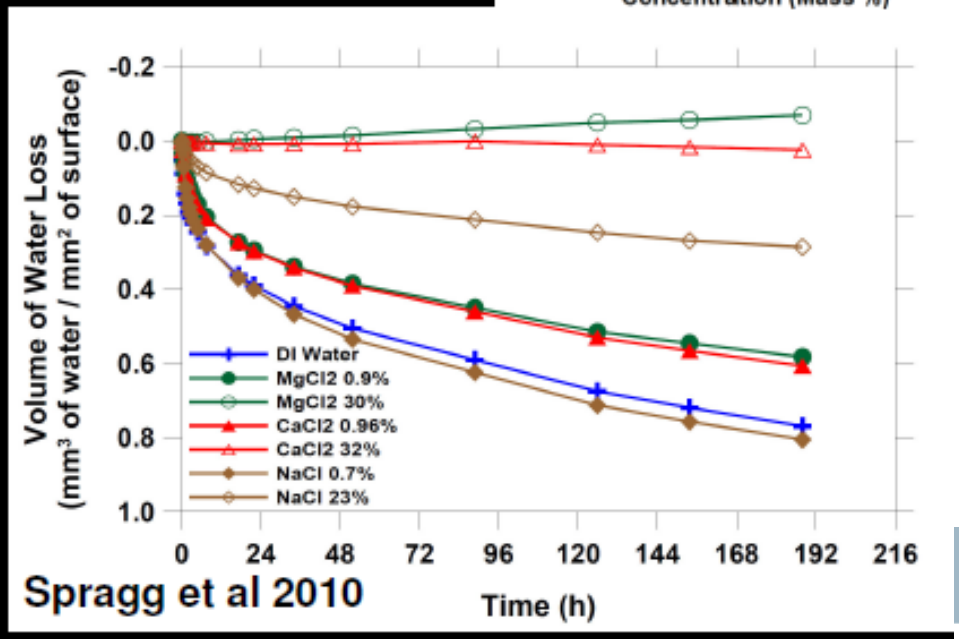
Purdue Work

- Some salts prevent drying

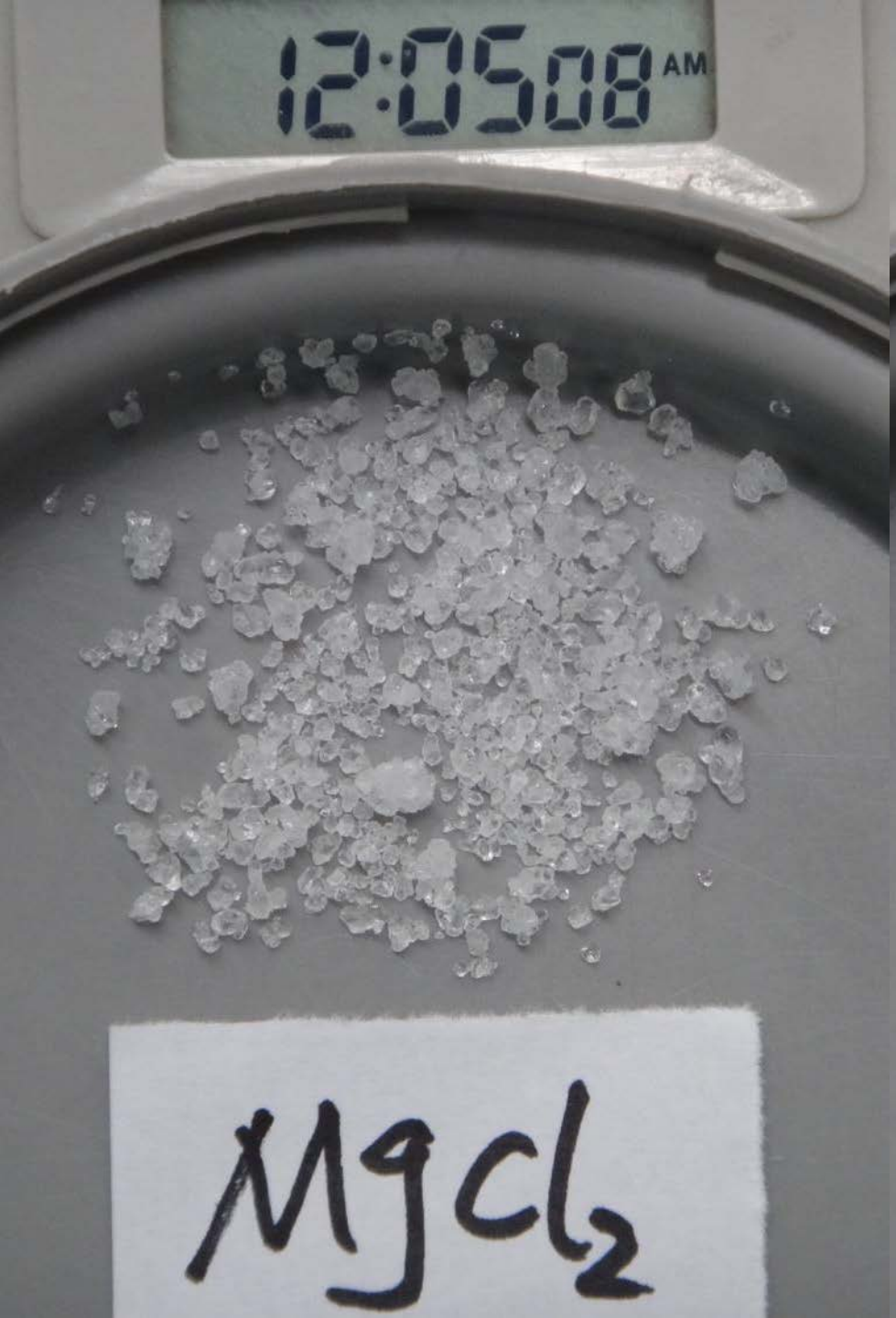
Drying of Concrete With Salt Solutions

- 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





Jason Weiss

