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

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

• 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

OUTLINE

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

MODEL SYSTEM – LOADING

Composites
Department of Civil, Construction, and Environmental Engineering, NC State University
**MODEL SYSTEM – EXPERIMENTAL SETUP**

- AE Sensor
- Coupling Agent
- Composite
- Steel
- Vibration Damper
- RH and Temp Control

**MODEL SYSTEM – RESULTS**

- Temperature
- Cumulative Energy (nW)
- Time (hr)
- 3 mm (1/8 in) Inclusions
- 5 mm (1/6 in) Inclusions
- Aluminum

**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

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

MORTAR – RESULTS

MORTAR – RESULTS 1

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

MORTAR – RESULTS 2

• Possible explanation: gel deposition in cracks
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 38°C
• ASTM C 1260 is at 80°C

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MORTAR – EFFECT OF GEOMETRY

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

MORTAR – EFFECT OF GEOMETRY

• 38°C
**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