American Concrete Institute®
Advancing concrete knowledge

Recent Advances in ASR Test Methods and Understanding Mitigation Mechanisms, Part 1

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Alkali-Aggregate Reaction

What Our Current Approach Tells Us and What is Doesn't

Toy Poole, ACI Meeting Spring 2012

Toy S. Poole (1946 -)

- Education:
  - BS Chemistry, PhD Zoology
- 32 y - Corps of Engineers.
  - Retired 2010
  - Live in Austin, Texas
- Currently employed:
  - CTL Group
  - Consulting with Corps of Engineers
- ASTM since 1985
  - Committees C1 (cement) and C9 (concrete)
  - Board of Directors

What Current Guidance Does Do

- Major Improvements:
  - Identification of reactive materials
  - Identification of reasonable mitigation procedures
  - Development of reasonably comprehensive concrete specifications

Purpose of Presentation

One Facility
Owner's Perspective

A Little History on Guidance

7

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Historical - ASR: Before 1940

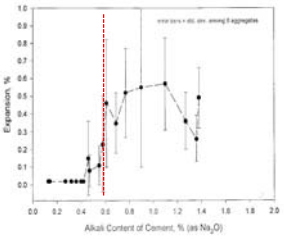
- ASR in Major Civil Works Projects
  - Parker Dam 1938
  - Copper Basin Dam – 1938
  - Coolidge Dam – 1928
  - Stewart Mtn Dam – 1930
  - American Falls Dam – 1927
  - Owyhee Dam – 1932
- Also Transportation Structures

Owhyee Dam - 1932

8

Historical - ASR: 1940 – early 1980's

- Identification
  - 1940 – first publications
  - Importance of cement alkalis →
- Low-alkali cement
  - ≤0.60% →
- Test methods
  - C 289 quick chemical
  - C 227 – mortar bar
  - C 441 – mod. C 227



Historical - ASR: Late 1980's – Present

- Problems in guidance
  - Test methods - detection errors
  - Specifications – insufficiently protective
- New TM's and Spec's
  - C 1260
  - C 1293 – reference condition
  - C 1567
- Field Service Record
- Comprehensive Concrete Specification
  - FWHA, ASTM

New Reference Condition?

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11

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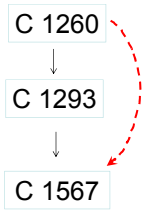
Commonly Used Scheme



- Mitigation
  - SCM's - primary
  - alkali's – deemphasized
- Specifications (ΔL%)
  - 0.10% mortar
  - 0.04% concrete

Historical - ACR

- Identification & Early Work
  - 1950's – 60's
  - Screening – chemistry, microscopy
  - C 586 – rock prism
  - C 1105 – concrete prism
- Sporadic work on mechanism
- Renewed interest

What Current Guidance Doesn't Tell Us

14

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Field Service Record

- C 33
- Rarely useful in practice
  - Variable conditions
  - Variable materials
  - Sufficient age (10 y)
  - Lack of records

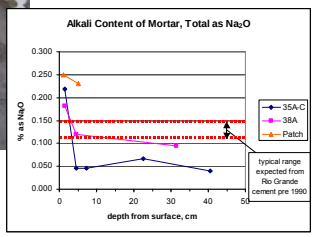
Some Materials Not Covered

- Blended cements
- C 1157 cements
- Lithium
- Specialty cements

Alkali Content of Materials

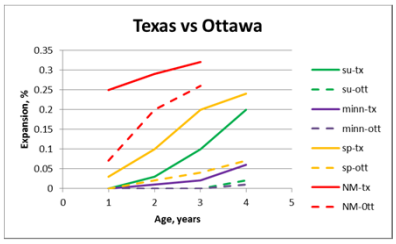
- Performance methods do not account for
  - Alkali-content of cements
- Alkali loading ~2 – 4 kg Na_2O_e/m^3
  - Based only cement alkalis
  - Low alkali cement
  - Alkalis in SCM's

Service Conditions: Alkali Redistribution



Service Conditions: Ambient Temperatures

ΔT = 15 °C



Different temperature activation among aggregates?

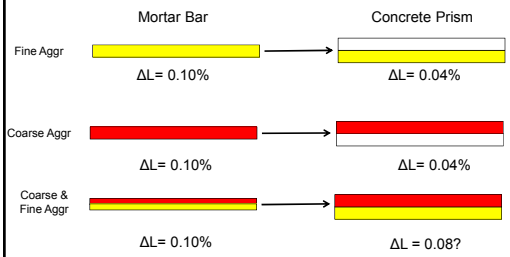
Lab Tests & Long-Term Projections

- Assumptions on Performance Tests
  - Alkali content simulates highest cement alkali condition
  - Test time-temperature simulate very long service conditions
- Translation: Lab - Field
  - Ottawa: 10 – 25 y ???
  - Texas: 5 – 10 y ???

Specificity of Test Methods: ASR vs ACR

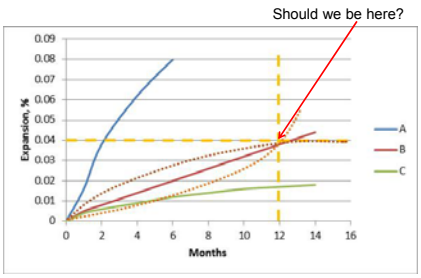
- Assumption: Methods are specific either to ASR or ACR
  - C 1260 is specific to ASR
  - C 586 is specific to ACR
  - C 1105 is specific to ACR

Combined CA – FA Testing



Is practice plausible?
Do we understand interactions?
Would we expect limits to be unchanged?

Details of Interpretation – e.g. C 1293



What Do We Need to Do?

- Maybe better record keeping and monitoring
- Develop better test methods
  - Alkali contents of materials
  - Non-standard materials
- Develop information on aggregate activation E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