Chapter 7 — Repair and Preservation

7.1—OVERVIEW

The primary objective of the Bridge Preservation Program is to maximize the useful life of bridges in a cost-effective manner, applying appropriate treatments and maintenance activities at the opportune time.

The FHWA Bridge Preservation Guide is very informative and comprehensive. This guide outlines many of the repair and preservation strategies adopted by NDOT (U.S. Department of Transportation Federal Highway Administration, 2018).

A general list of work items for Preventative Maintenance Activities of Bridges is included in the Roadway Design Manual, Chapter 1, §6.C.2.a. The activities are divided into Cyclical or Condition-based groups; the work is eligible for Federal funding (Nebraska Department of Transportation, 2023).

For information on preservation friendly design for new construction see §15.11.

7.1.1—Scoping of Repair and Preservation Projects

The needs for Nebraska Bridges are assessed by the Bridge Management Section of the Bridge Division. Bridges that are in Good or Fair condition and that are not recommended for replacement or rehabilitation are considered candidates for preservation or maintenance.

Engineering judgment is necessary when developing a scope of work for preservation and repairs because of unique site conditions and maintenance history for each existing bridge.

The main communication tool between the designer and Bridge Division for repair and preservation projects is the Bridge Determination. The approved BD can be found on OnBase and may be updated during the life of a project.

7.1.2—Organization of this Chapter

The following subsections of this chapter represent the current preferences of the Bridge Division for bridge repair and preservation. This chapter will evolve rapidly and represents a snapshot of the current practices.

To illustrate these practices, examples from recent plan sets are included. These examples are not intended to serve as standard cells but rather to provide general guidance on the level of details required. It is the designer's responsibility to adapt the detail to the specific structure.

Where applicable, references to the current Special Provisions and Pay Items are also provided.

7.2—SUPERSTRUCTURE PRESERVATION WITH OVERLAYS

7.2.1—Thin Overlays

7.2.1.1—Epoxy Polymer Overlay

Multi-Layer Epoxy Polymer Overlays are a deck treatment method, that use a high build epoxy resin and broadcast aggregate, resulting in a thin overlay. This system can be used when asphalt is not available for an asphalt overlay and waterproofing membrane system or when a thicker overlay would cause additional undue expense e.g., if asphalt placement would lead to the replacement of a finger expansion joint.

EPO is not recommended for use on approach slabs due to vapor drive upwards from soil through the approach slab.

7.2.1.2—Deck Surface Treatment

This is a flood coat system used as a “healer/sealer”. The material is a low viscosity resin capable of deep penetration into the deck to attempt to fill/bond small cracks and voids while acting as an overall surface sealer to prevent chloride penetration.

Use 90 sf/gal for estimating purposes for the Pay Item quantity. This gives a 10% buffer to allow for wastage during construction over the amount required to be applied by the Special Provisions.

For existing bridges with open rails and sidewalks deck surface treatment is the preferred preservation method on the sidewalk.

This Pay Item sees more frequent use in District 5 due to the limited availability of asphalt in that part of the State.

Consider applying Surface Treatment to raised medians, but the extensive preparation required by the Special Provisions may not be justified.

7.2.2—Rigid Overlays

7.2.2.1—Polyester Polymer Concrete Overlay

This rigid overlay consists of batching polyester concrete on-site and placing the overlay material with use of a screed or finishing machine. PPC overlays can be placed at a nominal thickness to preserve bridge decks as well as placed in variable thickness as a grade correction strategy. Full depth headers, block-outs, or repairs may be performed with this material. Minimum specified thickness for this material is ³⁄₄ in.

7.2.2.2—47B-OL Concrete Overlay

This rigid concrete overlay replaced the Silica Fume deck overlay system, which is not currently used by Bridge Division. This material has been used to protect entire bridge decks as well as used as a localized repair on decks that experienced shallow cover during the deck placement. Minimum specified thickness of overlay for this material is 2 in.

The first use of this overlay type was in 2012 on S080 36014. As of 2023, 7 total bridges have received this overlay type.

7.2.3—Asphalt Overlay and Waterproof Membranes

Asphalt Overlay and Waterproof Membranes are currently the most used superstructure preservation method for Bridge Division.

Between 1973 and 1977 approximately 27 bridges were built, and prior to opening to traffic, received an experimental deck preservation treatment using waterproofing membrane and an asphalt overlay. Most of these bridges are still in service as of 2022. The first known bridge is westbound I-680 over the Missouri River (S680 01343L) built in 1973. Of these bridges that are no longer in service, several were replaced for reasons such as realignment of the roadway, poor timber piles, or damaged due to floods.

Repairs of bridge decks and approach slabs are typically performed in conjunction with AC+M, see §7.2.3.6.

7.2.3.1—Asphalt Overlay Details

7.2.3.1.1—Mix and Placement of Overlay

The asphaltic concrete used on bridge decks as an overlay will almost always be the same mix provided for the resurfacing or maintenance strategy on the roadway. The best practice is to place an asphalt overlay in 2 lifts, for the purpose of achieving the best smoothness. Every effort shall be made to place the overlay in conjunction with the lifts placed on the roadway and to avoid use of headers. When feasible, asphalt overlays shall be placed with the lane lines in mind to avoid joints from landing in wheel paths.

Some situations may require an asphalt mix for the bridge overlay that is different than the mix specified on the roadway project.

When asphalt overlays and waterproofing membranes are part of Bridge-Only projects, the source of asphalt needs to be carefully considered. Not all districts have easy access to asphalt for smaller projects.

The asphalt types below are listed in order of preference based on optimal density and durability properties.

- SLX, by far the optimal mix for bridge overlays
- SPR
- SPH, only effective if the oil volume is increased, otherwise it is difficult to get density.

Most, if not all, of the overlays placed in the 1970's were placed in two lifts. The special provisions typically read "asphaltic concrete on waterproofing membrane shall be placed in at least two approximately equal layers. The first layer shall be at least ³⁄₄ in. thick after compaction".

MTVs for the placement of asphalt on roadway resurfacing projects are commonly used and are recommended for the asphalt placement on bridges.

Some of the benefits of using an MTV are:

- Helps maintain a consistent temperature of mix going through the paver.
- Prevents aggregate/material segregation by remixing the mix.
- Allows non-stop paving

7.2.3.1.2—Thickness of Overlay

To prevent delamination, cracking, and rutting of asphalt, the overlay thickness shall be 2 in. minimum.

A uniform 3 in. overlay thickness shall be used for all new bridges and for existing bridges that have bridge rails that are 30 in. or taller.

For existing bridges with 29 in. tall bridge rails, either provide a uniform thickness of 2 in., or provide 3 in. asphalt thickness across the driving lanes, and within the shoulder, taper down to 2 in. minimum thickness at the face of the bridge rail as shown in Figure 7.1.

Designers shall coordinate grade change tie-ins or inlay considerations beyond the ends of the bridge with Roadway Design as needed.

For bridges on a cross-slope, ensure that the taper on the high side does not create a flat spot. A flat spot is defined as a slope of 0.5% or less

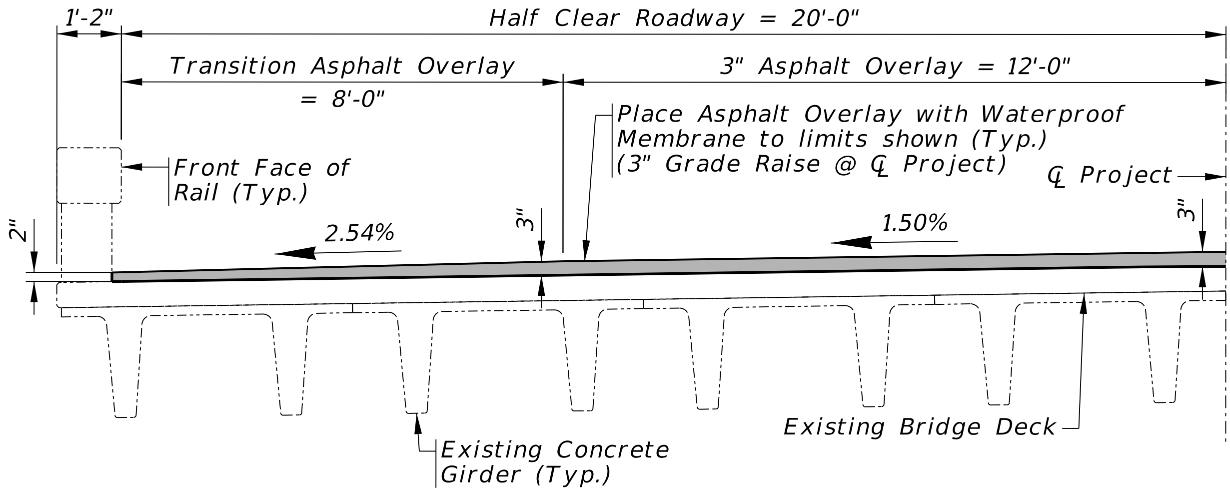


Figure 7.1—Tapered Asphalt Overlay
(example taken from S006 14316, CN 71208, 2022)

7.2.3.1.3— Wick Drains

When wick drains are used, designers should ensure that wick drains have proper termination points to daylight the water. Wick drain details should be provided and shown the plans in the following situations:

- Closed rail bridges with two or more floor drains per gutter line shall have the wick drains run between and terminated at the floor drains. If the bridge is superelevated, the wick drain would only be placed on the low side of the deck. It is not necessary to place wick drains in the area between the end of the bridge and the first floor drain.
- Bridges with raised medians with two or more floor drains per gutter line shall have wick drains provided like paragraph 1, above.

