Repairing Precast Concrete Girder with Ultra-High-Performance Concrete

US30 Snake River (Ontario)

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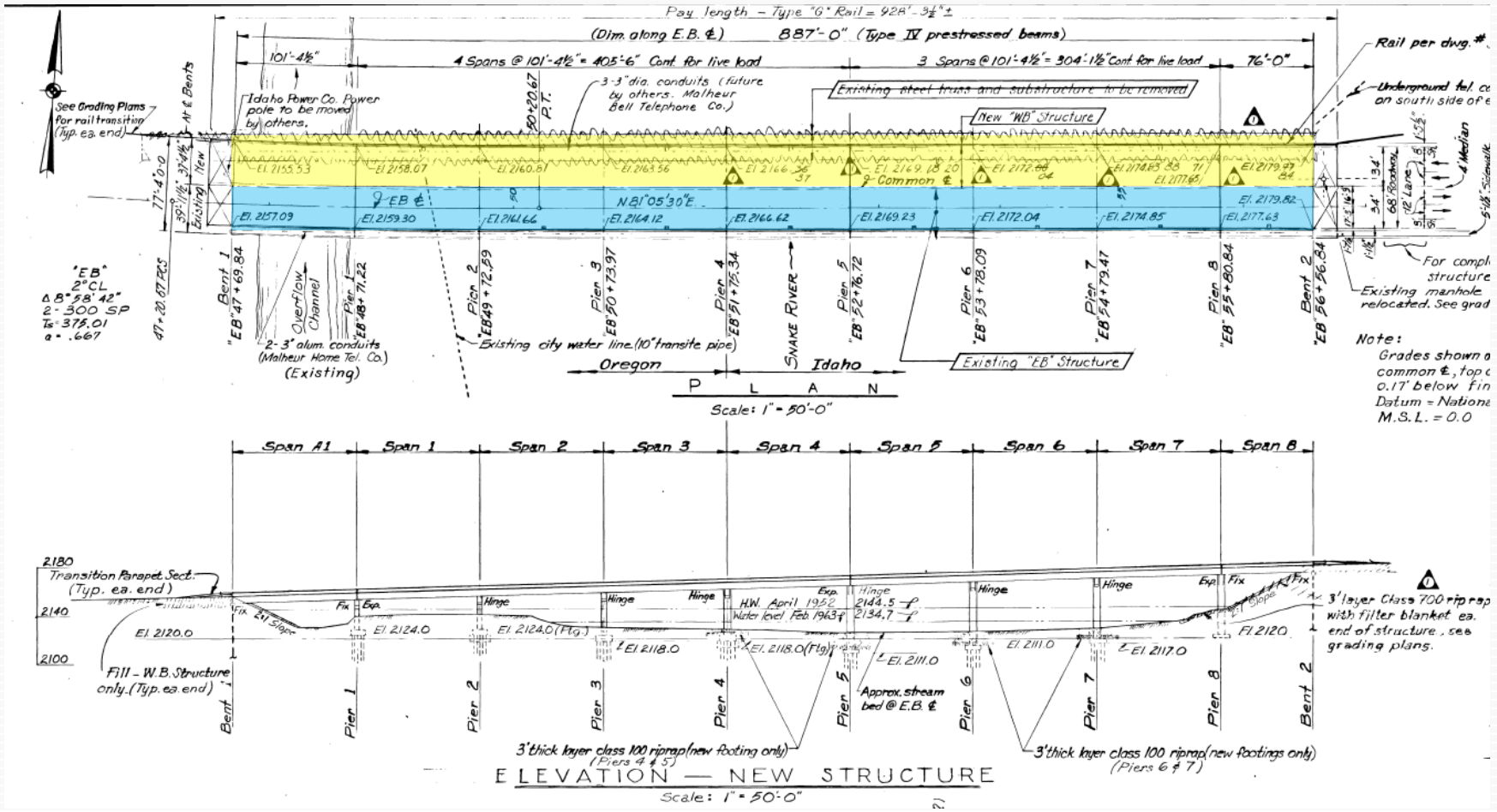
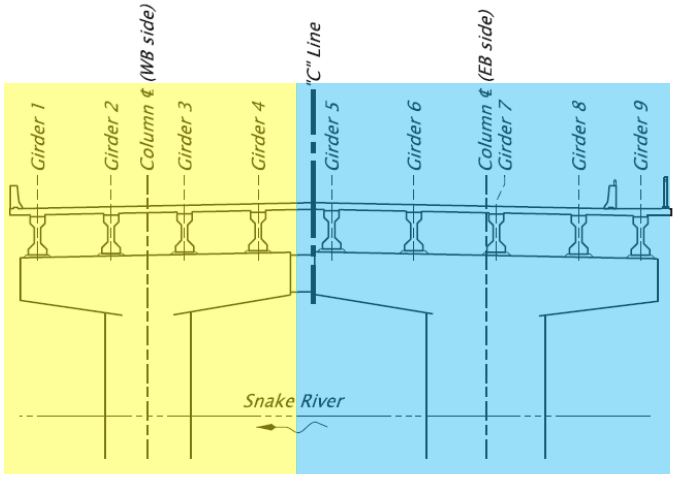
US30: SNAKE RIVER BRIDGE 01000B

- Original Bridge 01000B (EB) constructed in 1967
- Bridge (WB) widened in 1985 – similar design
- 887 ft long, 77.3 ft wide
- 9 spans: 9 PS concrete girder lines (AASHTO Type IV) with reinforced concrete deck
- 5 Interior Bents made continuous for live loads
- 3 Interior Bents with expansion joints (Asphaltic Plug Joint)
- Asphalt concrete wearing surface



