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

ACI Spring 2012 Convention
March 18 – 21, Dallas, TX

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WEB SESSIONS

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Can Acoustic Emission be used to Detect Alkali Silica Reaction

by
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Prepared for
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March 18-22

Can AE detect ASR? Pour-Ghaz, Spragg. Castro, Weiss

OUTLINE

- Model system – Purpose: to illustrates that AE detects cracking due to expansion of inclusions and address the issue of coupling at higher temperatures
- Mortar – Purpose: to illustrate cracking due to ASR can be detected by AE
- Effect of geometry and temperature

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MODEL SYSTEM – COMPOSITE

- A two-phase composite of cement paste and acetate aggregate (Acetal)
- Thermal loading
- Different COTE
- Spherical inclusions
- Controlled experiment and cracking rate

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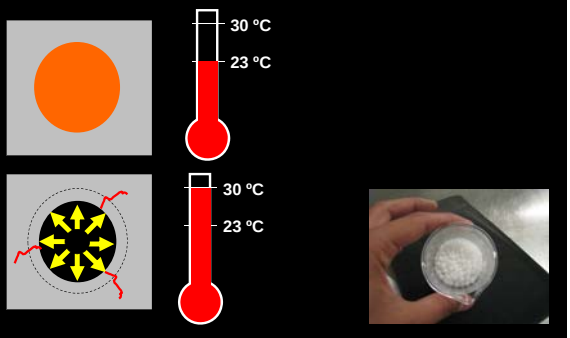
MODEL SYSTEM – LOADING



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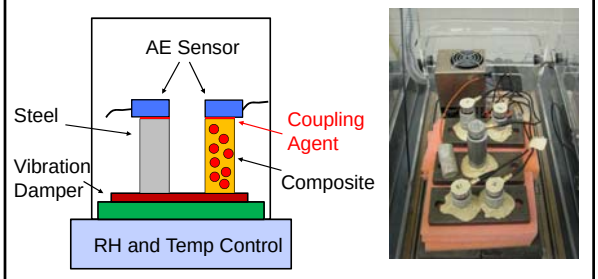
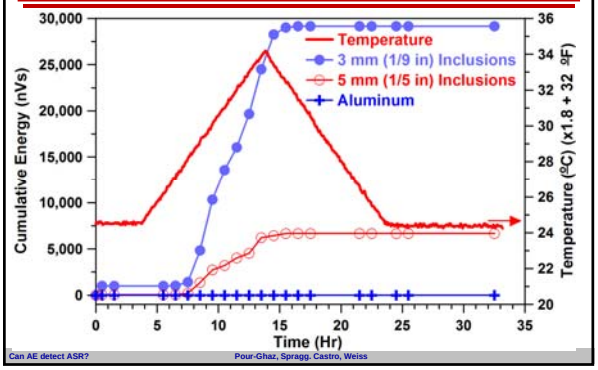
Model System – Experimental Setup



Model System - Results



Model System – Observations

- AE could detect cracking due to inclusion expansion (aluminum vs. composite)
- Coupling agent used was suitable for this experiment (sliding, decoupling, expansion of coupling agent are not an issue)

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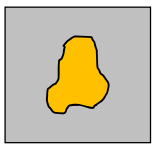
Mortar

- Aggregates are not spherical
- Mechanism of expansion is different
- Cracking may occur inside aggregates, at the interface, or in cement paste

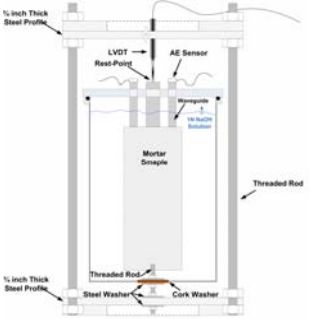


Mortar

- w/c = 0.47
- 55% aggregate by volume
- Jobe aggregate (Texas) – 0.67% after 14 days and 0.81% after 28 days; 0.1% less than 3 days (ASTM C1260)

Mortar – Experimental Setup

- 14.0 inch tall
- 4.0 inch diameter
- Fixture was placed in a RH and temp. controlled chamber



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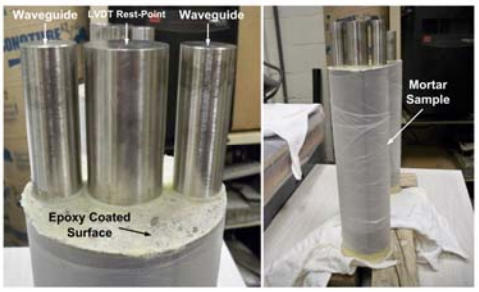
Mortar – Experimental Setup



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Experimental Condition

- 38±1°C (100±1°F)
- Solution and experimental fixture was temperature conditioned
- 6 hours after sample was placed
- Threshold of 42 dB
- Passive recording up to 24 days