To help ensure long-term asphalt overlay durability on bridge decks with waterproof membranes, it is recommended that adequate membrane-level drainage be provided to ensure water is quickly removed from the bridge deck. Poor drainage results an overlay that is saturated with water, leading to accelerated deterioration of the asphalt including potholes, cracking, stripping, and debonding.

Wick drains installed above the membrane, should help provide the necessary drainage on closed rail bridges. For bridges with closed rails without floor drains, designers shall determine whether or not to incorporate wick drains based on bridge geometry (vertical curve, width of bridge, potential for daylighting).

Open rail bridges allow for water to drain off the structure before any seepage into the asphaltic concrete can occur. Therefore, wick drains are not necessary for open rail bridges.

7.2.3.1.4—Payment

Asphalt overlay (by others) is typically noted in the Bridge plans, but the Pay Items and quantities for the asphaltic concrete are computed by M&R or Roadway Division and are not shown on the Bridge Plans.

7.2.3.2—Waterproof Membrane Details

There are two different types of membrane systems used to preserve existing and new bridge decks, including slab bridges:

- Preformed Fabric
- Liquid-Applied

Base Sheets for each membrane type are available for use in the Appendices.

Waterproofing membrane pay items will be listed as Group 9 Items on the front sheet of the bridge plans.

Membranes are paid for by the plan area of covered deck and approach. The limits of the waterproofing membrane will be specified in the bridge determination and will be shown in the plans.

For bridges with no approach slabs, the membrane is commonly extended 5 ft. beyond end of floor.

Figure 7.2 shall be used for membrane selection. On bridges that are selected for Hot Liquid or Fabric at the end of the flow chart, current practice is to indicate Hot Liquid Membrane on the plans and include the Special Provision that allows substitution of Fabric Membrane post-letting.

Consider using the fewest membrane types on a single project, i.e., consider using a single membrane type that satisfies all design factors.

Membrane type specified for a repair project is not always provided in the Bridge Determination.

- Fabric membranes are usually more cost effective and are the most common type used on new bridges. Fabric membranes can be substituted for Hot Liquid membranes post-letting except when existing concrete overlays are to be removed. Special Provisions may apply.
- Due to difficulty of fabric installation on horizontally curved and superelevated bridge deck, liquid membrane types are typically selected.
- Hot liquid membranes do not require a separate tack coat placement, unlike fabric or cold liquid types which do require tack coat.
- Cold liquid membranes possess superior crack bridging capabilities.

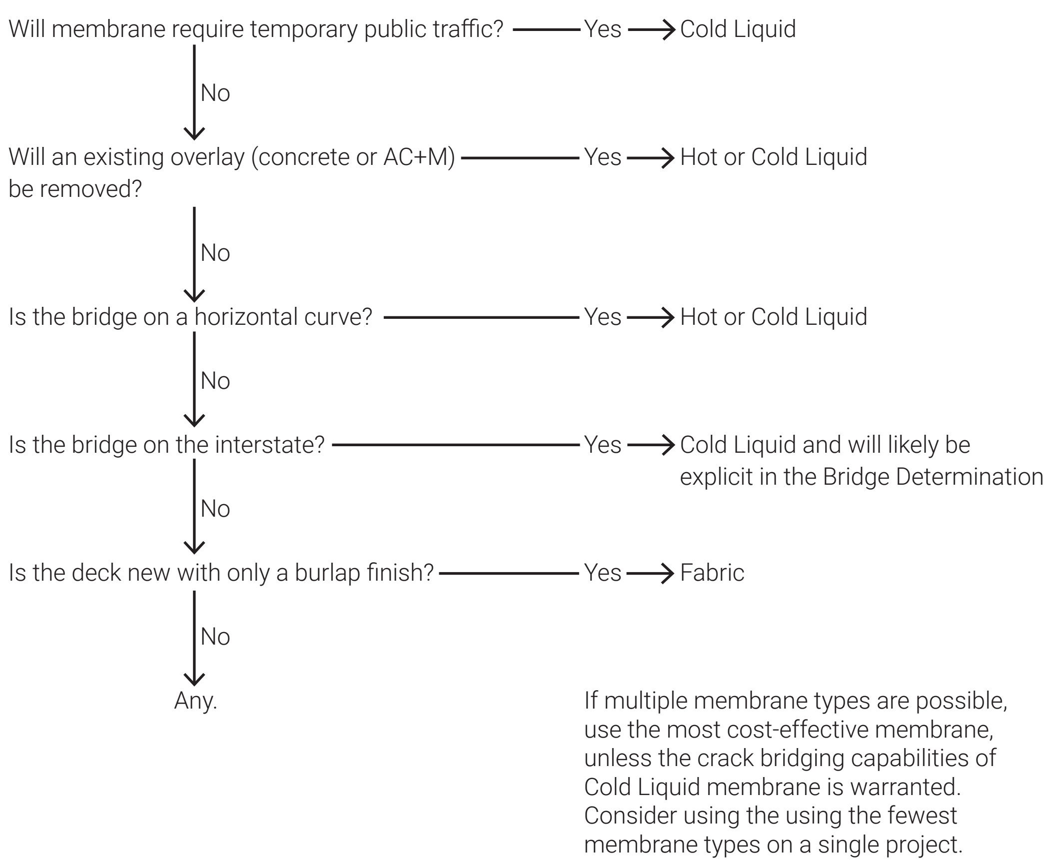


Figure 7.2—Membrane Selection Flowchart

7.2.3.2.1—Preformed Fabric Membranes

Specify Preformed Waterproofing Membrane, Type 2 for existing bridges, the Pay Item Bridge Deck Preparation must also be specified.

Specify Preformed Waterproofing Membrane, Type 3 for new bridge decks and new slab bridges. Newly placed concrete shall be drag finished with wet burlap. No tining, grooving, brooming, or other texturing shall be used.

Preparation of Bridge deck is not required for Type 3 membranes as all work to correct the deck surface to meet a smoothness requirement is covered in the special provision.

Fabric Membranes are measured by the square yard.

Preformed Fabric Membrane system consists of the membrane and a compatible primer coat. Tack coat is applied, and the membrane is paved with a hot asphaltic concrete wearing course.

Preformed Waterproofing Membrane, Type 1 was meant to be used on existing structures with adequately smooth decks that minimal preparation was necessary. Due to coordination issues with pay items and roughness determination this approach has been discontinued and the amount of field preparation is determined by the NDOT Field Engineer during construction.

7.2.3.2.2—Liquid-Applied Membranes

Liquid Membranes are measured by the square foot.

7.2.3.2.2a—Cold Liquid-Applied Membrane

Cold liquid-applied membranes are typically used to preserve higher value assets.

When closure time in high traffic areas is a concern, traffic can be placed temporarily on the completed membrane for up to 7 days.

Newly placed concrete shall be broom finished. No tining, grooving, or other texturing shall be used.

Cold Liquid-Applied Membrane system consists of a liquid primer, base coat membrane, top coat membrane, and broadcast aggregate layer. Tack coat is applied, and the membrane is paved with a hot asphaltic concrete wearing course.

The membrane chemistry has several allowable variations: polyurea, methyl methacrylate, or a blended polyurethane/methyl methacrylate. One polyurea product (Polyflex) is not to be placed on non-cementitious patches that consist of magnesium phosphate. No reactivity concerns are known between the allowable variations and deck repair materials listed in the special provision, “Polymer Bridge Deck and Approach Repair”.

7.2.3.2.2b—Hot Liquid-Applied Membrane

Hot liquid-applied membranes are mainly applicable to existing bridge decks or existing slab bridges. A few test cases of Hot liquid-applied membranes were applied to new bridges. However, the best historical performance has been with preformed fabric, due in part to no tining or texturing on new bridges.

Hot liquid-applied membranes have experienced some difficulty in asphalt placement in hot ambient conditions. Hot liquid-applied membranes are especially effective when an existing concrete overlay is to be removed by milling.

Hot Liquid-Applied Membrane consists of a non-modified, heated performance grade bituminous binder, that is spray applied to the prepared bridge deck. The membrane is then completely covered with a non-woven polypropylene paving fabric. The membrane is then paved with a hot asphaltic concrete wearing course. No additional tack coat is needed.

There is no requirement for the finishing of newly placed concrete.

7.2.3.2.3—Payment

Pay items for the waterproof membrane are to be listed as Group 9 Items on the front sheet of the bridge plans. In addition, standard note #111 shall be placed on the bridge plans when Group 9 Items are shown.

7.2.3.3—Curbs on Open Rails

Bridges with Open Rails shall be considered for the placement of a Curb Angle or Concrete Curb along the gutter line located at piers, bents, or ends of floor to deflect chlorides away from these areas.

Before detailing curb angles or concrete curbs, check for unacceptable water spread that might extend into the lane.

7.2.3.4—Expansion Joint Selection with Asphalt Overlay Projects

See Table 7.1, Table 7.2, and Table 7.3 for guidance.

Total thermal movement shall be decomposed into longitudinal and transverse movements (from the perspective of the joint) when designing joints on skewed structures.

Joint Selection Guidance for projects without an Asphalt Overlay is provided in §14.1.1.

For joints located on the bridge deck, the value of a watertight expansion joint that can protect the underlying structural elements cannot be overstated. For this reason, strip seals, modular joints, and finger joints with a drainage membrane are recommended for these locations. Other factors, such as maintenance level repairs, may preclude use of these joint types on a project.

Details for PPF, Strip Seal, and Modular Joints can be found in §14.1.