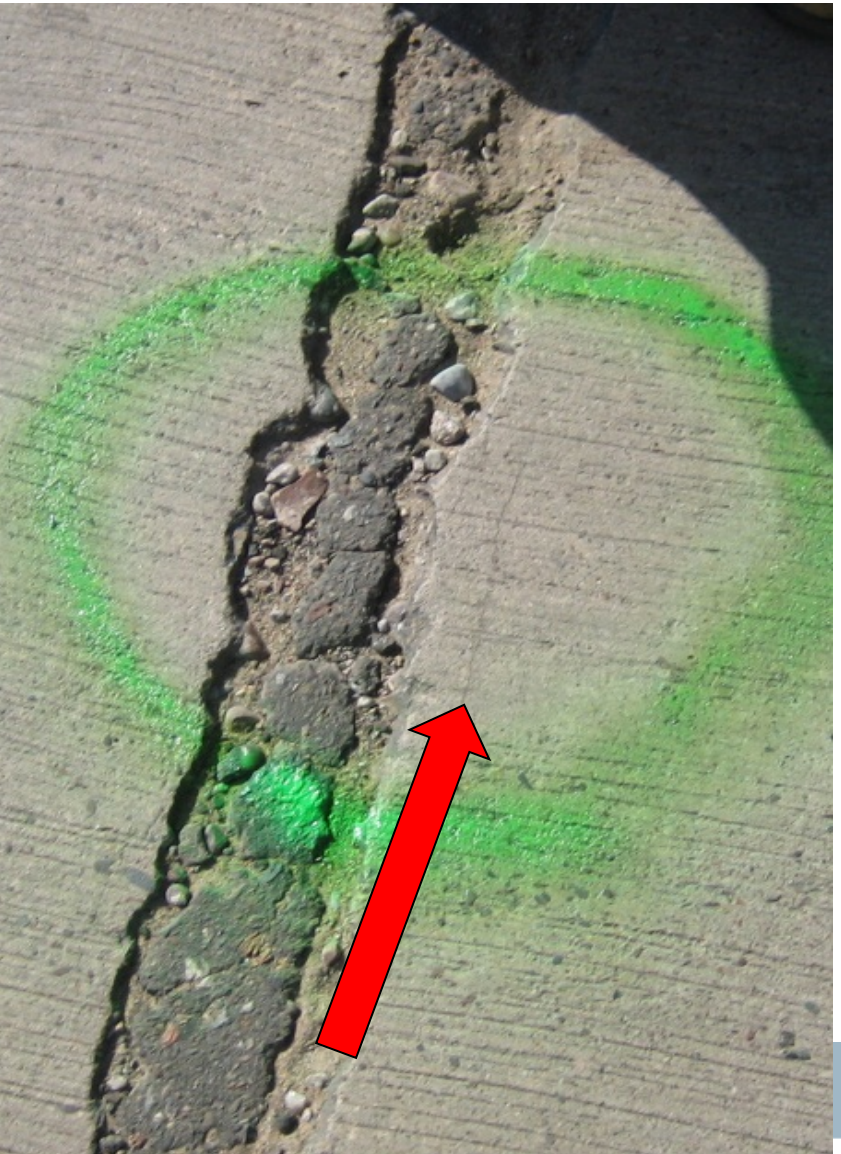

12:05 08 AM
MgCl2


4:00 27 AM
MgCl2

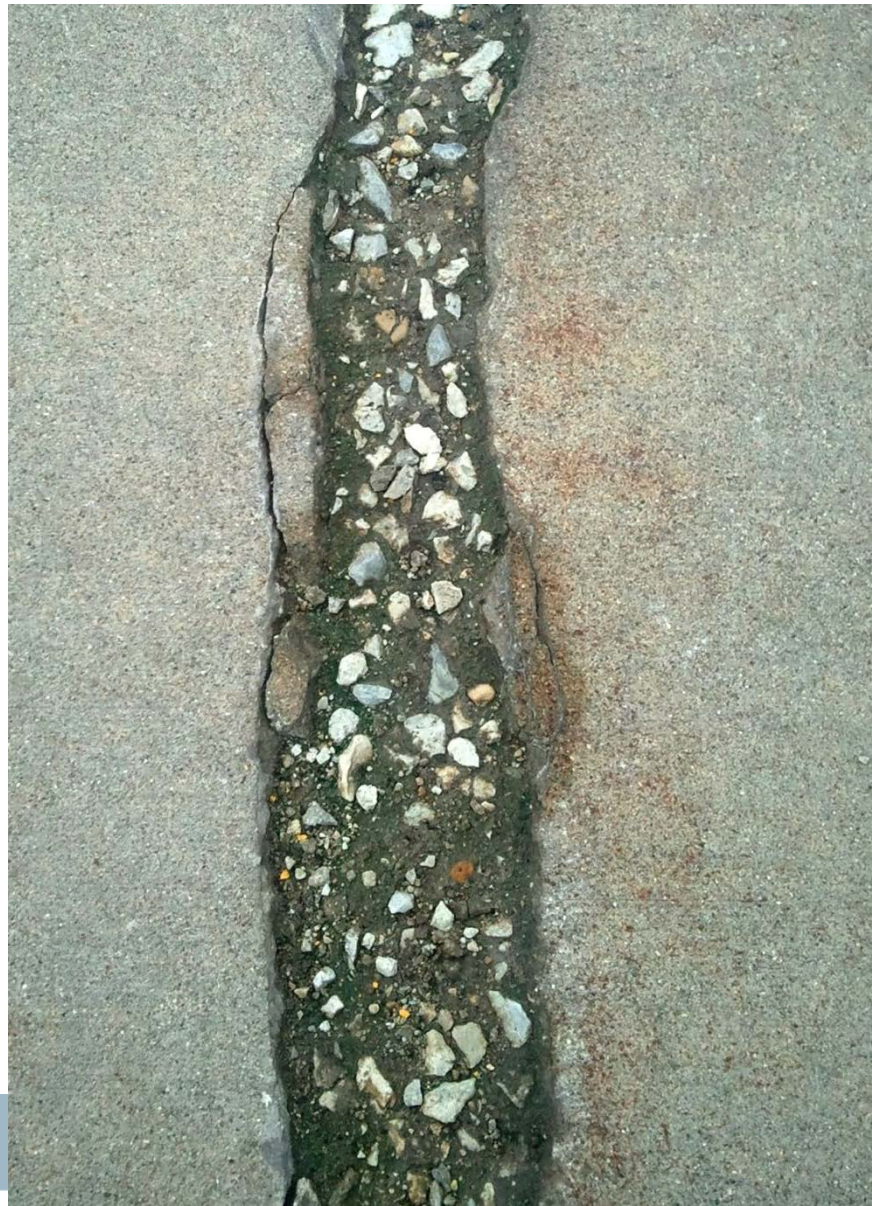
Salts can cause chemical attack

- Rates and amount are limited though

Incremental Cracking