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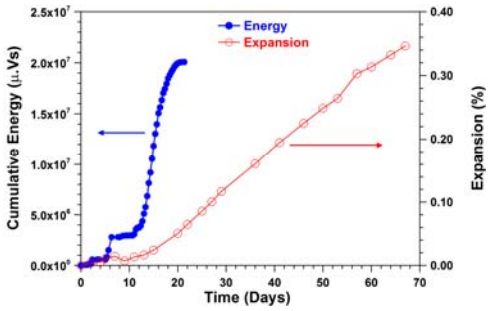
Mortar – Results



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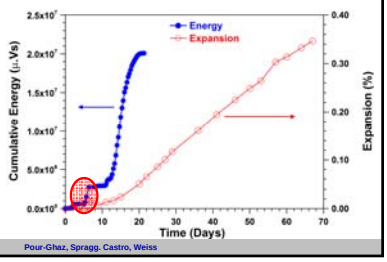
Mortar – Results 1

- Possible explanation: cracking within aggregate and cracking at the interface



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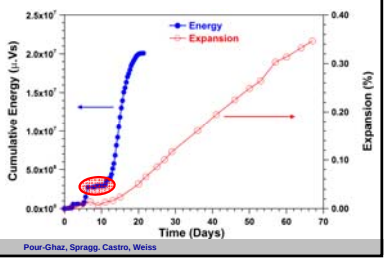
Mortar – Results 2

- Possible explanation: gel deposition in cracks



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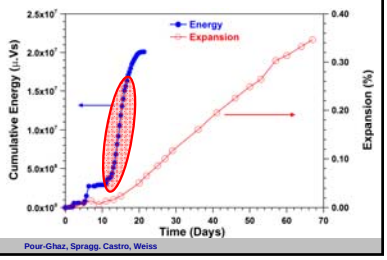
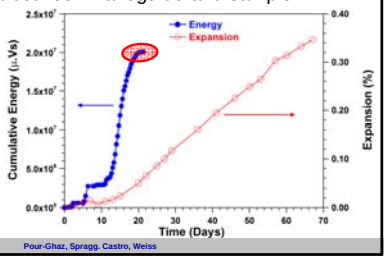
MORTAR – RESULTS 3

- Possible explanation: cracking of cement paste matrix and interface cracking



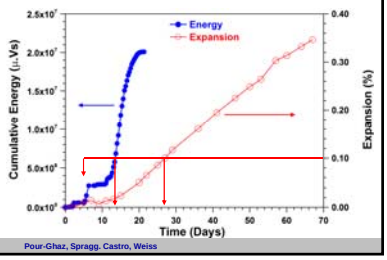
MORTAR – RESULTS 4

- Possible explanation:
  - Gel deposition in cracks
  - Elastic waves attenuation
  - Loss of contact between waveguide and sample
  - Combination



MORTAR – RESULTS 5

- Cracking preceded expansion at 38ºC
- ASTM C 1260 is at 80ºC



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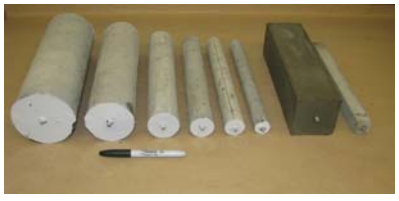
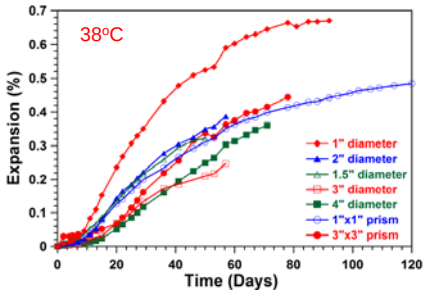
MORTAR – EFFECT OF GEOMETRY

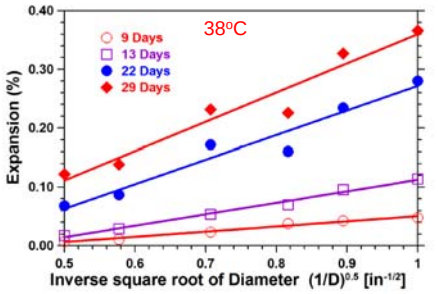
- In acoustic emission testing lager samples were used to obtain a more uniform distribution of cracking sites



MORTAR – EFFECT OF GEOMETRY

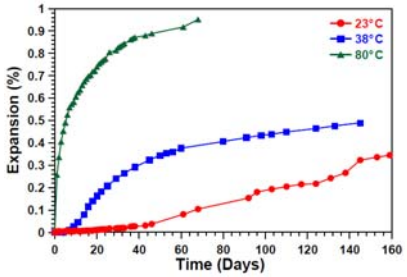


MORTAR – EFFECT OF GEOMETRY



MORTAR – EFFECT OF TEMPERATURE

- ASTM C 1260 is at 80°C



SUMMARY 1

- Acoustic emission could capture cracking due to ASR
- Different stages of cracking and "dormant period" were observed; further research is needed to better understand the behavior
- Cracking could be captured earlier than expansion

SUMMARY 2

- Waveform analysis may be used to differentiate between aggregate cracking and cement paste matrix cracking
- Temperature and geometry can have a significant effect of the rate of expansion and cracking
- Further research is needed to better understand the effect of temperature and geometry