Table 7.1—Selection Guide for Joints Located Over Grade Beams on Existing Approaches for Placement of Asphalt Overlay

TM Range	Typical Existing Joint Types	Typical Existing Nominal Joint Width At 50°F	Joint Recommendation
TM < 1 in.	Simple Gap* Armored Joints	≤ 2 in.	Saw and Seal Joint
		> 2 in.	Asphalt Plug Joint
	Strip Seals	2 in. minimum	
1 in. ≤ TM < 1 ½ in.	Simple Gap* Armored Joints	1 in. – 4 in.	
	Strip Seals	2 in. minimum	
1 ½ in. ≤ TM < 3 in.	Simple Gap* Armored Joints†	1 ½ in. – 3 ½ in.	PPF Joint with Bridge Joint Nosing‡
	Strip Seals†	2 in. minimum	
3 in. ≤ TM < 4 in.	Armored Joints† Strip Seals†	< 3 in.	Strip Seal
	Modular Joints† Steel Finger Joints†	≥ 3 in.	
TM ≥ 4 in.	Modular Joints† Steel Finger Joints† Segmental Joints†	> 4 in	Modular Joint Finger Joint

* Simple Gap Joint types: Joint Filler, PPF, Preformed Silicone, Compression Seals

† Existing joints utilizing a steel extrusion or other steel hardware at the top of deck shall not have new steel hardware installed directly atop them

‡ Remodel concrete to adjust gap to be appropriate for the expected thermal movement

Table 7.2—Selection Guide for Joints Located Over Grade Beams on New Approach Slabs with Asphalt Overlay

TM Range	Nominal Joint Width At 50°F	Joint Recommendation
TM < 1 in.	1 in.	Saw and Seal Joint
1 in. ≤ TM < 1 ½ in.	2 in. minimum 3 in. maximum	Asphalt Plug Joint
1 ½ in. ≤ TM < 3 in.	2 ½ in.	PPF Joint with Bridge Joint Nosing
3 in. ≤ TM < 4 in.	2 in.	Strip Seal
TM ≥ 4 in.	5 in. minimum	Modular Joint Finger Joint

Table 7.3—Selection Guide for Joints on Deck or at End of Floor on Asphalt Overlay Projects

TM Range	Typical Locations	Typical Existing Joint Types	Typical Existing Nominal Joint Width At 50°F	Joint Recommendation
TM < ½ in.	EOF btwn. Approach* Fixed Pin (P&H Bridges)	Simple Gap† Armored Joints	1 in.	1 in. Partial Depth Saw and Seal Joint Asphalt Plug Joint
½ in. ≤ TM < 1 ½ in.	EOF btwn. Approach*	Simple Gap† Armored Joints	1 in. – 3 in.	Asphalt Plug Joint
1 ½ in. ≤ TM < 4 in.	EOF btwn. Approach* Exp. Joints (P&H Bridges) Abutment Backwall Deck Joints between units	Simple Gap† Armored Joints Strip Seals Steel Sliding Plates	1 in. – 4 in.	Strip Seal Shallow Strip Seal with Bridge Joint Nosing‡
TM > 4 in.	Abutment Backwall Deck Joints between units	Modular Joints Steel Finger Joints Segmental Joints	> 4 in	Modular Joint Finger Joint

* Existing Slab Bridges, or Bridges with turndowns but older approaches
† Simple Gap Joint types: Joint Filler, PPF, Preformed Silicone, Compression Seals
‡ Bridge Division approval required

7.2.3.4.1—Bridge Joint Nosing with Asphalt Overlays

Bridge Joint Nosing can be used on Asphalt Overlay projects only as listed in Table 7.1, Table 7.2, and Table 7.3.

Bridge Division approval is required to use Bridge Joint Nosing in conjunction with Shallow Strip Seal and in any other application.

When joints are required to be raised to the height of the Asphalt Overlay, Bridge Joint Nosing is used as a rigid concrete header on both sides of certain expansion joint types. The material is either a polyester or elastomeric concrete.

Previous NDOT policy was to install Bridge Joint Nosing at joints on new concrete decks and/or approaches without an asphalt overlay. This practice has been discontinued, as the detail has been shown to delaminate from the underlying concrete in many cases.

While Bridge Joint Nosing can be used in non-overlay applications to repair minor concrete spalling at expansion joints, it is preferable to repair these areas in accordance with §7.4.1.

7.2.3.4.2—Asphalt Plug Joints

Asphalt Plug Joints consist of a flexible asphaltic binder, mixed with aggregate (Figure 7.3). The material is installed over an expansion gap to provide a smooth riding surface. They have proven to be a good option for small movement joints on Asphalt Overlay Projects, as well as a maintenance retrofit to repair existing joints.

While Asphalt Plug Joints can be used as a maintenance level repair for joints on bridges with a concrete riding surface, use of these joints in new construction without overlay is discouraged.

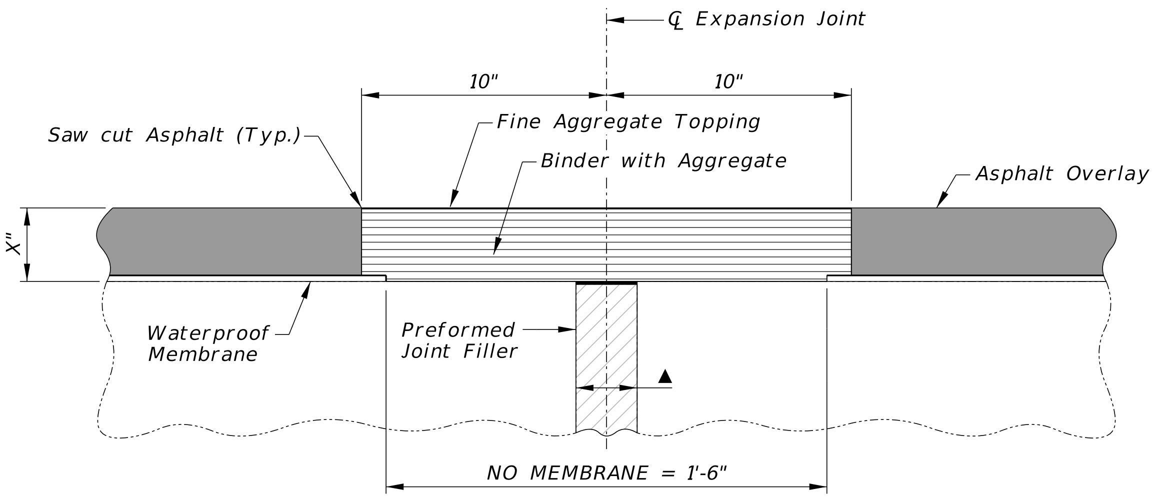


Figure 7.3—Asphalt Plug Joint Standard Detail

Standard notes and details for the Asphalt Plug Joint are provided in the Expansion Joint Base Sheet. The Base Sheet notes define when Backer Rod, Bridging Plate, or both are needed to be included as part of the system. When installing an Asphalt Plug Joint over an existing Strip Seal, the Bridging Plate is mandatory.

Asphalt Plug Joint pay item will be listed as Group 9 on the front sheet of the bridge plans and standard note #111 shall be included.

7.2.3.4.3—Asphalt Overlay Saw & Seal Joints

Saw & Seal Joint pay item will be listed as Group 9 on the front sheet of the bridge plans and standard note #111 shall be included.

7.2.3.4.3a—End of Floor—Non-Movement

For bridges receiving an asphalt overlay, a Saw and Seal joint at the End of Floor should be included on all projects, unless there is a movement joint at the End of Floor. This joint will only be cut 1 in. deep to control cracking of asphalt overlay. Fill with hot pour sealer (Figure 7.4).

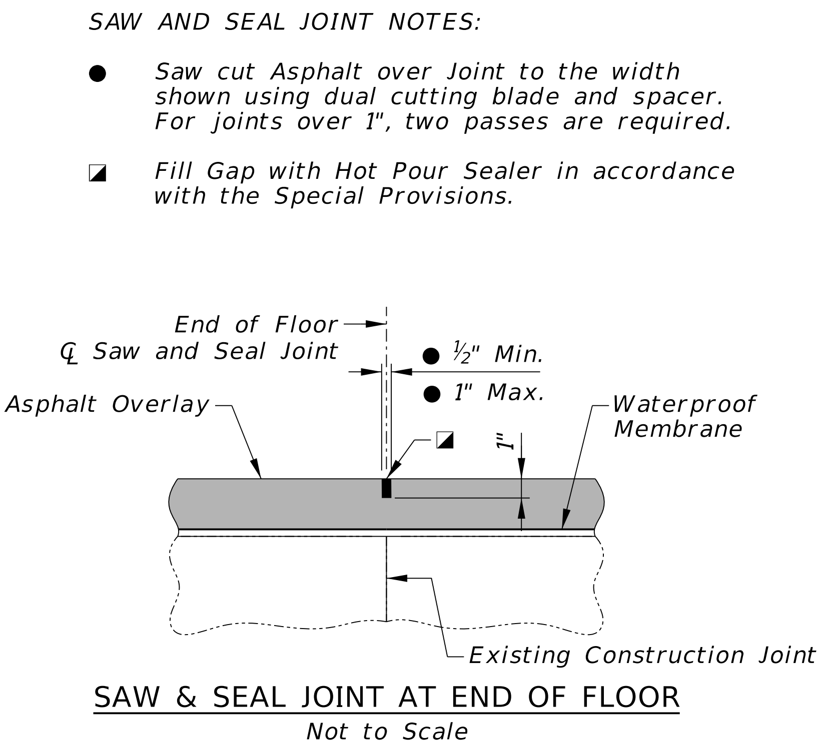


Figure 7.4— Saw and Seal Joint at EOF (Non-Movement)

7.2.3.4.3b—Grade Beams or Sleeper Slabs

For TM ≤ 1 in., install Saw & Seal joint to match existing joint width and fill with hot pour sealer only. If existing Grade Beam Joint is greater than 2 in. wide, or a Strip Seal type joint, a plug joint will be required (Figure 7.5).