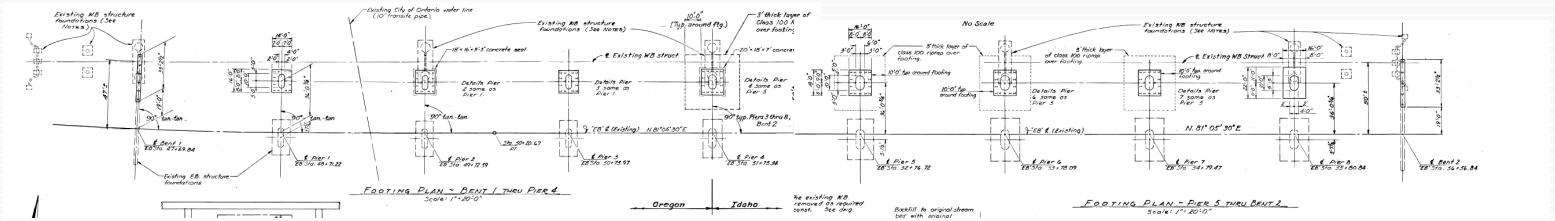
1967 1985



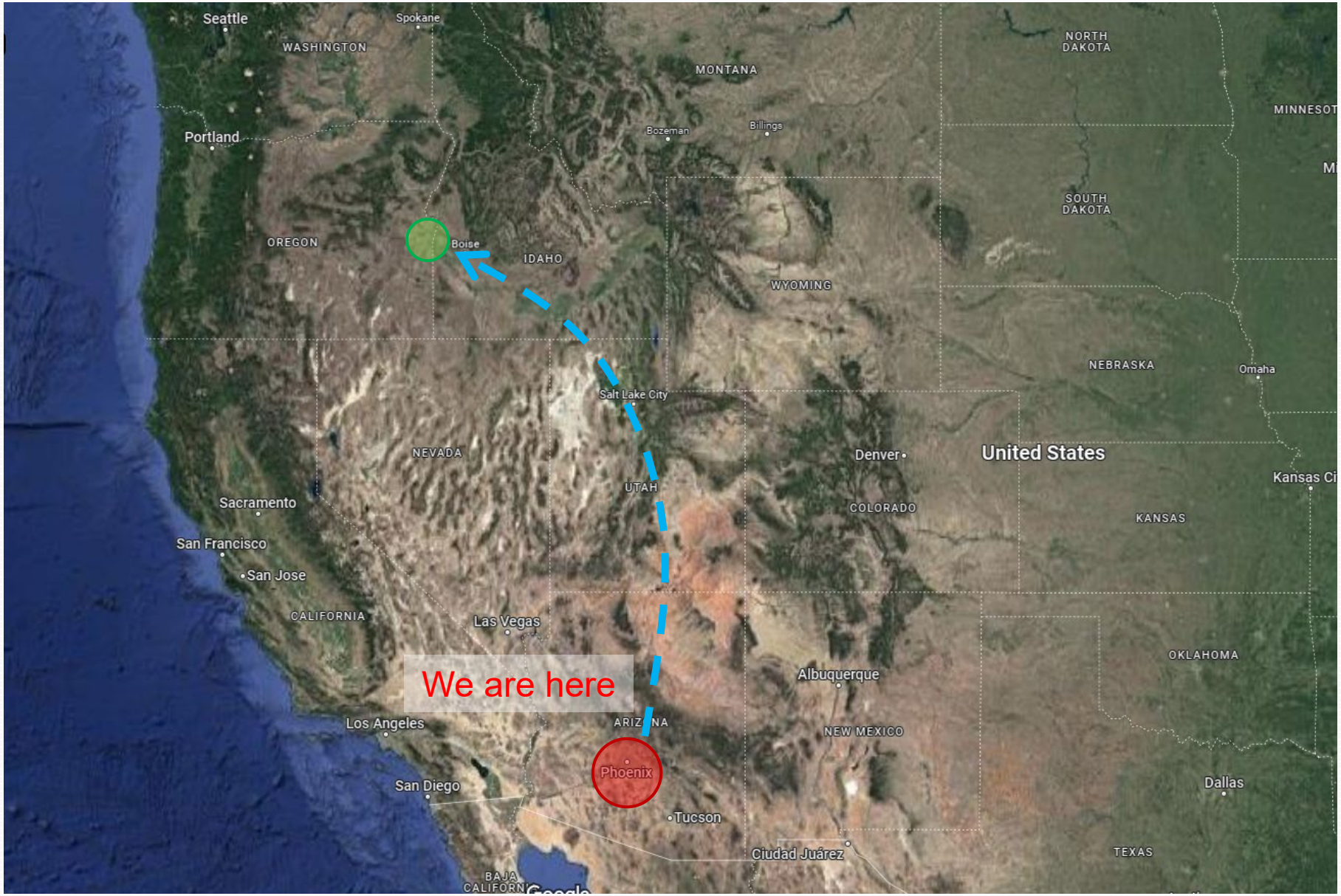
For bridge repair work locations, see table on sht. J03.

