

# Alkali Carbonate Reaction An Ongoing Study

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National Concrete Pavement  
Technology Center



IOWA STATE UNIVERSITY  
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# The Problem

Midwest suburban city

Residential developments built in 2000's

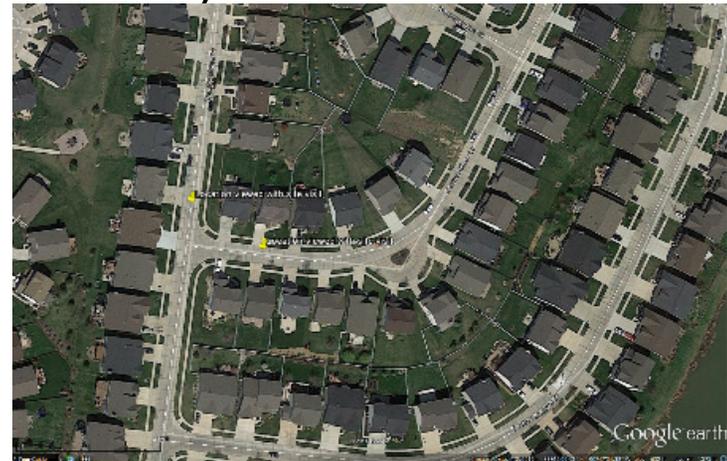
Unknown quarries

“DOT Approved aggregates”

Paste specs look OK (air / w/cm / SCM)

6” thick on clay

Looked OK 3-5 years ago



Google Maps

# The Problem



Major map-cracking on the slab

June 30, 2016



Minimal map-cracking on the slab

Late 2013

City Engineer

# The Problem

Abundant water

Damage is not at the low points

Curbs, driveways and sidewalks are fine

Localized distress

Considerable slab movement

Faulting



# The Problem

## Progression:

- Map cracking
- Surface discoloration/calcite
- Concrete loss
  - Cracks go around aggregates
  - Abundant calcite/gel



# The Problem



City Engineer

# The Problem



City Engineer

# The Problem



# The Problem



# Potential Causes

## Dueling petrographers

- ACR
- ASR
- Varied air void system
- Varied w/cm
  
- Add irrigation
- Add freeze thaw
- Add deicing salts



# ACR – Characteristics

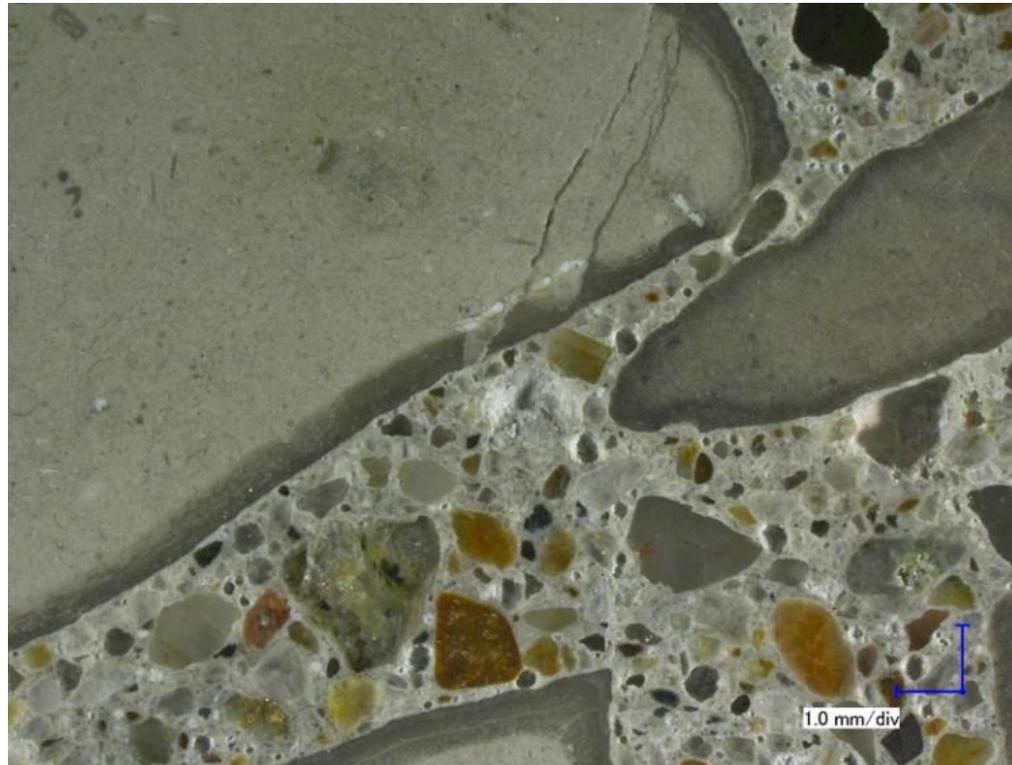
*Diagnosis and Control of Alkali-Aggregate Reactions in Concrete, p. 16, PCA, 2007*

