Infrastructure Repairs

Factors to consider when making repair decisions

David Tomley, P.E. (GCP/TCP-Chief Engineer)





Precast Reinforced Concrete Channel Beam Deterioration



200

Aspects Required to Evaluate and Execute Infrastructure Repairs

- Project management
- Structural/bridge engineering
 - Load evaluation
- Existing project records & plans
- Bridge inspection & Element level inspection
- Member deterioration assessment/evaluation & strengthening options
- Design Theory & Loading
- Design Codes (AASHTO, ACI, IBC)
- Traffic control
- Repair objective, materials, & repair procedures
- Performance & quality of repair materials & experience of staff performing repairs
- Bridge maintenance
- Good detailing & construction practices
- Type of repair (structural vs. non-structural)

- Execution of repairs
 - Access
 - Means & methods
 - Quality control
- Budgeting/construction cost estimating
- Job safety & environmental analysis (JSEA)
- Communication with owner agency staff
- Critical needs assessment & prioritization of repairs
- Corrosion mitigation solutions
- Service-life & durability
- Life Cycle Cost Analysis
- Timeframe for repairs to be in-service
- Scheduling
- Developing repair scope of work documents



REPAIR DESCRIPTION	UNIT	QUANTITY
replace timber piles	EACH	23
seal timber piles	EACH	172
add steel shim plate to top of existing piles	EACH	3
clean caps and underside of channel beams	EACH	18
patch bent caps and underside of channel beams	EACH	18
add new deck drain scuppers	EACH	80
Carbon Fiber Reinforced Polymer (CFRP) repair	EACH	18

Carbon Fiber Reinforced Polymer (CFRP) Repair

1. Wire brush and remove any loose scale from exposed rebar. Clean area with water and allow to dry completely.

2. Coat rebar with Corrverter by brush application and allow to cure. Corrverter is applied as a white coating and turns black when cured.

3. Use Planitop XS to complete a vertical and overhead repair of the area to receive CFRP. Cure Planitop XS according to the technical data sheet.

4. Apply Primer 1 to the surface area to receive CFRP per the CFRP shop drawings provided. (See Drawing No's 10-13) for the locations and spans to receive CFRP. The primer should extend past the CFRP area by approximately 1".

5. Apply Mapewrap 12 to the surface area to smooth any areas. Use the material to round any edges that will receive CFRP.

- 6. Apply CFRP wrap (Uni Ax 600 in 16" width rolls) per the CFRP shop drawings.
- 7. The material may be cut to achieve the 6" strips necessary for flexural strengthening on the bottom of the channel beams. Industrial grade scissors should be used for cutting the material.

8. Saturate the material using Mapewrap 31 for each layer to be applied. Allow each layer to cure before applying the next layer, following application guidelines from the manufacturer.

9. Once the layers are complete according to the CFRP shop drawings, apply a maximum thickness single coat of Elastocolor Coat.

Concrete Channel Beam CFRP Repairs



- CFRP locations were provided per span
- Separate CFRP designs were required for both interior & exterior channel beams



Concrete Channel Beam CFRP Repairs



- 18 of the 280 channel beams required structural repair and CFRP strengthening
- Repairs were performed in late summer of 2019

Repairs-Guidelines



MNL-137 does NOT address in-service repairs

- Washington DOT has fabricators submit annually list of common defects with recommended repair procedures using approved materials. Having approved repairs annually streamlines execution of repairs on all Washington DOT projects.
- FLDOT has noncomplying prestressed products guidelines in their standard specs for road and bridge construction (450-12)
- TxDOT has a concrete repair manual
- NCDOT has developed a list of standard repairs

SRP-01	Vertical Cracks
SRP-02	Spalls Web or Side Box Beam Cored Slab
SRP-03	Spalls Top Flange
<u>SRP-04</u>	Longitudinal Cracks
SRP-05	Bottom Corner Spall PPC Girder
SRP-06	Corner Spalls Box Beam Cored Slab
SRP-07	Missing or Broken Continuity Bars
SRP-08	Shrinkage Cracks