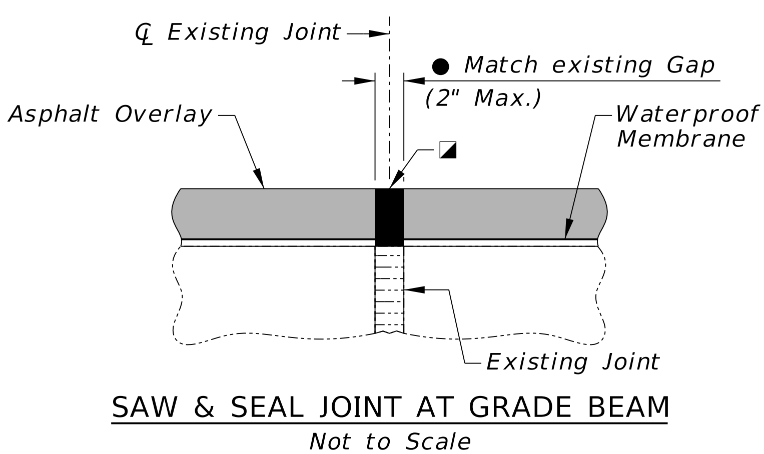


Figure 7.5—Saw and Seal Joint at Grade Beam (Expansion Joint)
See Figure 7.4 for symbols definitions and notes.

7.2.3.4.3c—End of Paving Pressure Relief Joint

Where there is no underlying joint (tie-bar joints and approaches against AC roadway pavement) install a 1 in. deep saw and seal joint above the EOP as shown in Figure 7.6.

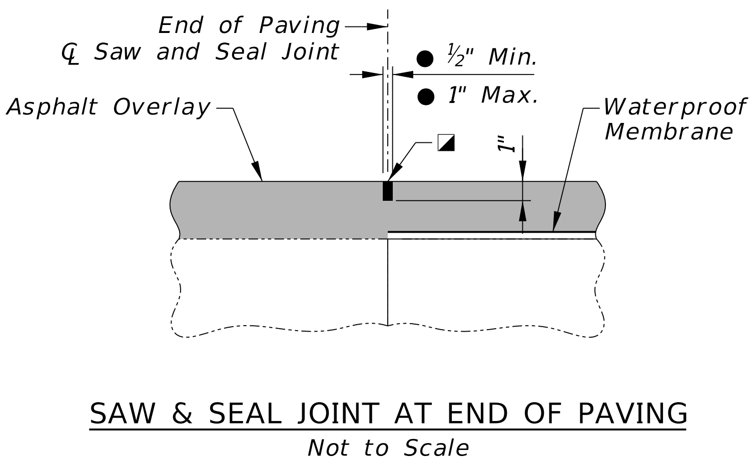


Figure 7.6—Saw and Seal Joint at EOP (Non-Movement)

See Figure 7.4 for symbols definitions and notes.

Where there is a 1 in. existing joint at the EOP mirror that joint as a 1 in. wide saw and seal joint in the overlay as shown in Figure 7.7. This style of joint was typical for approach construction from circa 1990 to 2005 and 2023 to current.

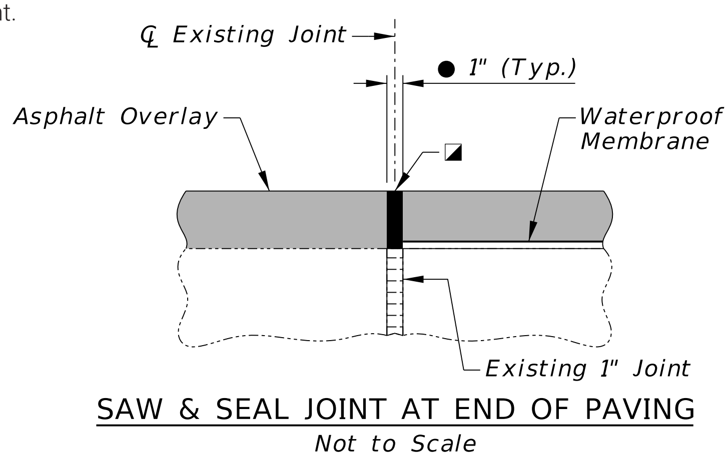


Figure 7.7—Saw and Seal Joint at EOP (Existing 1 in. Joint)

See Figure 7.4 for symbols definitions and notes.

Where there is a 3 in. existing joint at the EOP mirror that joint as a 3 in. wide saw and seal joint with support for the hot pour sealant in Figure 7.8. This style of joint was typical for approach construction from circa 2005 to 2022.

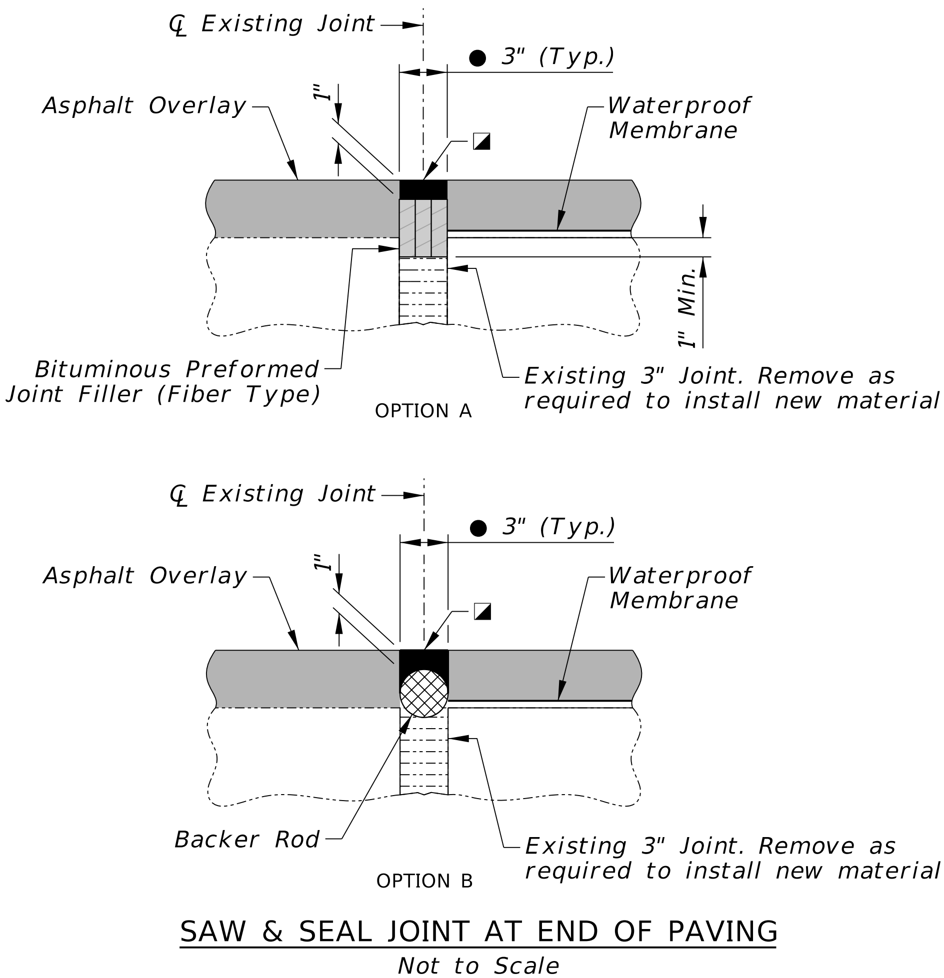


Figure 7.8—Saw and Seal Joint at EOP (Existing 3 in. Joint)

See Figure 7.4 for symbols definitions and notes.

Prior to circa 1990 the standard was a 4 in. pressure relief joint, joints that wide require an asphalt plug joint, see §7.2.3.4.2.

7.2.3.5—Delayed preservation of New Decks with AC+M

The most efficient construction results from placing asphalt overlays in conjunction with mainline asphalt paving projects for numerous reasons, which are beyond the scope of this document. When new bridges are built or bridges are re-decked on bridge-only projects, the decision can be made to delay the placement of the AC+M until a future resurfacing project that includes the bridge in the project limit.

Some design considerations for delayed deck preservation:

- For an AC+M project that is programmed and planned within a 2-year time frame with a high level of confidence, the new deck shall not receive grooving, but shall receive a burlap finish only. Otherwise, grooving shall be applied to the bridge deck.
- Consider joint selection and detailing that will avoid the placement of a second set of joints at the level of the asphalt overlay on the future project.

An example of delayed preservation is as follows:

- New construction: Three new bridges were built on CN 13204, Adams West Bridges in 2018. The bridges received a burlap finish only, per addendum No. 3, Call № 100, letting 18 Jan. 2018. The Midwest Guardrail System (thrie beam and w-beam) was installed at 34 in. height when the bridges were built.
- Delayed Preservation: The bridges received fabric waterproofing membranes and asphalt overlays in 2022 on CN 13186, Adams West.