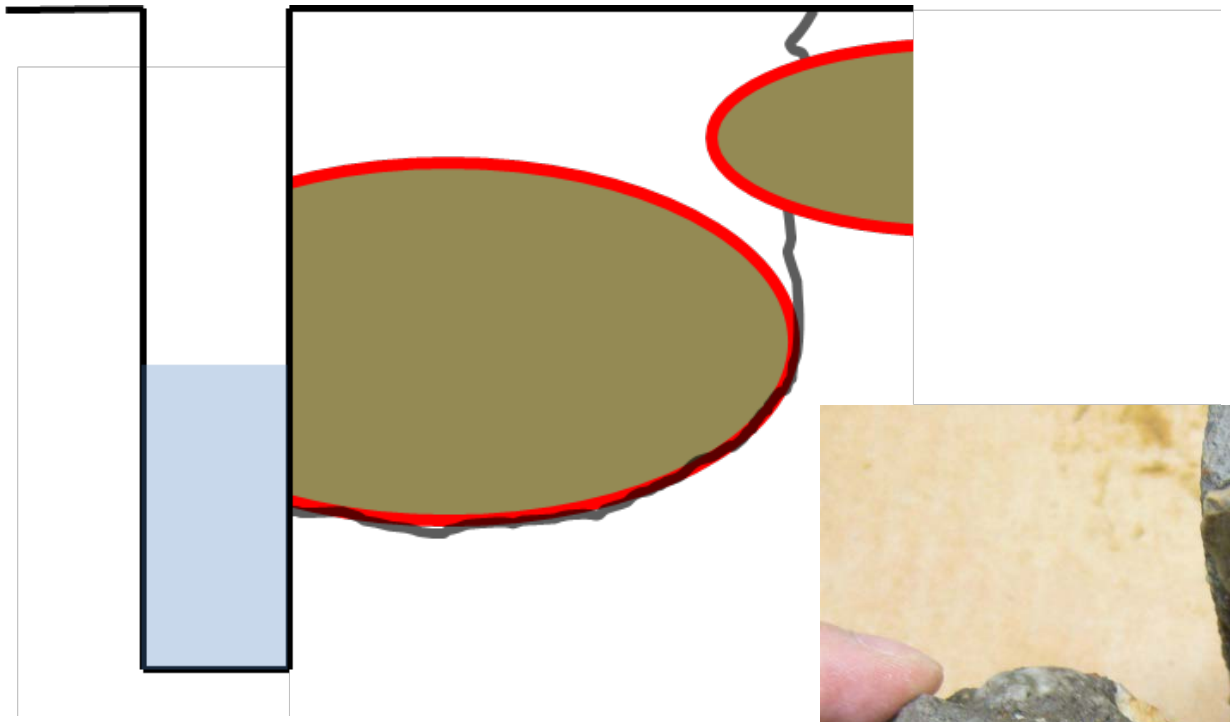
Incremental Cracking



The Symptoms

- Not typical freezing and thawing

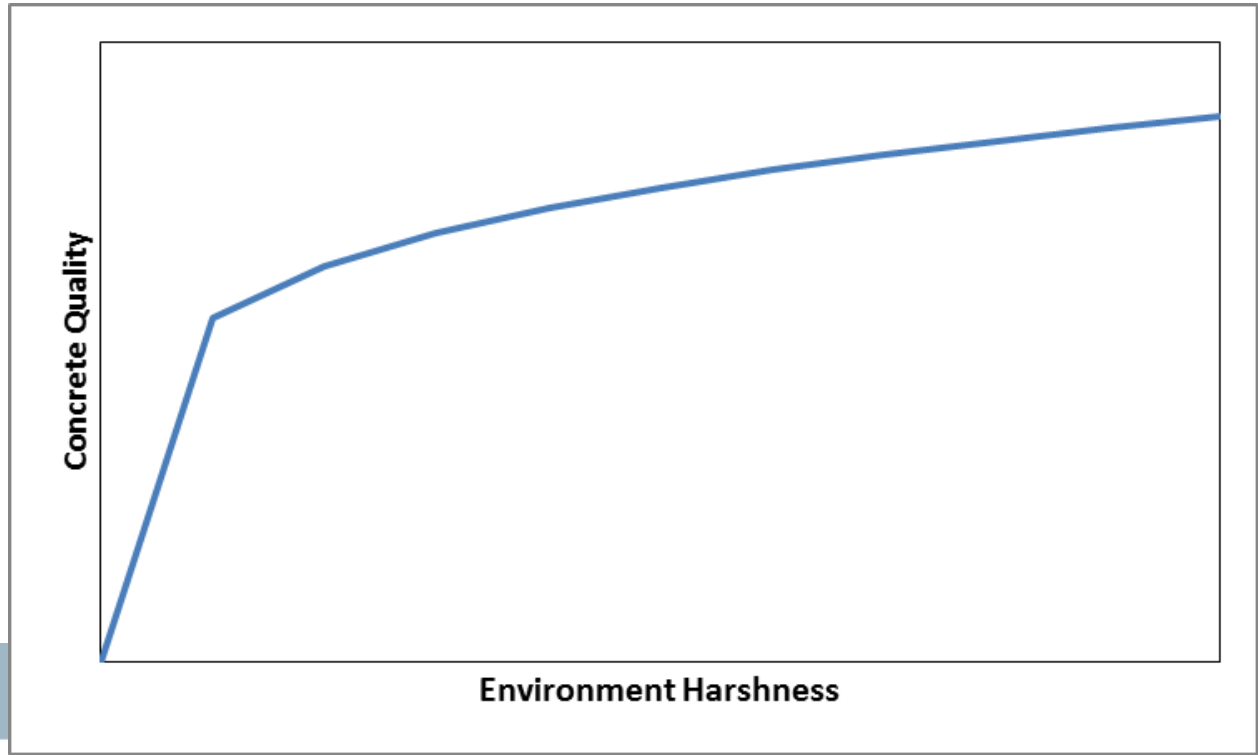
Interfacial Zone



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

Site 2

Site 4

