Epoxy Crack Injection (the basics)

John Bors
ChemCo Systems
Introduction

- Overview of pressure crack injection
- Practical and technical issues
  - Choose a primary repair technique
- Epoxy properties
- ChemCo Systems
  - epoxies and structural concrete repair
  - metering pumps and equipment
  - 50 years of experience
  - Kemko® applicator program
Injection Process

1. Identify cracks for repair
2. Optimum port spacing and location
3. Surface preparation
4. Seal crack at surfaces
5. Inject
6. Remove seal
7. Restore surface
Crack Preparation

- Wire brushing or grinding
  - remove laitance
- Seal selection
  - conditions dependent
- Port or portless (taped)?
- Crack chasing or routing?
- Useful tools
  - scalpel, razor, tape, wax
- Cleaning up
  - solvent, stripper, propane torch

Taped ports are considered to be more time efficient

J Bors ChemCo Systems
Special surface seals

- Epoxy pastes
  - high mod. vs. flexible
  - short vs. long potlife
- Wax, hot melt seals
- Silicone seals
- Cementitious
- StripSEAL™
- Considerations
  - wet conditions
  - post-repair surface appearance
  - ease of removal
  - seal cracking (thermal cycling)
Crack evaluation

What is a crack?
- width and depth limitations
- pocket microscope
- Structural vs. non structural
- Identify cause and need for repair

<table>
<thead>
<tr>
<th>Exposure condition</th>
<th>Tolerable crack width (in.)</th>
<th>Tolerable crack width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry air or protective membrane</td>
<td>0.016</td>
<td>0.41</td>
</tr>
<tr>
<td>Humidity, moist air, soil</td>
<td>0.012</td>
<td>0.30</td>
</tr>
<tr>
<td>De-icing chemicals</td>
<td>0.007</td>
<td>0.18</td>
</tr>
<tr>
<td>Seawater and seawater spray: Wetting and drying</td>
<td>0.006</td>
<td>0.15</td>
</tr>
<tr>
<td>Water retaining structures (excluding pressure pipes)</td>
<td>0.004</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Epoxy Injection

- Port locations
  - access to both sides?
- Sequence
- Is water present?
- Pressure and duration
- Finished appearance

Pacoima Dam in Southern CA
Injection QC

- Pump ratio check
  - volumetric samples at pressure
- Static mixer condition
- Temperature vs. crack width
- Cure time and temp relationship
- Core examinations

ChemCo’s Ratio and Pressure Check Device

J Bors ChemCo Systems
Strength of Injected Repair

- Standardized reinforced concrete beams were tested to failure
- Cracked beams were injected then retested
- Repaired beams had same failure strengths as original beams
- Study by Dr. H.W. Chung, University of Hong Kong
Epoxy behavior

- Temperature behavior
  - viscosity change
  - reaction/cure rate change
- Crack size and viscosity
- Exothermal in bulk (large quantities and voids)
- Excellent shelf life (3 years typical)

J Bors ChemCo Systems
Epoxy cure time

When can you move a panel or vibrate the concrete?

CURE RATE OF EPOXY INJECTION ADHESIVES

Hours Required to Reach 5000 psi

Cure Temperature Deg. F

- Typical injection resin
- Slower
- Faster

J Bors ChemCo Systems
<table>
<thead>
<tr>
<th>Property</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>6-9,000 psi</td>
</tr>
<tr>
<td>Elongation</td>
<td>2%</td>
</tr>
<tr>
<td>Compressive</td>
<td>14-16,000 psi</td>
</tr>
<tr>
<td>Flexural</td>
<td>10-12,000 psi</td>
</tr>
<tr>
<td>Viscosity</td>
<td>200-500 cps</td>
</tr>
<tr>
<td>HDT</td>
<td>120-165°F</td>
</tr>
<tr>
<td>Gel time</td>
<td>14-210 min.</td>
</tr>
</tbody>
</table>
Special applications

- Large voids, honeycombs
- Old-to-new concrete
- Leaks or underwater
- No backside seal
  - slump pumping
  - paste injection
- Internal splices
- External plates
- Cold joints
- Water tanks
Equipment

- Positive displacement mix pumps
  - gear vs. piston
  - portability
  - reliability
- Static mixers
- Ports
- Pressure test kit
- Functional gauges
- Flush kit

ChemCo Systems Model B

J Bors ChemCo Systems
Safety & Environmental

- **Eye protection**
  - glasses or shield
  - eyewash (5 minutes)

- **Solvents & strippers**
  - in confined spaces
  - grounded containers

- **Skin protection**
  - use gloves
  - long sleeves and pants
  - dermatitis

- **MSDS on site access**

- **Cleanliness**
  - wash-up every time

- **Disposal**
Where to find more information

- Company training sessions
  - Kemko applicator training
- ICRI booklet and specification
- *Epoxy Injection in Construction*, Trout Aberdeen Grp.
- ACI repair committees