Concrete Repair Basics

Daniel Dennis, Jr. PE
NYSDOT Materials Bureau
Presentation Outline

Commonly Observed Problems and Situations in both New Construction and Existing Structures

– Field Evaluations/Assessments of Existing Conditions
– Some Commonly Utilized Repair Procedures & Techniques
– Materials Selection Considerations
– Summary/Tips
1st Step – Thorough Assessment of Problem
Field/Site Inspection

- Hammer sounding / delamination survey
- Chain Drag - delamination survey
Review of Records

- Inspector Records – (recollections)
- Batch Tickets
- Weather /Working Conditions
Obtain Test Samples - Coring

- Core evaluated for abnormalities
- Lab Testing usually performed
  - Compression
  - Freeze Thaw / Petrographic Analysis
  - Chloride Content
Some Commonly Encountered Problems and Repairs Procedures/Techniques
Cracks - *Inspection*

- Number of cracks - isolated cracks or part of a pattern?
- Attempt to identify any potential causes that may have contributed.
- Inspect and measure crack width and estimate depth to determine most appropriate repair.
- “Active” cracks may require further monitoring. Glued-in-place crack gauges can be used to monitor movement.
Common Options for Crack Repairs

- Penetrating Sealer
- High Molecular Weight Methacrylate (HMWM)
- Epoxy Injection Repair Materials
- Sealants for Non Structural – (Silicone)
- Be aware of
  - Costs -Specialty Equipment/Crew
  - Temperature use limitations
  - Proper Curing time
  - Ensure adequate penetration depth in cracks
Penetrating Silane Sealer Application

- Helps address smaller hairline cracks
- Relatively inexpensive
- Sealer “coats” the interior crack faces
- (2) coat coverage (perpendicular directions) to ensure uniform coverage
- Surface Prep key to good performance.
  - The presence of any dirt, laitance, and/or moisture will decrease the effectiveness of sealer

SEALED vs. UNSEALED
High Molecular Weight Methacrylate (HMWM)

Best for horizontal surfaces. Very low viscosity allows easy flow & penetration in small cracks. High bond strength glues back together”

**Linear Crack Treatment with HMWM**

Resin is mixed & poured into crack
Distributed by brush or squeeze bottle
0.75 mm wide crack filled with HMWM
Caution with HMWM

- If full depth cracks - potential for leakage of the HMWM due to very low viscosity
- HMWM repairs will be visible for some time, but eventually wear down - Need to consider if aesthetics are a concern
- Not effective with “working” cracks

Follow all Manufacturer recommendations with regards to the safe handling of the material
Epoxy Injection

- ASTM C 881
- Injected through port system
- Excellent cohesive strength
- Not successful if movement occurs
- Not practical if cracks are wet or too numerous
- Better suited for Vertical applications than HMWM
Non-Structural Repair – Crack Sealing

• Seal to minimize intrusion of chlorides and other contaminants.
• Filled with silicone sealant
Honeycomb

- Due to a lack of appropriate consolidation during placement
- Structural integrity may be compromised
- Need to remove back to sound concrete – leaving honeycombed in place can become a weak point
- Core evaluation may be necessary
Surface Irregularities – Torn Surface

- Section 557-3.07- Finishing Integral Wearing Surfaces on Superstructure Slabs – Surface Irregularities greater than \( \frac{1}{4} \) inch in 10 ft. in either direction require repair.
- Presence of a poor finish as a result of the texturing operation.
- Typically a result of delays from the placement and finishing operations that lead to surface drying.
Open/Torn Surfaces

*Solution* – Broomed in Shear key grout

*Before*

*After*

Then…

Diamond Grind – and saw cut groove
When Possible- Assess surface defects before saw cut grooving. Difficult to re-establish grooves
Bridge Deck – Overlay Delamination

- A smooth textured surface identified on broken pieces of overlay and cores at the deck/overlay interface.

- Need a clean, pre-wet, roughened surface prior to placement (expose at least 50% of the coarse aggregate).

*Repair* - Mill and inlay new concrete
Scaling and Freeze Thaw Damage

- Wide spread scaling after first winter – inadequate protection
- Over Finishing “Blessing”
- Visual inspection & cores obtained to determine extent of compromised concrete

Hand finished areas where machine can’t reach
Scaling - Repairs

- Cores usually obtained to determine extent of compromised concrete
- Depending on extent of damage, a mill and inlay/overlay may be required
- Thin Polymer Overlays – need to be aware of re-application of broadcast aggregate and any friction concerns
Existing Defective Concrete - Repair

Section 555-3.13 Damaged or Defective Concrete

555-3.13 Damaged or Defective Concrete. All defects or damage to concrete which occurs prior to the final acceptance of the work shall be repaired or replaced at no additional expense to the State. The defects shall include but are not limited to: spalling and irregular cracking at joints, edge spalls, honeycombing, and damage or other imperfections caused by traffic and/or construction operations. Any concrete requiring complete replacement shall be replaced in kind as concrete originally called for in the contract documents. Any repairs shall be performed to the methods described in these specifications.

Figure 712.1 Square the patch to avoid multiple corners as best as possible.