7.2.3.5.1—Joint Considerations

Joint concepts to be considered when the grade raise associated with AC+M is scheduled for a separate project within 5-10 years of initial construction.

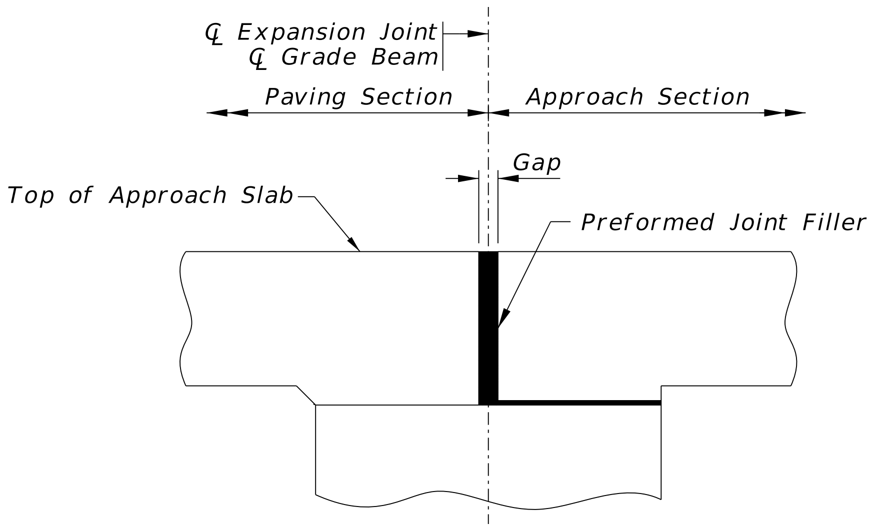
NDOT Material and Research Division (M&R) has provided guidance about the safety of new bridge decks relative to burlap surface texture. M&R performed skid testing of burlap finished, non-tined PCC in November 2015; the bridge deck of S080 39562 (NW 48th Street, Lincoln, NE) and a concrete shoulder just west of the same bridge. Average friction numbers were 42 and 49, respectively. These numbers are in the range of a new HMA pavement and slightly higher than 1 year old HMA pavement (see typical values in Table 7.4). M&R has stated that bridges should be evaluated on a case-by-case basis, but in general are comfortable allowing burlap finished decks open to traffic as long as they have membrane/overlays included within the 5-year program following the new deck opening to traffic.

Table 7.4—Typical Friction Numbers

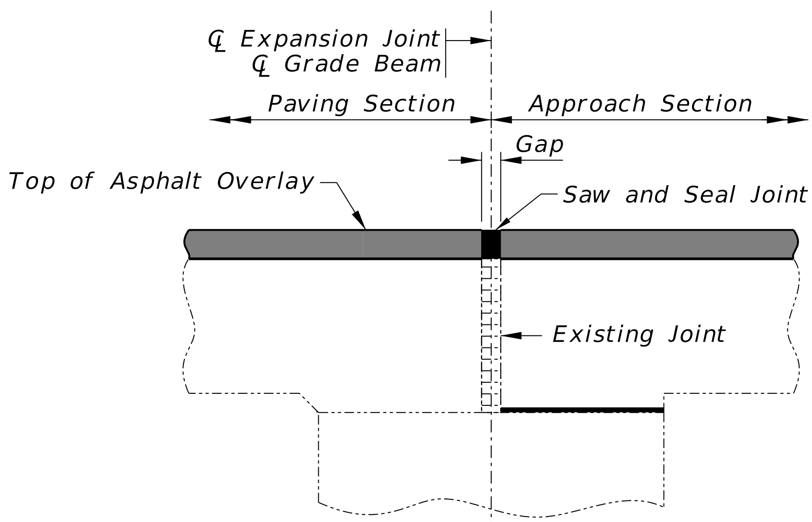
Comparison of Surface Treatments (Li et al., 2012)		
Chip Seals	Immediately after Application	SN 50-70
	At 12 months	SN 44-52
	Failure Segments at 12 months	SN 20-30
Microsurfacing	Immediately after Application	SN 28-57
	At 12 months	SN 40-60
	Continuous Decline after 12 months	
Ultra Thin Bonded Wearing Course	Immediately after Application	SN 48-59
	At 33 months	SN 32-39
Dense Graded HMA Overlays	Immediately after Application	SN 32-52
	At 12 months	SN 30-40
Fog Seals reduce friction by 20% to 33% until the return to the original SN after about 12 months		

7.2.3.5.1a—Small Movement Joints

Use Preformed Joint Filler in the gap in the initial condition. At the time of overlay, install a Saw and Seal Joint or Asphalt Plug Joint above it, see Figure 7.9 for an example.



A. Initial Construction

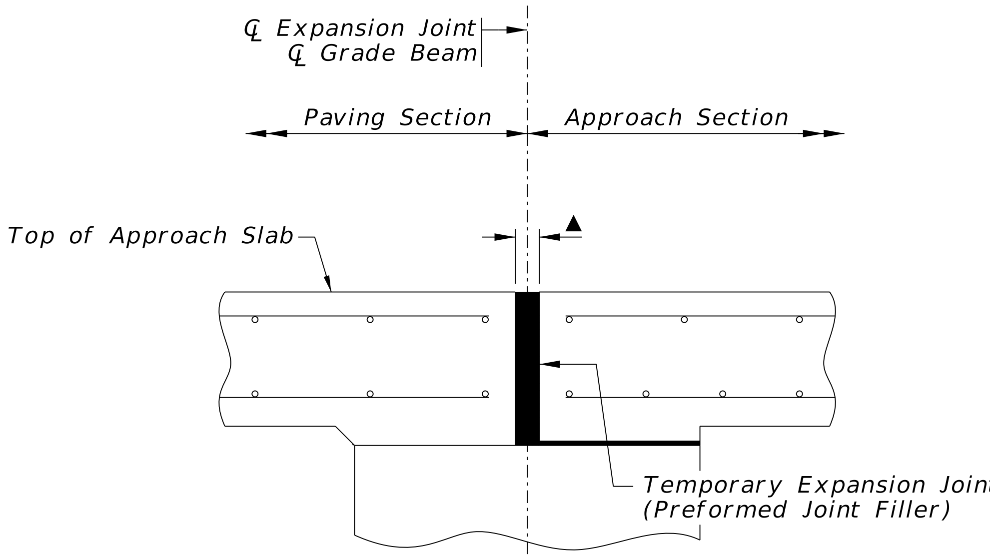


B. After Delayed Asphalt Overlay

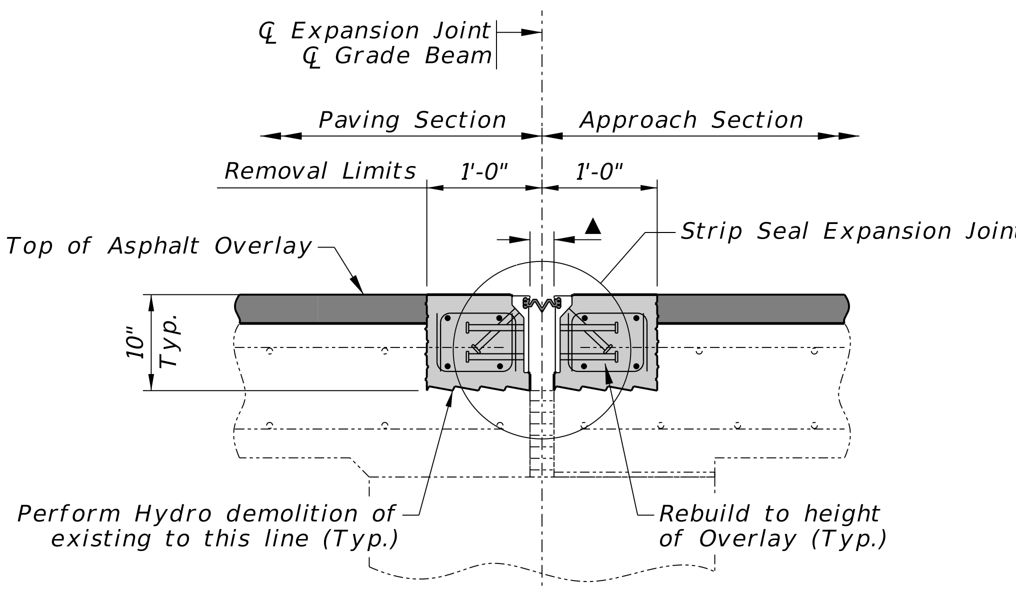
Figure 7.9—Small Movement Joints at Initial Construction and After Delayed Asphalt Application

7.2.3.5.1b—Medium Movement Joints

The example shown in Figure 7.10 uses a simple gap in the initial condition. At the time of overlay, hydro demolition is used to remove existing approach slab concrete to the depth needed for installation of a strip seal anchorage.



A. Initial Construction



B. After Delayed Asphalt Overlay

Figure 7.10—Medium Movement Joints at Initial Construction and After Delayed Asphalt Application

7.2.3.5.1c—Large Movement Joints

The example shown in Figure 7.11 utilizes temporary wedges on each side of a large modular expansion joint device to install the joint to overlay grade at the time of initial construction. Coordination with Roadway Division will be required.

