Alkali Carbonate Reaction
An Ongoing Study

51st Annual Mid-Atlantic Quality Assurance Workshop
February 13-15th, 2018
Dover, Delaware

Steven L. Tritsch, P.E.
stritsch@iastate.edu
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

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 μm), discrete dolomite crystals (rhombs) suspended in a clay matrix
ACR

- Rim around the dolomitic aggregate
- Crack in the aggregate
ACR

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