TYPICAL BENT SECTION

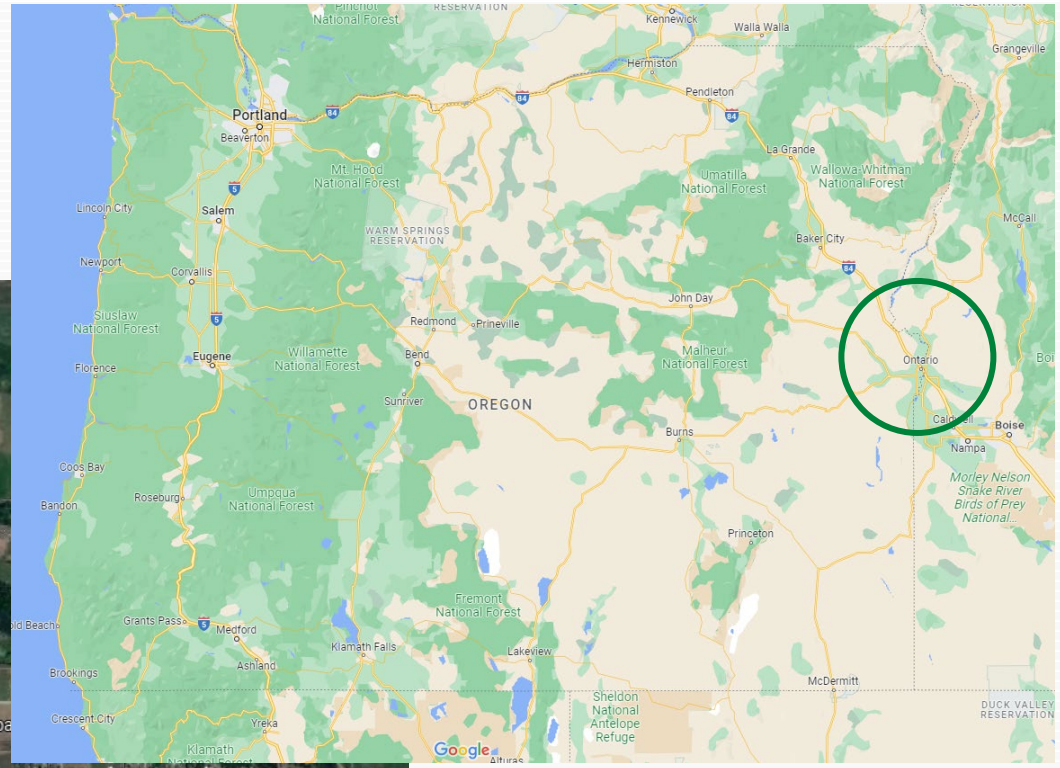
Scale: 1"=20'



BRIDGE LOCATION

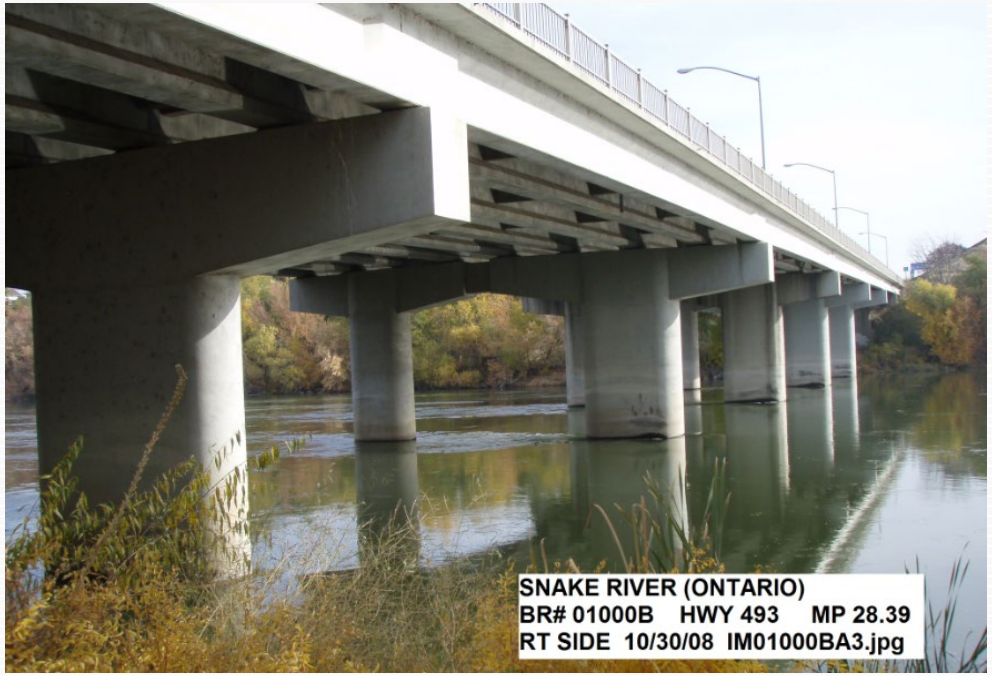


BRIDGE LOCATION




SNAKE RIVER (ONTARIO)
BR# 01000B HWY 493 MP 28.39
LT SIDE 10/21/14 IM01000BA4.jpg


SNAKE RIVER (ONTARIO)
BR# 01000B HWY 493 MP 28.39
SIDEWALK (LOOKING BACK ON LINE)
10/30/08 IM01000BA6.jpg


SNAKE RIVER (ONTARIO)
BR# 01000B HWY 493 MP 28.39
RT SIDE 10/30/08 IM01000BA3.jpg

FHWA EVERYDAY COUNTS (EDC-6)

UHPC for Bridge Preservation and Repair

Every Day Counts
Innovation for a Nation on the Move

Ultra-high performance concrete (UHPC) offers enhanced durability and improved life-cycle cost performance for bridge preservation and repair.

Keeping bridges in a state of good repair is essential to keeping the transportation system operating efficiently. Agencies at all levels can deploy UHPC for bridge preservation and repair to maintain or improve bridge conditions cost effectively.

STRONGER REPAIRS, EXTENDED SERVICE LIFE

UHPC is a fiber-reinforced, cementitious composite material with mechanical and durability properties that far exceed those of conventional concrete materials. This has made it popular for bridge construction, especially for field-cast connections between prefabricated bridge elements (PBE). Bridge infrastructure preservation and repair (P&R) is a new application of UHPC that offers enhanced performance and improved life-cycle cost over traditional methods. Because of its strength and durability, UHPC can be an optimum solution for some repairs. UHPC can be used in situations that normally use conventional concrete or repair mortars, and in some cases those that use structural steel. Some UHPC mixes gain strength rapidly, so bridges could be opened to traffic 24 hours after completing the necessary repairs. Additionally, UHPC repairs are long lasting and resilient, requiring less maintenance and fewer follow-up repairs than conventional methods. In some cases, they can outlive and outperform their conventional counterparts—UHPC repairs could be the strongest and most durable part of the bridge.