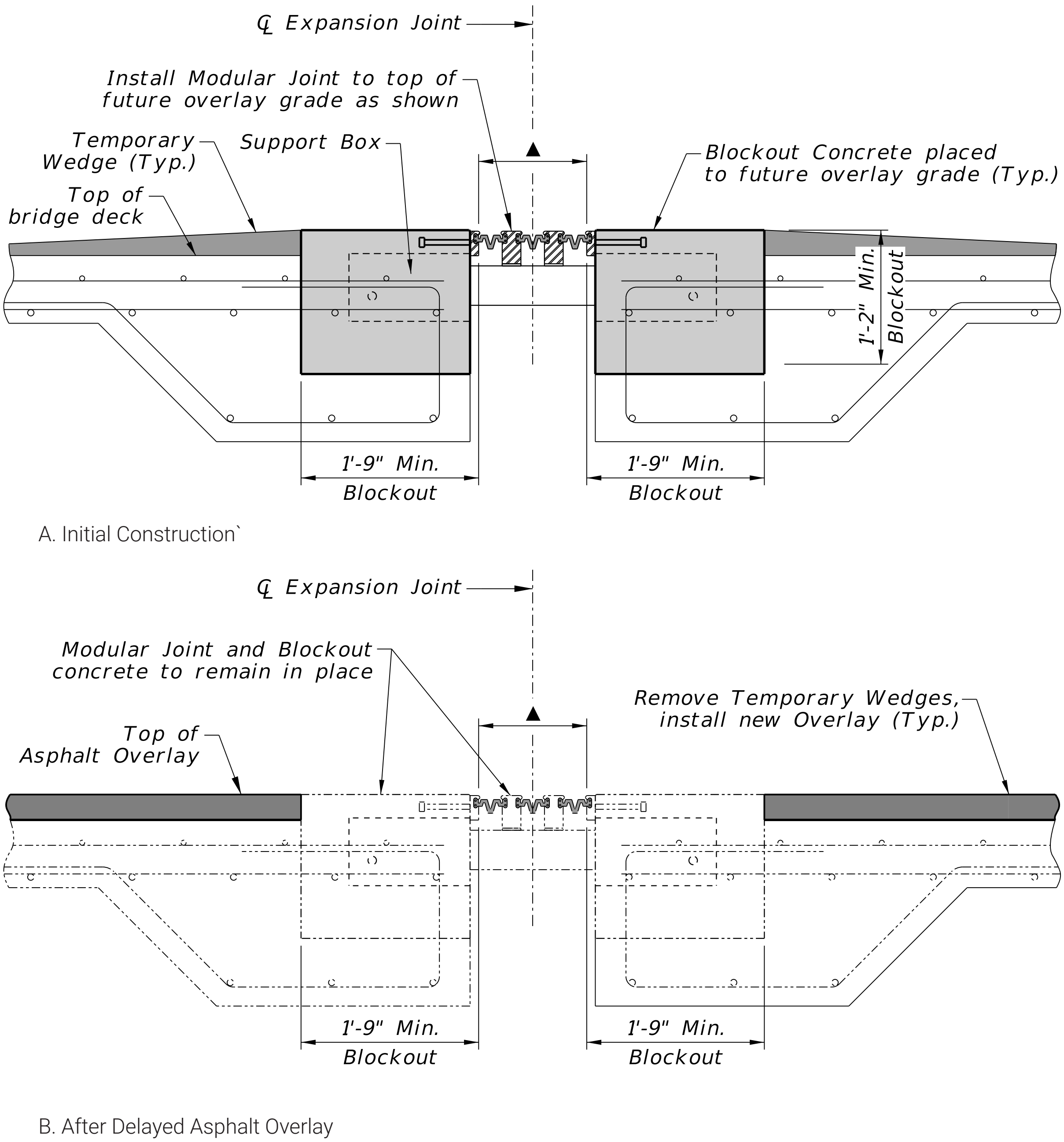


Figure 7.11—Large Movement Joints at Initial Construction and After Delayed Asphalt Application

7.2.3.6—Removal of Existing Overlays

7.2.3.6.1—Concrete Overlay to be removed

When placing a waterproof membrane on a bridge with an existing concrete overlay, the existing overlay shall be removed to the top of the concrete bridge deck. The pay item "CONCRETE SURFACE MILLING" shall be included in the plans. In exceptional cases, AC+M may be placed on top of existing concrete overlays.

Common practice prior to 2010 was to place concrete overlays on decks at the time bridges were widened. It was typical for bridges to also have new bridge approaches built to the height of the concrete overlay. To meet minimum overlay thickness on the approach slabs, the top of the approaches are milled for 1 in., while the concrete overlay on the bridge is removed. This lead to a 1 in. grade raise, as shown in Figure 7.12.

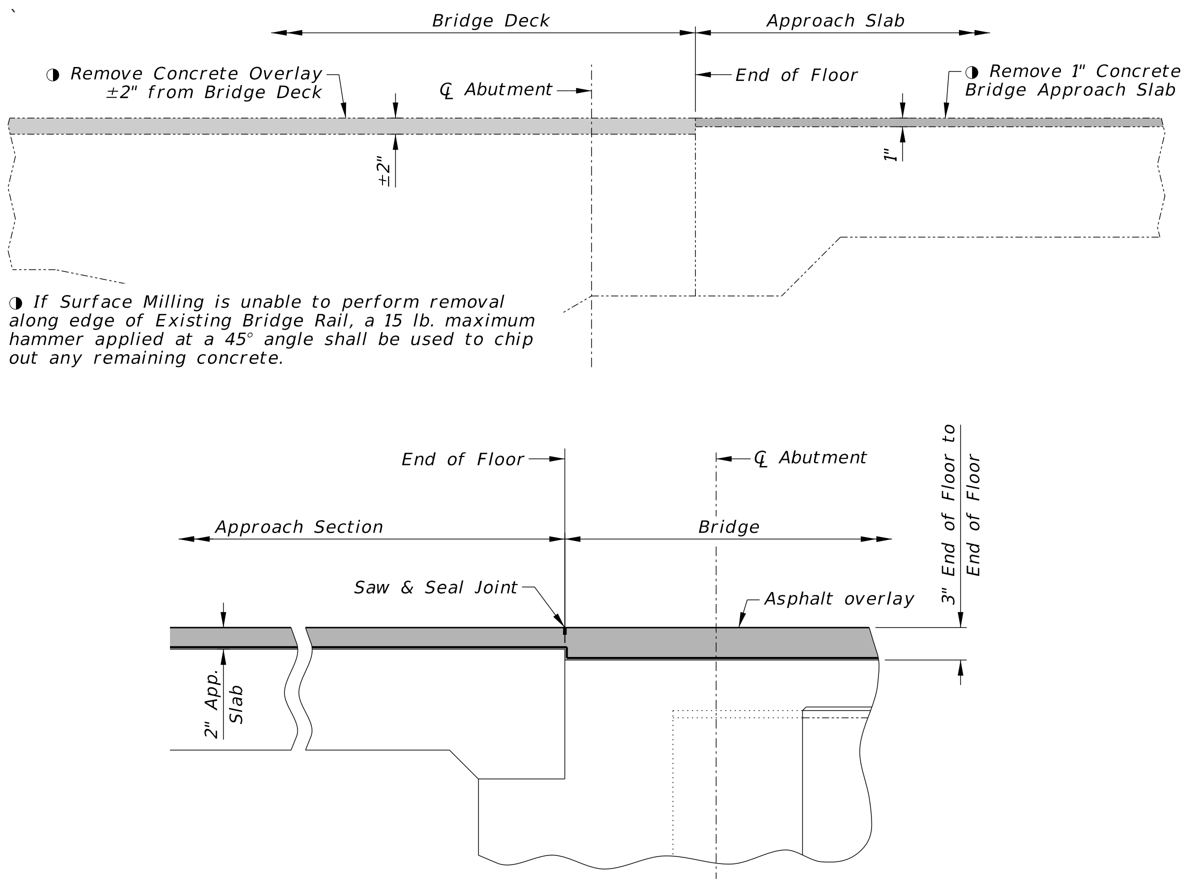


Figure 7.12— Removal and Asphalt Overlay Detail for Bridges with Existing Concrete Overlays (example taken from S025 00256, CN 71227, 2023)

7.2.3.6.1a—Parabolic deck cross-section

For existing bridges that have a parabolic deck cross section, a detail similar to Figure 7.13 should be shown on the plans.Asphalt Overlay to be removed

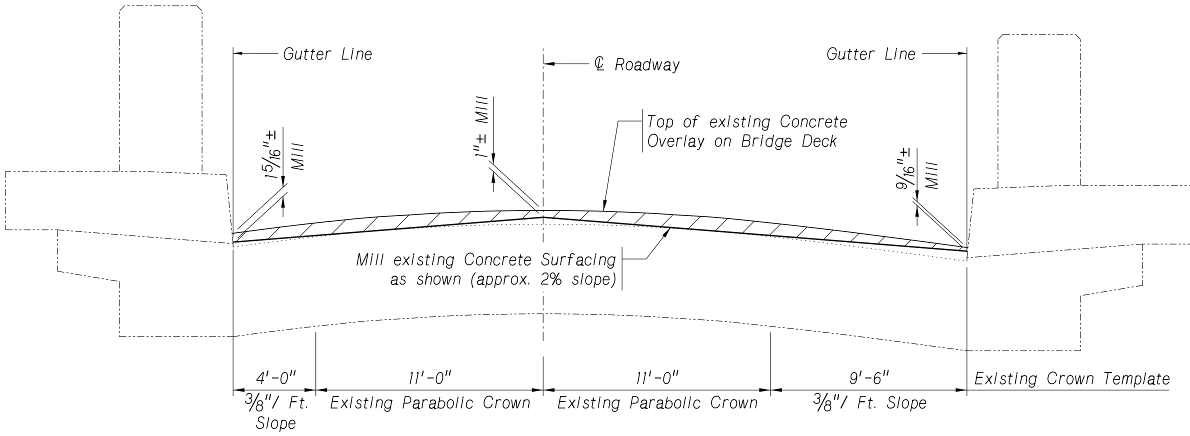


Figure 7.13—Milling of Existing Concrete Overlay for Parabolic Bridge Decks (example taken from S080 32744R, CN 42888, 2020)

7.2.3.6.2—Asphalt Overlay to be removed

When placing a waterproof membrane on a bridge with an existing asphalt overlay, the existing asphalt shall be removed to the top of the concrete bridge deck. The pay item “REMOVE ASPHALT SURFACE FROM BRIDGE” shall be included in the plans.