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

MN Road

Unsealed Joints

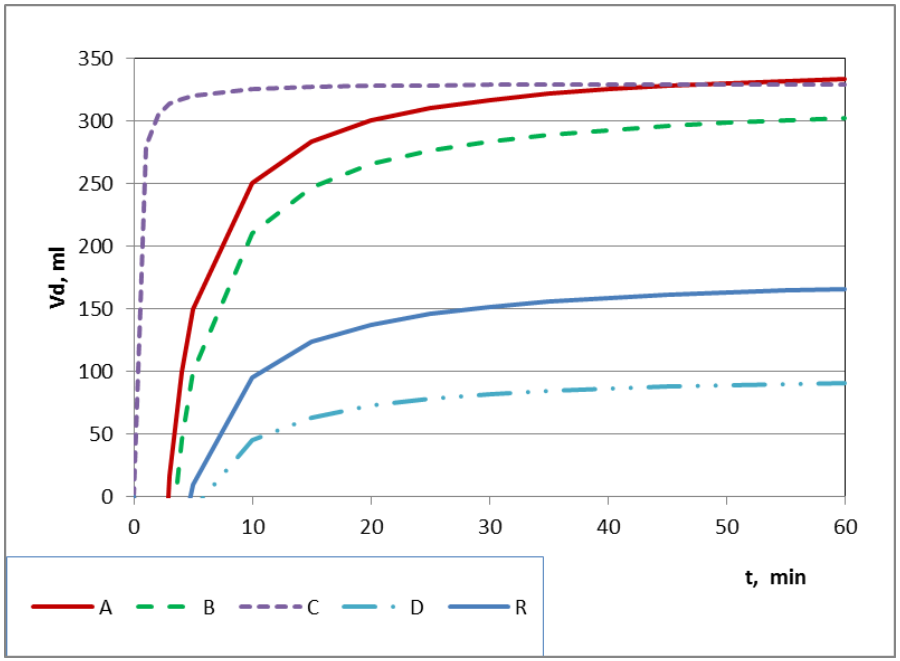
46% cracked panels

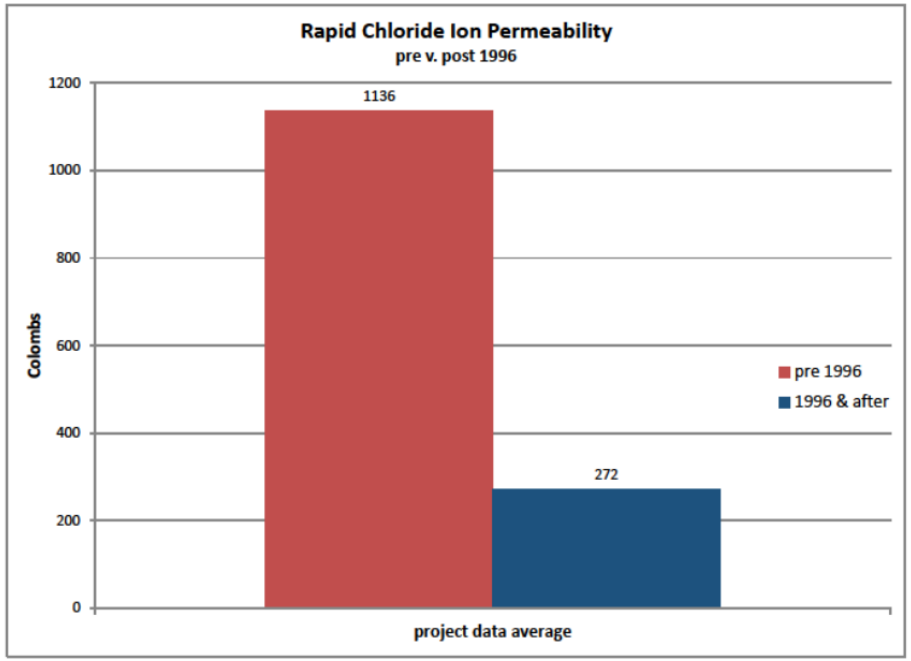
Sealed Joints

5% cracked panels

The Mixture

