ACI RAP 2
CRACK REPAIR BY GRAVITY FEED WITH RESIN
OCTOBER 16, 2018
SCOTT DISTEFANO
AGENDA

- Introduction
- Purpose of Repair
- When to Use
- Proper Preparation
- Selecting Materials
- Equipment
- Safety
- Repair Procedure
- Evaluation
INTRODUCTION

- Life, Death, Taxes and Cracks!

FIELD GUIDE TO CONCRETE REPAIR
APPLICATION PROCEDURES

Crack Repair by Gravity Feed with Resin
INTRODUCTION

- Causes may include:
  - Steel corrosion
  - Freezing & thawing
  - Sulfate attack
  - Alkali aggregate reaction
  - Poor construction practices
  - Improper joint spacing
  - Load imbalances
  - Many others...
PURPOSE OF REPAIR

- Restore structural integrity
- Resist moisture penetration (0.002 in. width and greater)

- Form a plug to keep out:
  - Chlorides
  - Carbon dioxide
  - Sulfates
  - Aggressive chemicals

- Reduces future or further deterioration
WHEN TO USE GRAVITY METHOD

- Large horizontal cracks
  - Individually treat

- Many small horizontal cracks
  - Treat as a whole, “healer/sealer”
WHEN TO USE GRAVITY METHOD

- Large horizontal cracks
- Individually treat
- Many small horizontal cracks
- Treat as a whole, "healer/sealer"
PROPER SURFACE PREPARATION

- ½” wide on each side
- Wire brush
  - Grinders may fill crack with dust
- Pressure washer
  - Allow to dry, at least 24 hrs
  - Moisture tolerant epoxy
- Compressed Air (oil free)
- Power Vacuums

- For large areas, consider power sanding or shotblast
- “V” groove or notch
PROPER SURFACE PREPARATION
SELECTING THE CORRECT MATERIALS

- 2 most common resins
  - HMWM
    - Lower viscosity & surface tension
    - Less critical mix ratios
  - Epoxies
    - Moisture tolerant
    - Safer to mix & apply

- Low Viscosity & Low surface tension is very important
  - Typical requirement, <200 cps
  - Epoxies tend to be <100cps
  - HMWM’s tend to be <50 cps
  - Both have been documented <0.006” cracks
SELECTING THE CORRECT MATERIALS

Epoxy
- ~100 centipoise
- Low Surface Tension
- Bond Well w/damp concrete
- Safe to Mix and Apply

High Molecular Weight Methacrylate
- ~50 centipoise
- Lower Surface Tension
- Less Critical Mix Ratio
- Faster set Time
- Resin Based
- Low Viscosity
- Easy to Pour
SELECTING THE CORRECT MATERIALS

- ASTM C881 identifies basic criteria
- Other considerations include:
  - Modulus of elasticity (rigidity);
  - Working life;
  - Moisture tolerance;
  - Color
  - Compressive, flexural, and tensile strengths.

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**Table 1—ASTM C 881 requirements for epoxy resins that are used to bond hardened concrete to hardened concrete**

<table>
<thead>
<tr>
<th>Property</th>
<th>Type I</th>
<th>Type IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, centipoise</td>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td>Grade 1 (low-viscosity), maximum</td>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td>Grade 2 (medium-viscosity), minimum</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consistency, in.</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>Grade 3 (non-sagging), maximum</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Gel time, min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bond strength, minimum, psi</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>2 days, moist cure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 days, moist cure</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Absorption, 24 h maximum, %</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Heat deflection temperature</td>
<td>—</td>
<td>120</td>
</tr>
<tr>
<td>7 days minimum, °F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear coefficient of shrinkage</td>
<td>0.005</td>
<td>0.005</td>
</tr>
<tr>
<td>On cure, maximum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressive yield strength</td>
<td>8000</td>
<td>10,000</td>
</tr>
<tr>
<td>7 days minimum, psi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compression modulus, minimum, psi</td>
<td>150,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Tensile strength, 7 days minimum, psi</td>
<td>5000</td>
<td>7000</td>
</tr>
<tr>
<td>Elongation at break, minimum, %</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Type I: for use in non-load-bearing applications.

*Type IV: for use in load-bearing applications.


*Moist-cured systems should be tested by assembling the sections to be bonded before immersing in water.
PROPER EQUIPMENT

For small to midsize projects (up to 10,000 ft2 [930 m2]):

- Mixing buckets, drills, mixing paddles;
- Flat rubber squeegees, brooms, or rollers;
- Small cans or squeeze bottles for pouring into individual cracks; and
- Grinder and air compressor.

For large projects (over 10,000 ft² [930 m²]):

- Mixing buckets, drills, mixing paddles;
- Mixing tanks with spray bar (low pressure pumps, no atomization);
- Flat rubber squeegees, brooms, or rollers;
- Sand spreaders or blowers; and
- Grinder and air compressor.
SAFETY CONSIDERATION

- User must document safety practices:
  - Having Material Safety Data Sheets (MSDS) available on site;
  - Wearing protective clothing and protective eyewear
  - Wearing rubber gloves or barrier creams for hand protection
  - Having eye wash facilities available;
  - Wearing respirators where needed;
  - Providing ventilation of closed spaces;
  - Secured storage of hazardous materials;
  - Having necessary cleaning materials on hand; and
  - Notifying occupants of pending repair procedures.

- SPECIAL NOTE ON HMWM – NEVER MIX INITATOR AND PROMOTER DIRECTLY!
REPAIR PROCEDURE

1. Mix the resin

- After prep, mix according to manufacturer.
- A sealant can be used on individual cracks to create a reservoir.
REPAIR PROCEDURE

1. Mix the resin
REPAIR PROCEDURE

1. Mix the resin – NOT LIKE THIS!
REPAIR PROCEDURE

1. Mix the resin – OR THIS!
REPAIR PROCEDURE

1. Mix the resin – OR THIS!
REPAIR PROCEDURE

1. Mix the resin – AND ESPECIALLY NOT LIKE THIS!
REPAIR PROCEDURE

2. Pour the Resin

- Pour mixed material (within pot life)
- Allow to penetrate, pour until full

- Flood coats:
  - Apply resin evenly
  - Pool over cracks
  - Flat squeegee, broom, roller
REPAIR PROCEDURE

2. Pour the Resin
REPAIR PROCEDURE

3. Inspect the filling
   - Signs of proper penetration
     - Air bubbles
     - Dry spots
   - ALLOW TIME!
     - 20-30 minutes min.
REPAIR PROCEDURE

4. Remove Excess Resin
   ▪ Flat squeegee

5. Apply Sand
   ▪ Safety purposes, non-slip
   ▪ Adhesion for coatings

6. Finish Smooth
   ▪ Remove sealant and excess polymer if required
HOW TO CHECK THE REPAIR

1. Test cores
   - Engineer should determine location to avoid high stress areas
   - Visual evaluation for penetration depth
   - Must patch with expansive high strength grout (epoxy or cement based)
   - ASTM C492 – Splitting Tensile

2. Resin Properties – ASTM D495
   - Cured Prisms
   - Compressive strength
   - Correctly mixed and cured
SOURCES

THANK YOU FOR YOUR ATTENTION!

QUESTIONS?