7.2.3.6.3—Waterproof Membrane to be removed

In cases when there is an existing waterproof membrane on the bridge that is intended to be removed, it shall be called out in the plans. Typically, the removal of existing membranes is laborious, and contractors need to be made aware of their existence.

7.3—COMMON REMODELING GUIDELINES AND EXAMPLES

7.3.1—Approach Slab Addition or Replacement

The following guidelines apply to adding and replacing Approach Slabs.

This policy attempts to encapsulate the most common Approach Slab Addition/Replacement scenarios and may not apply to all situations.

7.3.1.1—Approach Slab

7.3.1.1.1—General

Approach addition/replacement shall follow the same criteria as new approach slabs, see §15.1.

As part of an Approach addition/replacement, designers shall, as much as possible, remodel EOF to move any existing joint to the new grade beam location.

7.3.1.1.2—Preliminary Investigation

Review of the As-Built Roadway Plans is needed in many cases to determine whether there are approach slabs on the existing bridge. This determines whether Approach slabs are being added or replaced.

- Approach Slab Replacement - Most existing Bridges were built with Reinforced Concrete Approach Slabs, which for many years were included in the Roadway Standard Plans.
- Approach Slab Addition - In less common circumstances, the existing bridge will not have Approach Slabs. This is usually in cases where the adjacent roadway is purely asphalt pavement. For these cases, Approach Slabs will have to be added to the bridge.

Do not assume the presence of an approach seat on the turndown or abutment indicates the presence an approach slab, this was not uncommon in the past.

Satellite imagery has become high enough resolution it is often possible to tell an approach slab exists just by looking for reflective cracking at the end of floor and grade beam/sleeper slab.

7.3.1.1.3—Abutment Pile Evaluation

When adding Approach Slabs to an existing Bridge, the designer shall evaluate the capacity of the existing Abutment Piles to determine whether they can handle the additional load of the new approach slabs and turndowns (if necessary). Live loading for Abutment Pile Evaluation shall be per §3.4.4.

Until Chapter 3 is published, use the following for live loading:

Evaluate Abutment Piles for the live loading that was used when the bridge was constructed.

For Approach Slab Replacements, no analysis of the Abutment Pile is needed. The Abutment Pile are assumed to have accounted for this load during the original design.

7.3.1.1.4—Use of Relative Elevations

For Approach Slab addition/replacement, unless the bridge is undergoing more extensive remodeling work (Redeck or Rehab) on the project, it is typically not necessary for the designer to calculate and report Profile Grade Elevations in the plans.

In these cases, the profile grade can be established in the field during construction. Figure 7.14 shall be put in the plans for the field personnel.

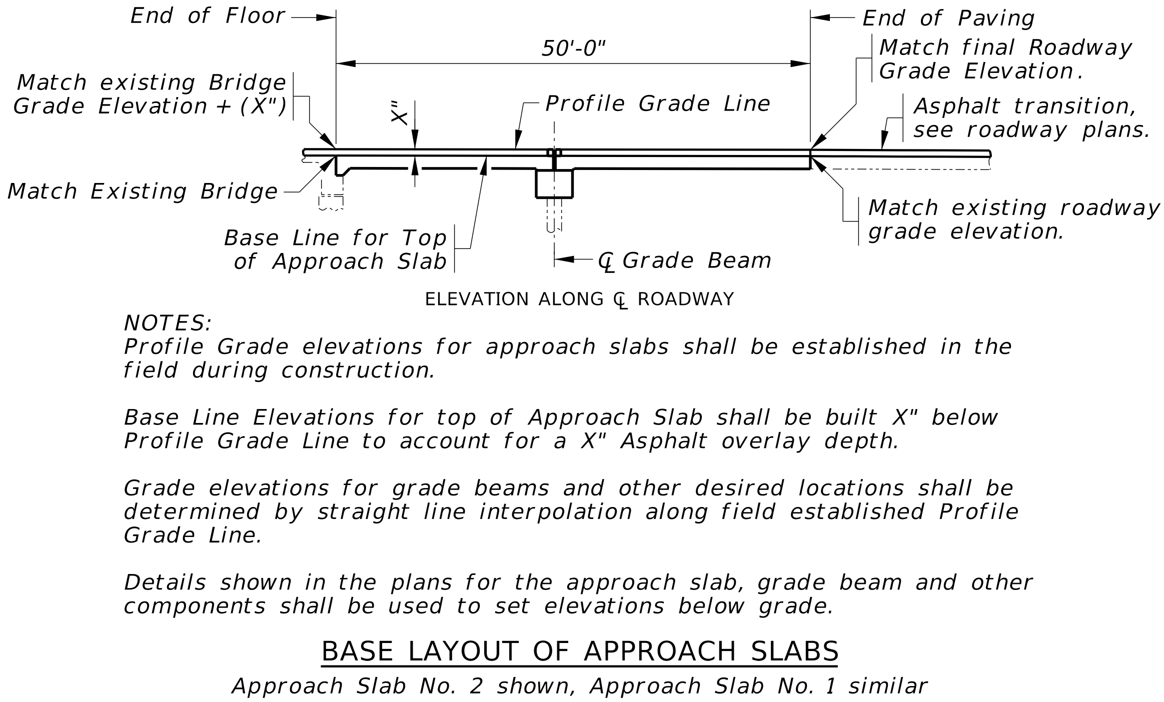


Figure 7.14—Base Layout for Use of Relative Elevations in Approach Slab Remodel (available as Cell “013-Appr. Slab Base Layout”)

7.3.1.2—Existing Wingwall Remodel

In most approach slab replacement projects, the existing Abutment wings will be incorporated into the new work. When existing wingwalls interfere with placement of new approach slabs, the top of the wing wall shall be broken down to accommodate the thickness of the new approach and 2 in. of polystyrene, see Figure 7.15.

Existing Abutment wing walls that interfere with new Approach Slab placement will typically be broken down 1 ft. 4 in.± from the top of the new Approach Slab elevation. This depth will accommodate the placement of a 1 ft. 2 in. thick Approach Slab and a layer of 2 in. polystyrene to be placed atop the Wing Wall.

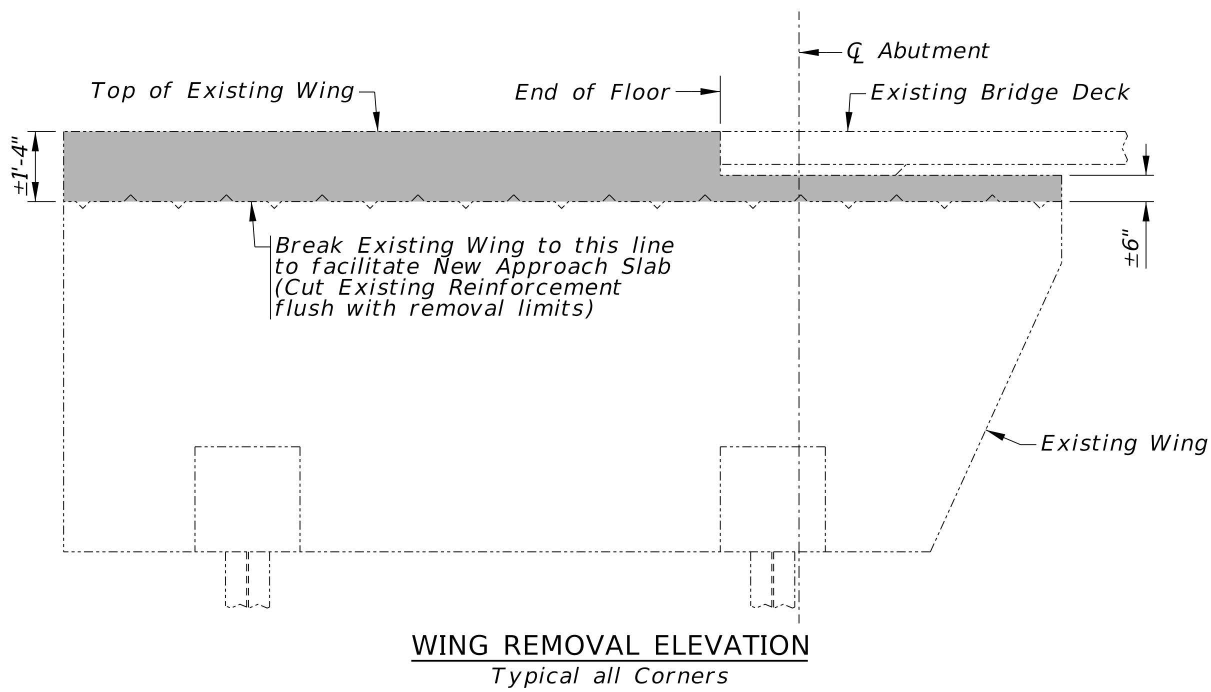


Figure 7.15—Partial Wingwall Removal to Accommodate New Approach Slab (example taken from S006 36293)

7.3.1.3—Adding or Replacing Sheet Pile at Abutments

Installation of new Steel Sheet Pile to convert existing flared wings to U-Type and/or behind an existing abutment cap need only be considered if there is a hydraulic concern regarding scour, which will require coordination with the Hydraulics Section, or a structural concern regarding the condition of the existing wings, see Sheet Pile Policy in §11.1.5.