Argillaceous dolomitic limestone contains calcite and dolomite with appreciable amounts of clay and can contain small amounts of reactive silica. Alkali reactivity of carbonate rocks is not usually dependent on clay mineral composition. Aggregates have potential for expansive ACR if the following lithological characteristics exist:

- clay content, or insoluble residue content, in the range of 5% to 25%
- dolomite content (percentage in carbonate fraction) in the range of 40% to 60%
- interlocking dolomite grains (late expansion)
- small size (25 to 30  $\mu\text{m}$ ), discrete dolomite crystals (rhombs) suspended in a clay matrix

# ACR

- Rim around the dolomitic aggregate
- Crack in the aggregate



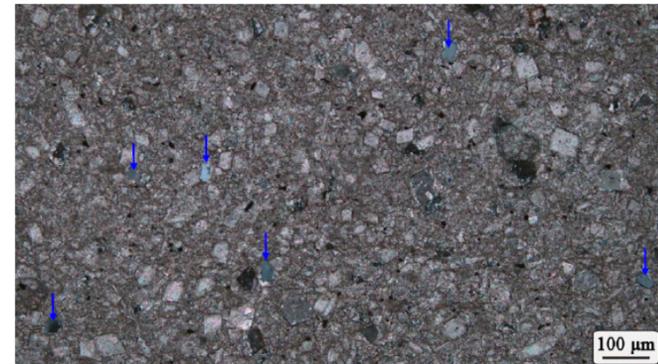
CRT, LLC

# ACR

## Characteristics:

- Rhombic aggregate
- Fly ash does not help
- No gel
- Mechanism is debated
- Tough to detect in the aggregate

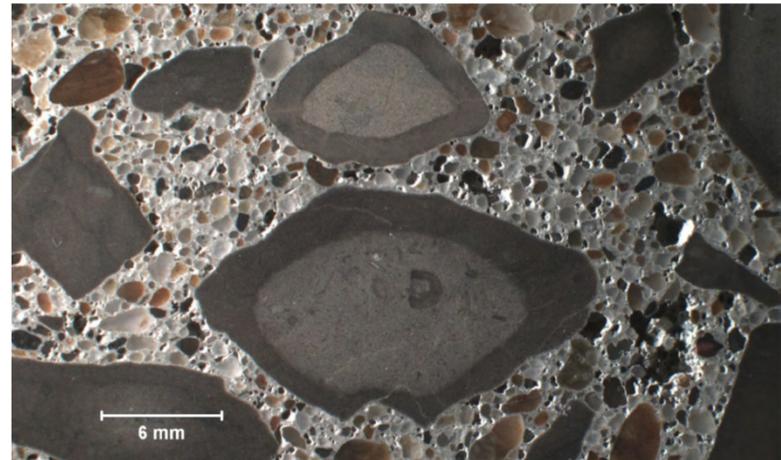
CRT, LLC



# Aggregate Evaluation

Aggregate sample received – similar to that in the cores:

- Clay content = high
- Void size distribution = poor
- ASTM C 1260 = pass



# ASR

Cracks start in aggregate  
Gel deposits



# Paste Characteristics

Air void system varies

- Air content 4 to 8%
- Spacing factor: 0.021 & 0.013 inch ( $>0.008$ )