Pop outs
spalls
General Concrete Repair

- **Removal to sound concrete**
  - 1 ft beyond visible / delamination distress
  - Remove at least 2” of material
  - Chip walls of repair cavity at 45 degrees towards center of repair
    
    *This allows for more bonding surface around perimeter of repair*

- **Adequate Surface Preparation**
  - Clean concrete and exposed reinforcing
  - Pre-wetting to SSD condition

- **Selection of Appropriate Repair Material**
  - Concrete - *use low permeability*
  - Prebagged repair products from Approved List or Equivalent

- **Curing**
  - Wet cure for at least 7 days (ideal)

*Follow repair with application of Penetrating sealer*
Galvanic anodes are tied to the top rebar along the perimeter of the area to be patched.

Corrosion Cracks

Concrete

Steel

Galvanic Anodes

Pier Bent

Deck Patch
Material Considerations
Selecting the Proper Approach/Material

- Quality Materials
- Compressive strength
- Durability
- Viscosity
- Temperature limitations
- Available Working and Cure time
- Required mixing and installation equipment
Technical Services - Materials - Approved List

Concrete, Repair Materials

Description

Concrete Repair Material, Portland Cement Based (701-04)
Vertical and Overhead Patching Material (701-08)
Rapid Hardening Concrete Repair Material (701-09)
Rapid Hardening Polymer Concrete (721-20)

Revised on: February 1, 2013
AL Material Requirements

701-04 CONCRETE REPAIR MATERIAL

SCOPE. This specification covers a portland cement based concrete mix generally used in the repair of precast concrete products such as pipe, cribbing, manholes, etc.

MATERIAL REQUIREMENTS. This material shall have a maximum initial setting time of 1 hour. Compressive strength shall be a minimum of 2000 psi after 1 day and 5000 psi after 28 days. The material shall be able to withstand 25 cycles of freeze-thaw (10% NaCl) with a maximum loss of 4%, in accordance with NY Test Method 502-3P. The material may exhibit expansion at no more than 0.40% and shrinkage of no more than 0.05% such that no cracks are produced. The bond strength shall be a minimum of 200 psi after 5 days air cure without the use of a special bonding agent. The material shall exhibit no appreciable heat of hydration. The color of the repair after it cures will be of substantially the same color as the item being repaired.

BASIS OF ACCEPTANCE. Application for approval of concrete repair material shall be submitted to the Materials Bureau accompanied by a labeled 50 lb standard production sample. Upon approval, the name of the product will be placed on an approved list. Such product will then be accepted on the basis of the brand name labeled on the containers. The manufacturer is required to print the date of manufacture on the container in the following format “month, year.” Inclusion of the day of manufacture in the date is optional. The expiration date of acceptance for this material shall be one calendar year from the date of manufacture or as stated in the Approved List, whichever is less. If in the opinion of the Engineer the material is determined to be unsuitable for Department work, the material will be rejected.
Repair Materials

- **New AL Materials Requirements – EI 12-009**
  - More stringent durability requirements
  - Lesser quality products were removed from AL

- **What if not on the AL...but salesmen/contractor insists......“greatest product since...”**

The Specifier should define:
- Performance requirements
- Durability /Lifespan expectations
- Acceptance procedure and assurance quality (certs)
- Post installation evaluations / tracking important
The above F/T chamber is used in conjunction with the NYSDOT Test Method for Freeze Thaw Testing (TM 502-3P) for testing cores and cylinders. The test samples are soaked in a 3% Sodium Chloride (rock salt) solution. The samples are subjected to 1 freeze/thaw cycle per day for 25 days (-10°F to +70°F). Weight loss (percent loss) and visual condition are measured during this test.
Specialty Concrete - Self Consolidating

Has the ability to easily flow beneath bars with excellent consolidation

Smooth Finish Achieved

Normal Slump test  Inverted Slump Cone  SCC Spread Test
Specialty Concrete - Accelerated

- Mix Development key to success. Lab and Field Trial Batches recommended
- Generally not as durable
- Only use if needed & select best mix for conditions
Repair is only as good as the prep

Figure 712.10 Thin overlay failure due to improper surface preparation.
Summary

• To properly address repairs – need to have a good sense of the extent of the damaged area – good field inspection is key

• For most repair situations – there can usually be several ways to address – *key is to select most appropriate for the circumstances.*

• Proper prep is important towards a successful repair

• Use of appropriate materials/techniques and follow manufacturer guidelines (don’t over engineer if it’s not needed)
The End
Learning Assessment Question #1

• Which of the following are common problems that are encountered with Concrete applications
  A. Scaling
  B. Cracking
  C. Honeycombing
  D. All of the Above

Answer D. All of the Above
Learning Assessment Question #2

• True or False: Epoxy based materials are best suited for vertical crack applications
  A. True
  B. False

Answer – True

High Molecular Weight Methacrylate (HMWM) are better suited for horizontal surfaces due to their low viscosity
Learning Assessment Question #3

• Which of the Following considerations are important when considering repairs?
  A. Thorough Field Inspections
  B. Proper Material Selection
  C. Following Manufacturer Recommendations
  D. All of the Above

Answer – D All of the above