APPLICATIONS

A few examples of UHPC P&R applications include bridge deck overlays, girder end repairs, expansion joint repairs, PBE construction joint repairs, and column or pile jacketing. Some applications, such as bridge deck overlays and replacing expansion joints with UHPC link slabs, can extend the service life of bridges well beyond that of traditional repair strategies and are more cost-efficient than bridge replacement.

Repair of a deteriorated steel bridge beam end using UHPC.
Source: University of Connecticut

EDC

UHPC for Bridge Preservation and Repair

BENEFITS

- **Versatility.** UHPC can generally be used anywhere other types of concrete would be used, and due to its strength and durability, it can be the optimum material for many applications.
- **Durability.** UHPC-based repairs are long-lasting and require less maintenance and fewer follow-up repairs.
- **Cost Savings.** UHPC repairs can outlive and outperform their conventional counterparts, resulting in life-cycle cost savings. UHPC bridge deck overlays and link slabs can extend the service life of bridges well beyond that of traditional preservation and repair strategies.
- **Accessible.** UHPC-based solutions can be used by both local and State transportation agencies, and although some new knowledge is required, designers and contractors will be able to leverage their existing skillsets to deploy this solution.

STATE OF THE PRACTICE

State departments of transportation (DOTs) and other highway agencies have repaired or strengthened more than 20 bridges using UHPC in recent years, with half of these completed in 2019. These projects used multiple repair techniques and strategies to return the bridges to a state of good repair and extend service life. Examples are listed below.

- **Bridge Deck Overlays:** Iowa DOT, Buchanan County (Iowa), Delaware DOT, New York State DOT.
- **Link Slabs:** New York State DOT, Maryland DOT, New Jersey DOT.
- **Beam End or Girder Repair:** Connecticut DOT, Rhode Island DOT, Florida DOT, St. Clair County (Michigan) Road Commission.

To see more examples of UHPC deployments, visit the interactive map on the Turner-Fairbank Highway Research Center website.

Replacement of an expansion joint with a UHPC link slab.
Source: New York State Department of Transportation

Installation of a UHPC overlay. Source: FHWA

RESOURCES

FHWA EDC-6 UHPC for Bridge Preservation and Repair

Advancing Bridge Repair and Preservation Using Ultra-High Performance Concrete, Aspire, Spring 2019

FHWA TechNote: UHPC for Bridge Deck Overlays (February 2018)

North American Deployments of UHPC in Highway Bridge Construction

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Publication No: FHWA-20-CAI-014

2021 REHABILITATION PROJECT

Bid date: 11/18/2021 Completion date: October 2022

Scope of Work

- Premixed Polymer Concrete (PPC) Overlay
- Girder end plug repair using UHPC
- PS concrete girder end repair using UHPC
- Expansion joint surface repair using UHPC
- Expansion joint seal replacement

