Damaging Interactions Among Concrete Materials

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Interactive Effect

- Ad hoc definition: Effect of two or more materials acting on each other in unexpected ways.
- Focus on the negative
- Usually are problematic because of lack of understanding of mechanism
- Tend to defy specifications
AAR: One of the Older Ones
AAR

- Cement alkalis
  - Solution: Total alkalis < 0.60%
- Reactive Constituents

![Graph showing the relationship between cement alkali content and expansion percent, with error bars indicating standard deviation among 6 aggregates.](image)
Low Alkali Didn’t Work!
Cement – Air Entraining Admixture (relatively new)

- Some AEA’s?
- Some concrete materials?
- Some conditions?
- Air voids collapse around aggregate
Failure of Air Void Systems
Early Stiffening Reactions

- Portland Cement – WRA Reactions
- Portland Cement – Fly Ash Reactions
- Vary from mild to severe
  - Mild – nuisance
  - Intermediate – often most problem
  - Severe – total show stopper!
Flash Setting vs False Setting

- **Flash setting** – doesn’t disappear on extended mixing – usually caused by accelerated cement hydration
- **False setting** – disappears with extended mixing – caused by plaster in cement
Cement – WRA: Flash Setting

heat, mcal/g.s

water

cement

cement + 3% Disal

time, min

0 10 20 30 40 50 60
Cement – Fly Ash Reaction

Olmsted file 970307

- Heat, m cal/g.s
- Time, min

- Portland cement
- Portland cement + Class C
- Portland cement + Class F

- PC
- Class C
- Class F
Damage Factors

- Poor compaction
- Temptation to add water
- Economic - Lost productivity
Poor Compaction
Extra Water
Lost Productivity
Extreme Retardation

- Cement – WRA Reactions
- Cement – Fly Ash – WRA Reactions
Inhibition of $C_3S$ Hydration

integral heat

<table>
<thead>
<tr>
<th>heat, kJ/kg</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>time, hr</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>

- $\text{cem+adm (9 oz/cwt)}$
- $\text{cem+fa (25%)+adm}$
- $\text{cem+alt fa+adm}$
- $\text{fa+alt cem+adm}$

\text{c:\work\ical\cc0054.xls}
Damage Factors

- Plastic Shrinkage
- Cracking
- Economic – Lost Productivity
ASTM Task Group on Interactions

- Developing test methods
  - Early stiffening
  - Delayed setting
- No specification activity
  - Plausible with fly ashes
  - No clear responsibility tag with admixtures
The End