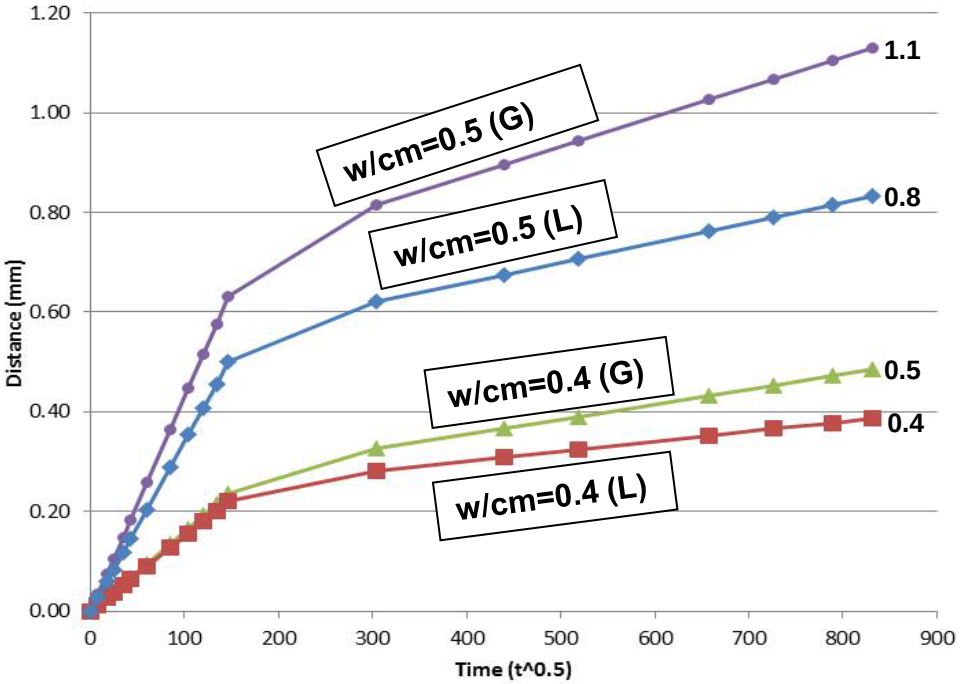
- 5% minimum <u>behind the paver</u>
- 0.40 max w/cm
- Use appropriate SCMs





Why 0.4?

- **Keep the water out**
  - Connectivity of capillaries increases with higher w/cm

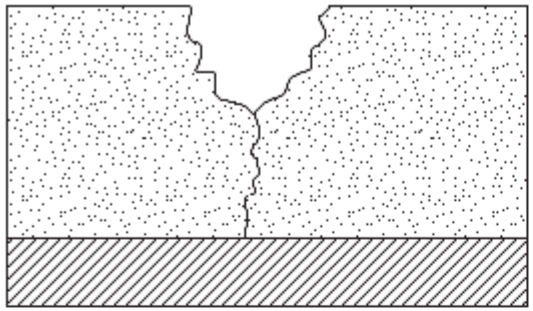