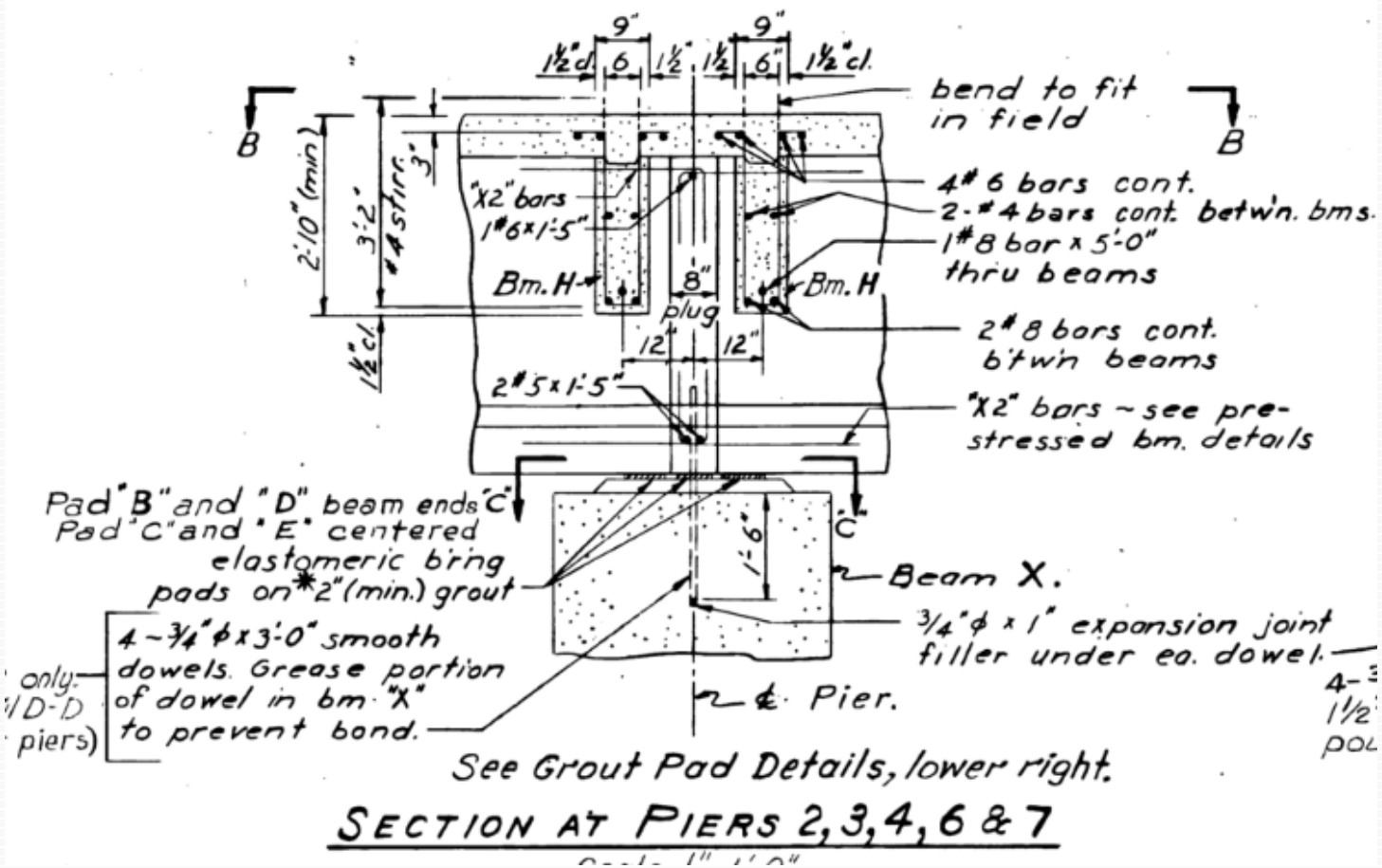
PRE-REHAB DECK

10/2022

PRE-REHAB GIRDER END PLUG

PRE-REHAB GIRDER END PLUG

As-Constructed Details



PRE-REHAB GIRDER END PLUG

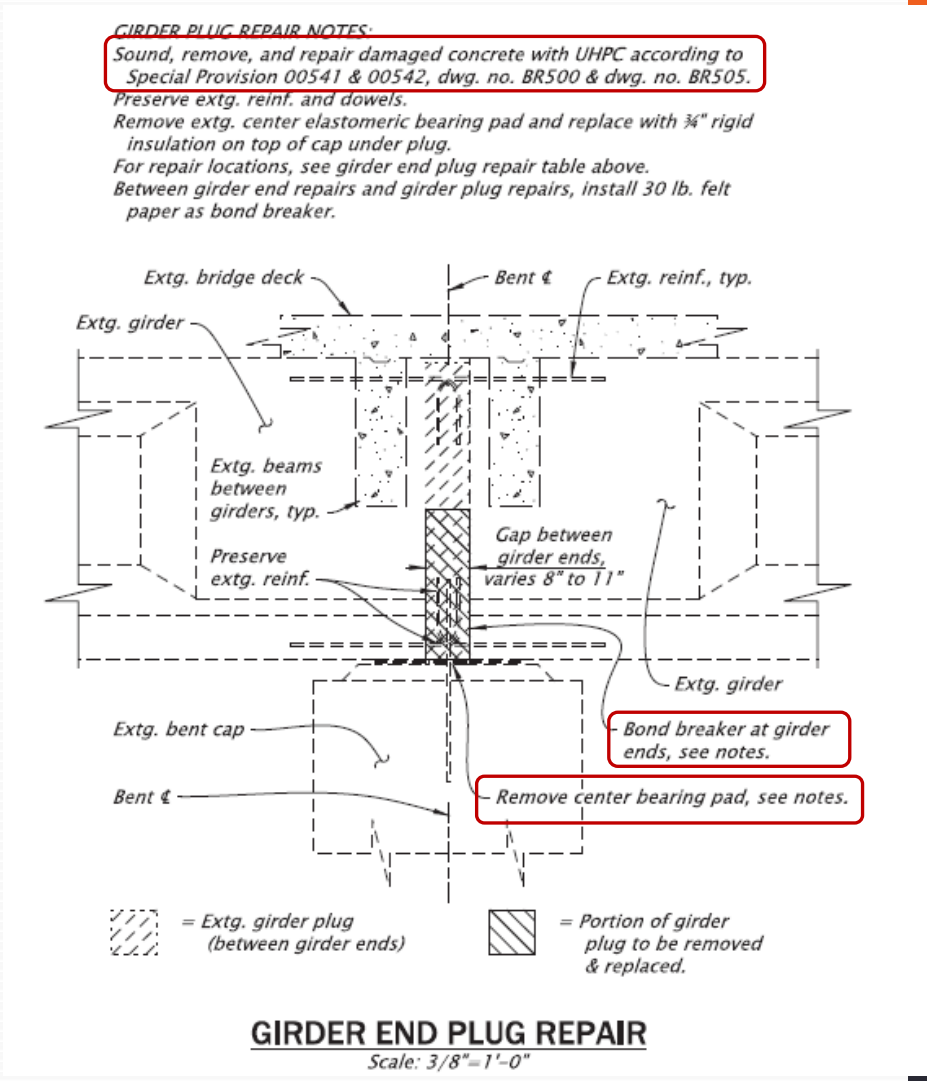
GIRDER END PLUG REPAIR

What We Know

- Thermal movements
- Traditional concrete repair material failed

Repair Plan

- Use UHPC
- Replace existing material up to midheight
- Remove middle bearing pad
- Provide bond breaker to girder ends
- Bents 3, 4, 5, 7, 8 = 5 Bents, 9 girders each

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GIRDER END REPAIR

<u>What we know</u>

- Steel bearing plate embedded in PS Girders
- Failed expansion joint
- Pack rust developed and broke girder bottom bulb

<u>Repair plan</u>

- Use UHPC to re-construct girder bottom bulb

GIRDER END REPAIR

GIRDER END REPAIR LOCATION TABLES

Note: Bents not listed have no girder end repair locations.