w/cm varies

- 0.42 to 0.60



# Summary

Appears to be a combination

- Which came first?
  - Debated
- Who started it?
  - Debated

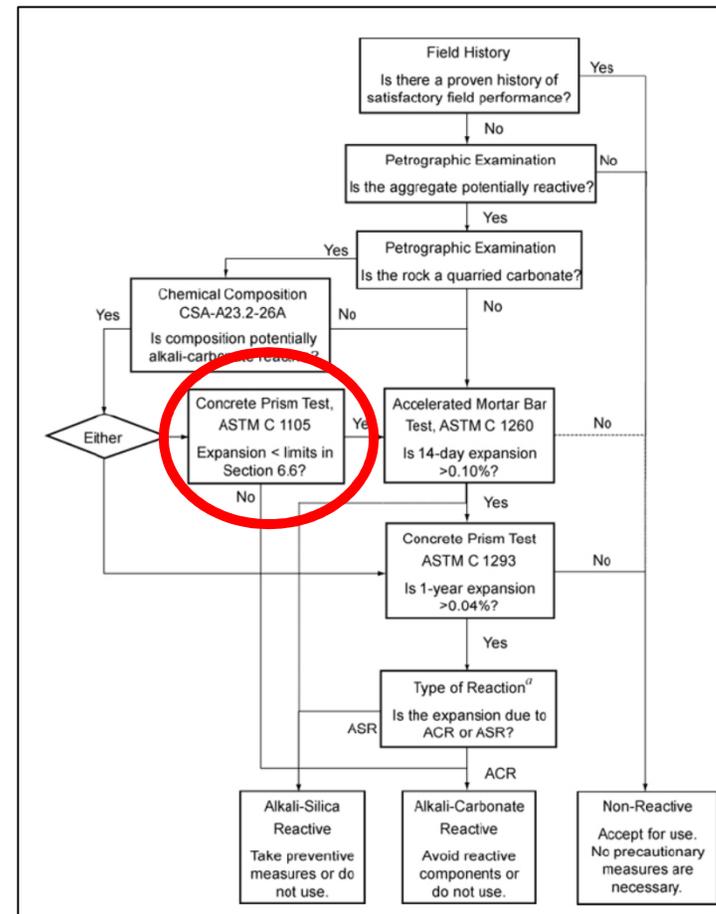
Questions to be addressed

- Is it an aggregate issue?
- How do we identify the aggregate?
- What about the paste?

# Prevention in new concrete

## AASHTO R 80-17 Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Prevention Deleterious Expansion in New Concrete Construction

- Does current DOT practice catch ACR?
  - Maybe not
- Ledge control?
  - Blending

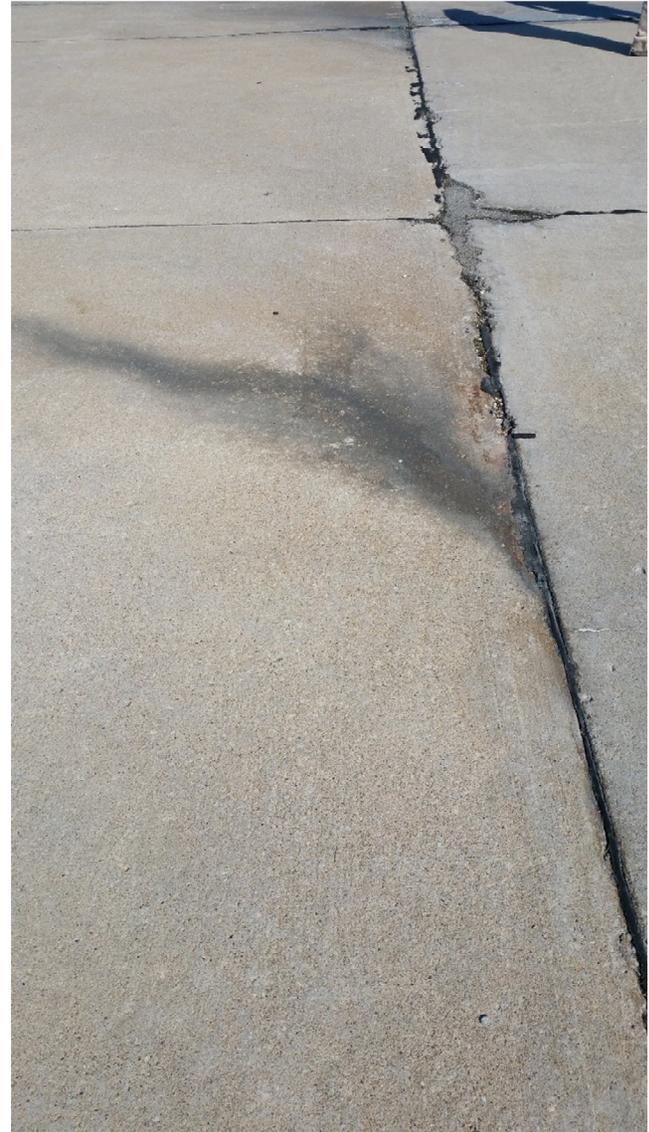


# Mitigation

Will this section go bad?

When?

Can we prevent it?



# Repair

Remove and replace

Partial depth repair

Overlay

Penetrating seal



# Should We Ignore Gravels

## Convict Road

- Built in 1914
- \$30,000/mile
- 6"- 8" thickened edge
- 1.5 miles
- 16' wide
- 20 man crew
- 40 cents/hour
- First use of Baker-type expansion joint at 30' spacing



Fredonia, Iowa  
Hanson, IDOT 2017

# Thanks for your time



[www.cptechcenter.org](http://www.cptechcenter.org)