Workmanship

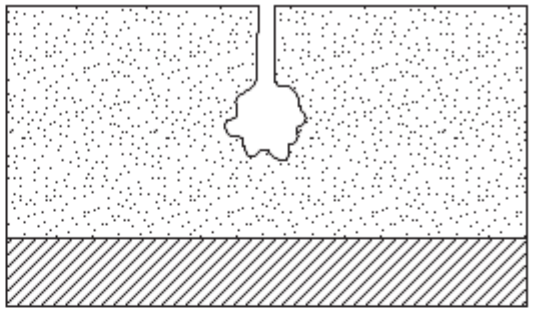
- Curing (poly-alpha-methylstyrene)
- Consider topical surface sealants
- Choose salts carefully
- Maintain drainage systems

Repairs

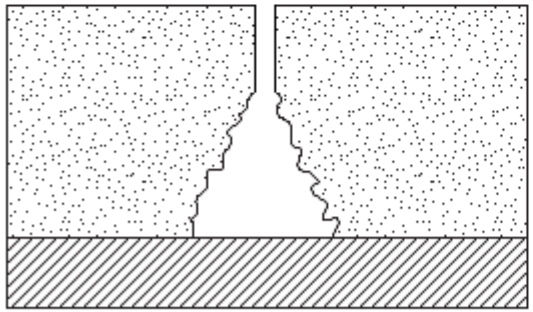
- Depends on damage
- Need NDT



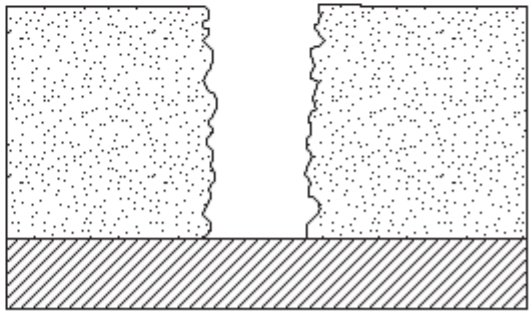
A. Damage in top third



B. Damage below the saw-cut



C. Damage from the bottom



D. Full depth damage

Help

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