GIRDER END REPAIRS

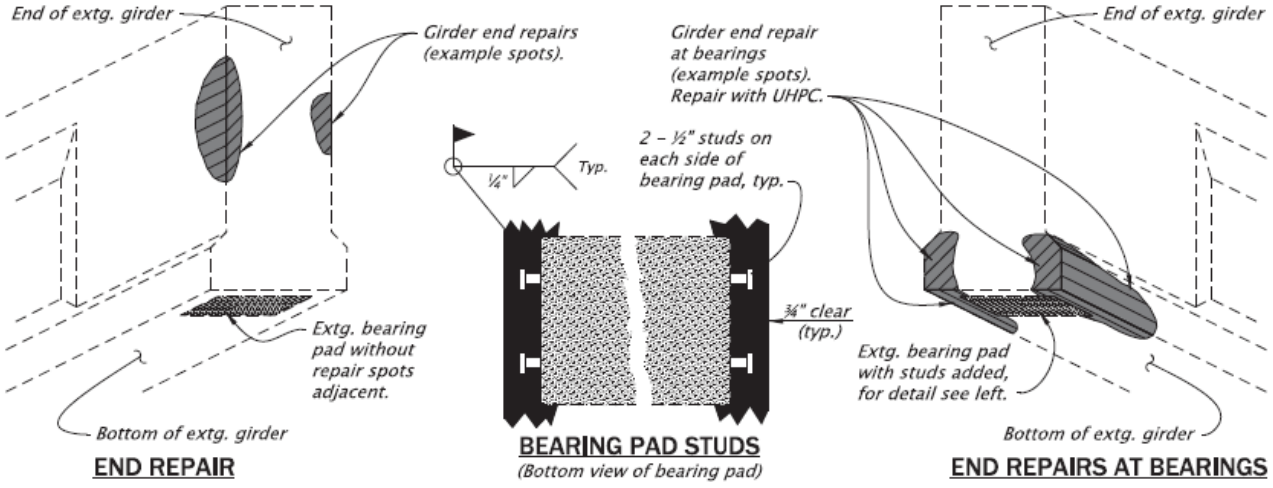
GIRDER BEHIND BENT:	AT BENT:	GIRDER AHEAD OF BENT:
No girder end repair	Bent 2	Girder #1 of Span 2
Girder #1 of Span 2	Bent 3	No girder end repair
Girder #1 of Span 3	Bent 4	No girder end repair

GIRDER END REPAIRS AT BEARINGS

GIRDER BEHIND BENT:	AT BENT:	GIRDER AHEAD OF BENT:
Girder #1 of Span 5	Bent 6	Girder #1 of Span 6
Girder #5 of Span 5	Bent 6	No girder end repair
Girder #6 of Span 5	Bent 6	No girder end repair
Girder #7 of Span 5	Bent 6	No girder end repair
Girder #8 of Span 5	Bent 6	No girder end repair

GIRDER END REPAIR NOTES:
Example repair spots on girders shown (verify in the field).
For repair locations, see girder end repair location tables above.
Sound, remove, and repair damaged concrete (pressure grout) according to Special Provision 00542, dwg. no. BR500 & dwg. no. BR505.
Preserve extg. reinf. and strands of girder.

ADDITIONAL NOTES FOR REPAIRS AT BEARINGS:
Clean and prepare metal bearing surfaces according to Special Provision 00542.
Field weld studs at bearing pads according to AWS D1.1, centering on thickness of bearing pad with 4" spacing.
Provide 30 lb. felt paper as bond breaker under repairs.



GIRDER END REPAIRS
Scale: No scale


#2

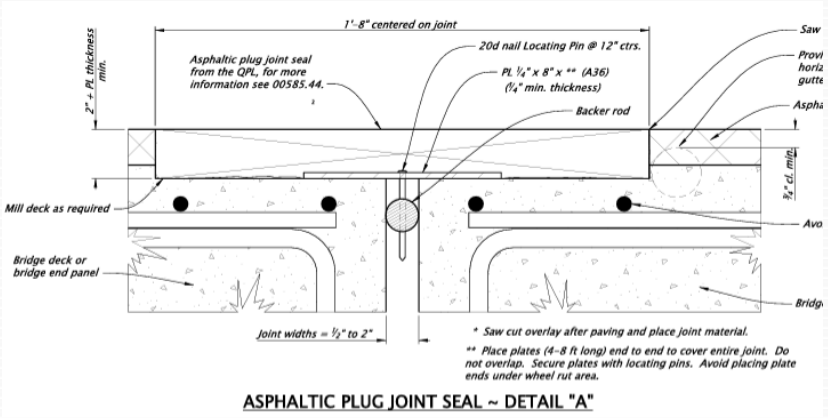

9
5

PRE-REHAB JOINTS

2016

2020

PRE-REHAB JOINTS



ASPHALTIC PLUG JOINT SEAL ~ DETAIL "A"