Repairs-Guidelines

• ALDOT has a procedure (ALDOT-367) addressing production and inspection of precast non-prestressed and prestressed concrete that includes a table with criteria for sealing cracks

NON-AGGRESSIVE ENVIRONMENT ²			
CRACK SIZE	LOCATION	CORRECTIVE ACTION	
≤ 0.012"	ANY AREA ON ANY TYPE OF MEMBER	SEAL WITH LOW VISCOSITY EPOXY ³	
> 0.012" BUT ≤ 0.025"	ANY AREA ON ANY TYPE OF MEMBER	EPOXY ³ INJECTION	
> 0.025"	ANY AREA ON ANY TYPE OF MEMBER	STRUCTURALLY ANALYZE	
ANY SIZE	BEARING AREA	STRUCTURALLY ANALYZE	
AGGRESSIVE ENVIRONMENT ²			
CRACK SIZE **	LOCATION	CORRECTIVE ACTION	
≤ 0 . 006"	ANY AREA ON ANY TYPE OF MEMBER	SEAL WITH LOW VISCOSITY EPOXY ³	
> 0.006" BUT ≤ 0.025	ANY AREA ON ANY TYPE OF MEMBER	EPOXY ³ INJECTION	
> 0.025"	ANY AREA ON ANY TYPE OF MEMBER	STRUCTURALLY ANALYZE	
ANY SIZE	BEARING AREA	STRUCTURALLY ANALYZE	
 NOTES: THESE GUIDELINES DO NOT APPLY TO CRACKS GENERATED BY BUMPING OR CAUSED BY MISHANDLING OF MEMBERS. AGGRESSIVE ENVIRONMENT SHALL BE CONSIDERED TO BE A MARINE ENVIRONMENT OR AN ENVIRONMENT WITH POTENTIAL OF SULFATE OR ACID ATTACK. ALL EPOXY MATERIALS USED SHALL BE IN ACCORDANCE WITH SECTION 870.03 OF THE SPECIFICATIONS. 			

TABLE 16-1: CRITERIA FOR SEALING CRACKS¹

Repairs to precast or precast/prestressed concrete members

- Common defects or nonconformances
 - Surface porosity
 - Bug hole
 - Honeycombing
 - Chip
 - Formed surface misshaping
 - Bearing area flaws
 - Crack
 - Spall
 - Missing or incorrect insert locations, holes, or embed items
- Categorization of defects
 - Cosmetic or minor (i.e., non-structural) or
 - Major (i.e., structural)
 - location of defects
 - size guidelines
- Recommended repair procedures for cosmetic or minor repairs & approved materials
- Personnel involved with repairs (owner & fabricator)

- Repair related communication and review procedures
- Documentation required
 - Photos
 - Product marks
 - Location of defects on product members
 - Shop drawings (as reference information)
 - Dimension of defects (as appropriate)
 - Use crack width ruler
 - Batch information and/or pour number(s)
 - Explanation as to how the defect or nonconformance occurred
 - Address preventative techniques, procedures, solutions to mitigate future occurrences
 - Recommended repair procedure/letter including material product data sheets

Repairs

• Next steps?



Section 804

Section 804

804.03.21--Final Cleanup. Upon completion of the work all equipment, surplus materials, forms, and waste material shall be removed, the bridge cleaned, and the site of the work given a final cleanup.

804.03.22--Precast-Prestressed Concrete Bridge Members.

804.03.22.1--General. All installations and plants for the manufacture of precast-prestressed bridge members shall be PCI (Prestressed Concrete Institute) Certified. Bridge members manufactured in plants or installations not so approved will not be accepted for use in the work. The Contractor or other manufacturer shall employ a technician skilled in the adopted system of prestressing to supervise the manufacturing operations. This technician shall be certified according to the guidelines of this specification. The Contractor shall develop and implement a Quality Control Program as per Division I of PCI Quality Control Manual, 4th Edition. The Quality Control Program shall be submitted to the District Materials Engineer for approval.