PRE-REHAB JOINTS

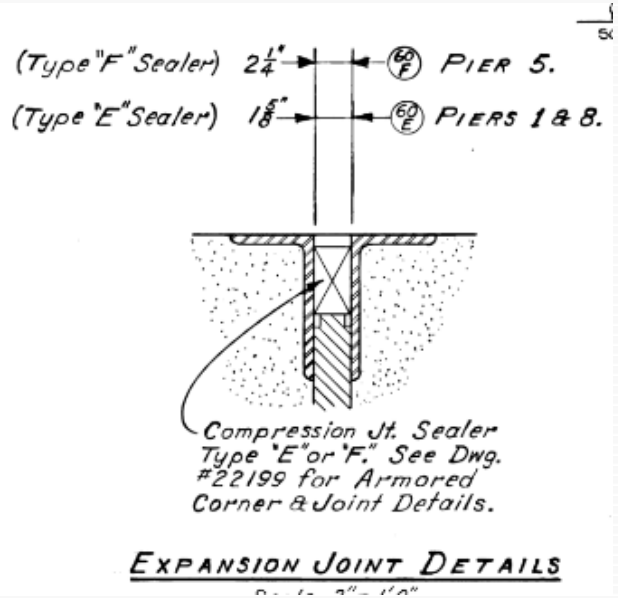
BRIDGE EXPANSION JOINT REPAIR

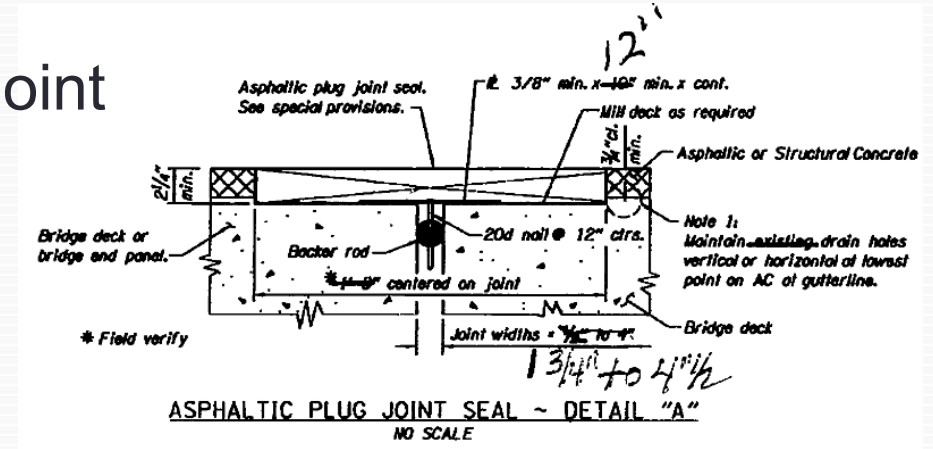
What we know

- Original compression joint seal was replaced with APJ
- Joint openings were wider than necessary for movement range
- APJ failed

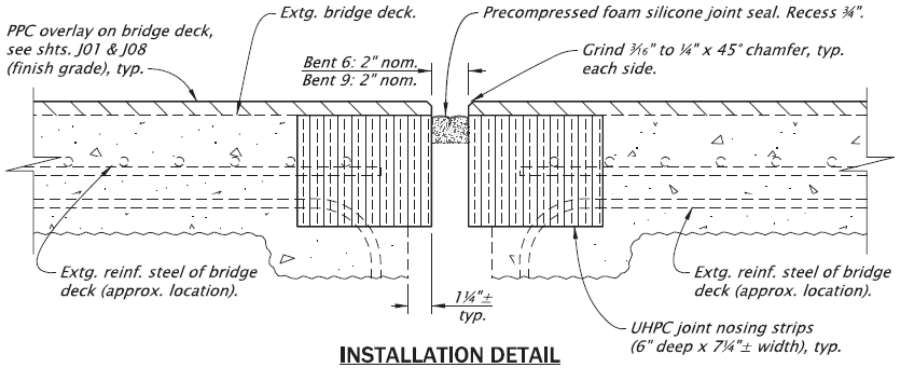
Repair Plan

- Narrow bridge joint opening
- Replace APJ with precompressed foam silicone joint seals
- Use UHPC for joint surface re-construction
- Provide ADA Compliant joint seals in sidewalk





BRIDGE EXPANSION JOINT REPAIR

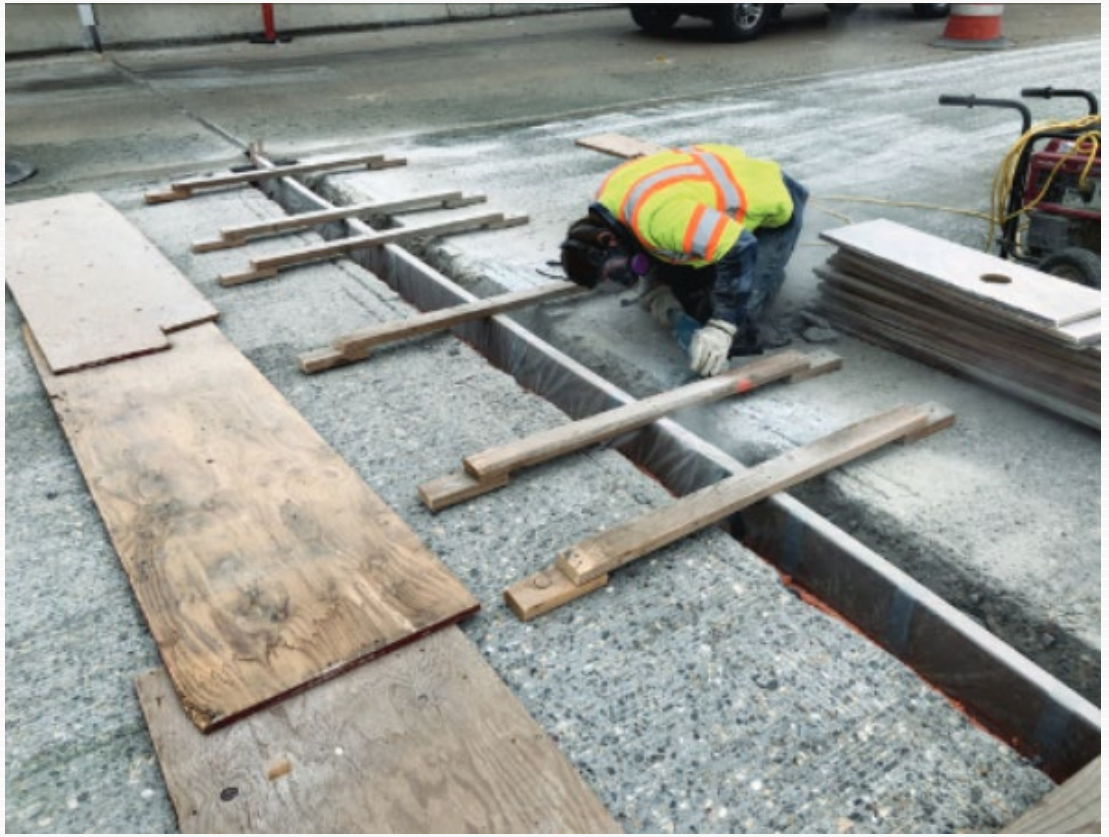


INSTALLATION DETAIL

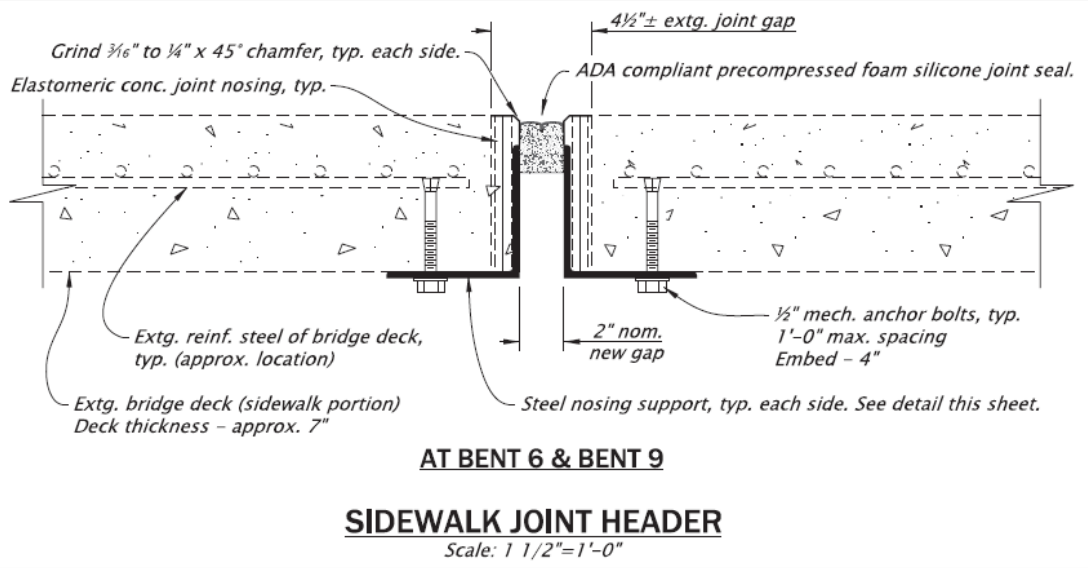
JOINT HEADER – BENT 6 & 9 NOTES:
Saw cut perimeter ½" deep & remove extg. joint armor and concrete in blockout.
Preserve deck and diaphragm reinf.
Provide water tight forming seals for UHPC.
Cap UHPC nosing with PPC overlay ¾" nom.

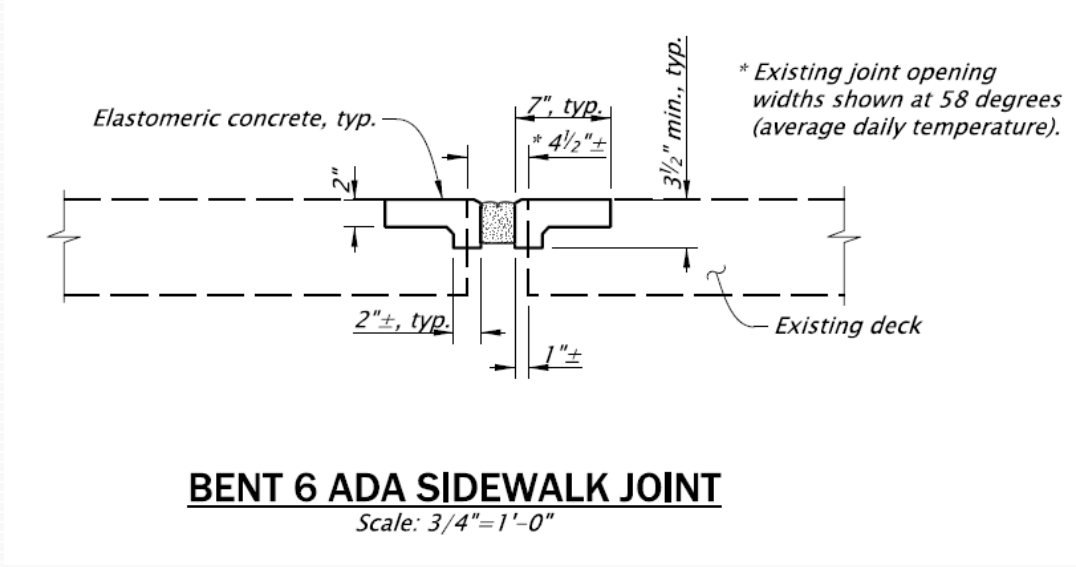
Start transition of precompressed foam silicone joint seal recess depth from roadway to sidewalk at traffic face of barrier.
For precompressed foam silicone joint seal details, see sht. J05.

JOINT HEADER - BENT 6 & BENT 9
Scale: 1 1/2"=1'-0"



SIDEWALK JOINT REPAIR





BENT 6 ADA SIDEWALK JOINT

Scale: 3/4"=1'-0"

UHPC MATERIAL TESTS

On site testing

- Flow test (ASTM C1437) before pouring

3rd party laboratory testing

- Compressive strength (ASTM C1856)
- Laboratories located in CA and MO

ODOT laboratory for QA

- Compressive strength (ASTM C1856)
- Splitting tensile strength (ASTM C496) for information only

CONSTRUCTION COST

- Total = $2.67 million
- Bridge work = $1.79 million
- UHPC for girder end plug repair = $30,000/cuyd (5.0 cuyd)
- UHPC for girder end repair = $62,500/cuyd (0.20 cuyd)
- UHPC for joint header = $28,571/cuyd (3.5 cuyd)

or

Comments