7.3.1.4—Turndown Modifications

7.3.1.4.1—Preliminary Investigation

Before initiating final plans, designers should investigate, and sketch out as necessary, the as-built details of the abutment, expansion joint, and bridge deck to determine the most appropriate backwall modification for the bridge.

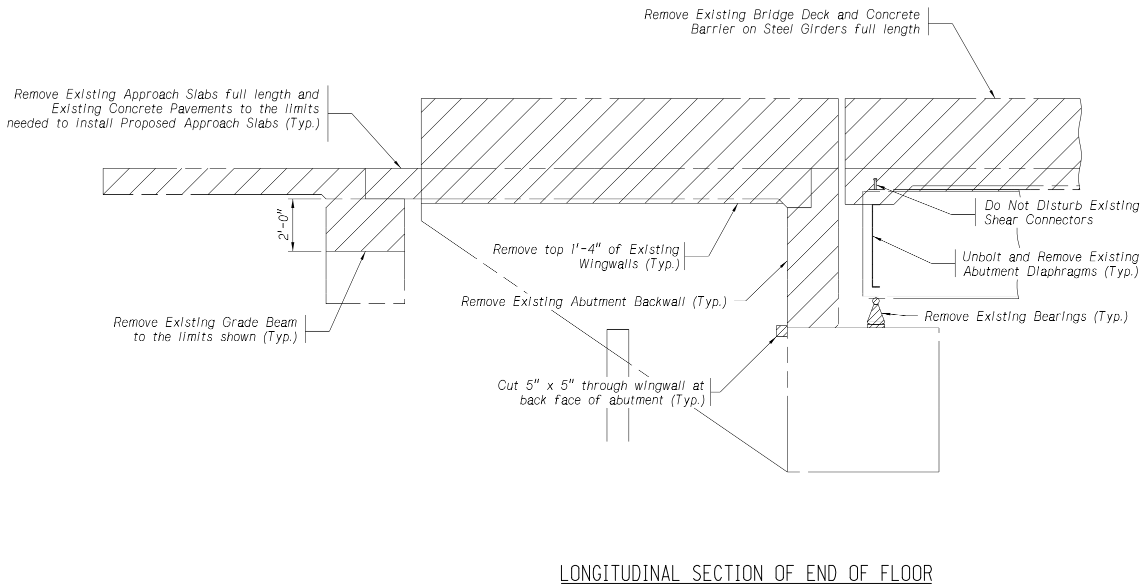
When eliminating an existing expansion joint with a turndown, it's important to keep the remaining abutment substructure elements isolated from the expansion and contraction of the superstructure. This is particularly true on long span bridges subject to large thermal movements.

7.3.1.4.2—Existing Abutment/Backwall Considerations

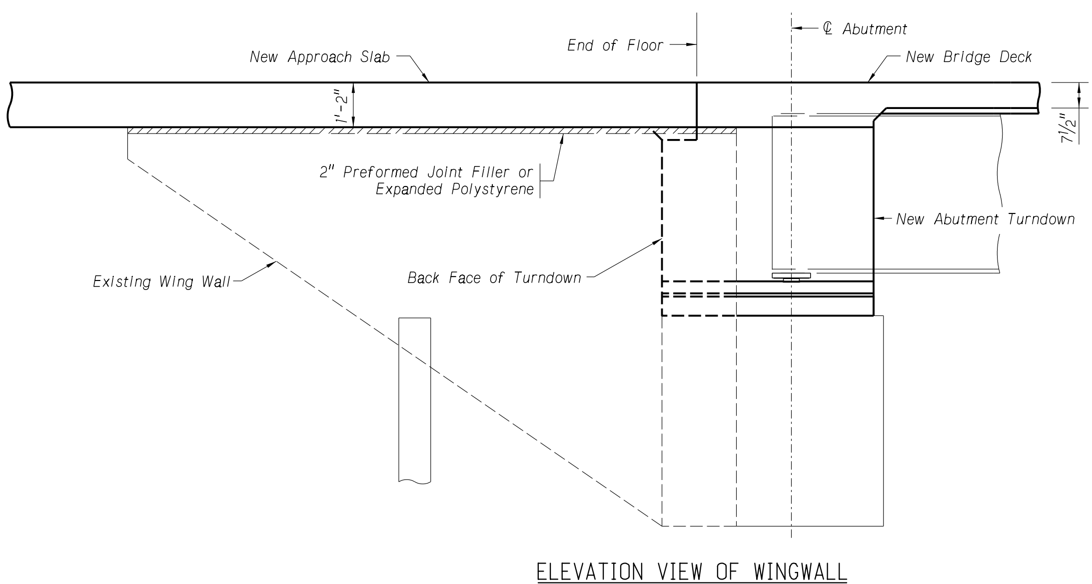
Typical Existing Bridge Abutment scenarios are listed below.

7.3.1.4.2a—Backwall Abutment

Remodel End of Floor with turndown, move expansion joint to grade beam, see Figure 7.16 for example details.



A. Removals



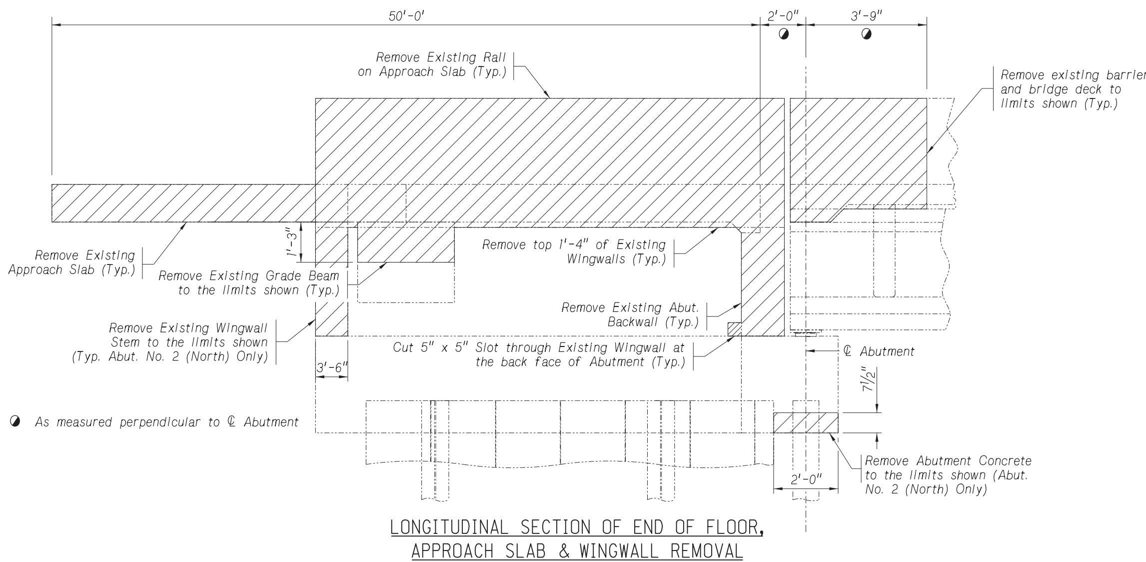
B. Final Condition

Figure 7.16— Remodeling of Abutment with Backwall to Semi-Integral Abutment with Expansion Joint at Grade Beam. Bearings without Anchor Rods

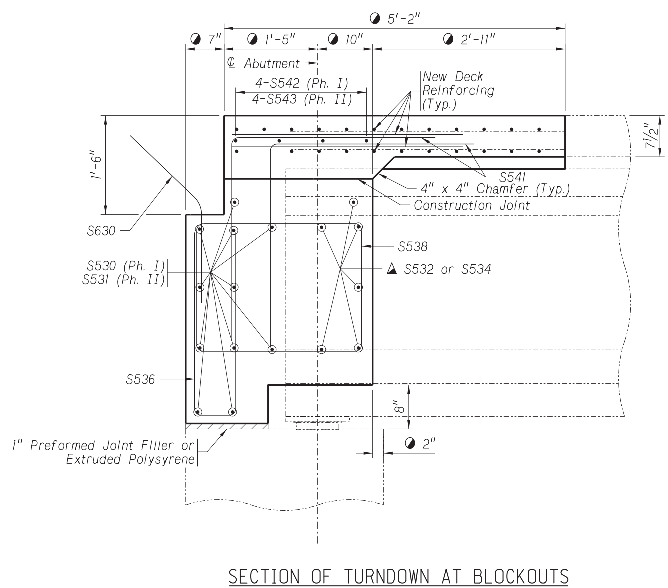
(example taken from S064 07011R CN 22689, 2018)

7.3.1.4.2b—Bearings with Anchor Rods

Block out turndown around existing bearings as needed to accommodate proper functionality of the components (Figure 7.17).



A. Removals



B. Turndown Final Condition

Figure 7.17—Remodeling of Abutment with Backwall to Semi-Integral Abutment with Expansion Joint at Grade Beam. Bearings with Anchor Rods
(example taken from SL56G00048, CN 61590, 2020)

7.3.1.4.2c—Existing Abutment Cap without Pedestals & Heavy Skew

Consider guiding expansion by installing a stepped grade beam as seen in Figure 7.18.

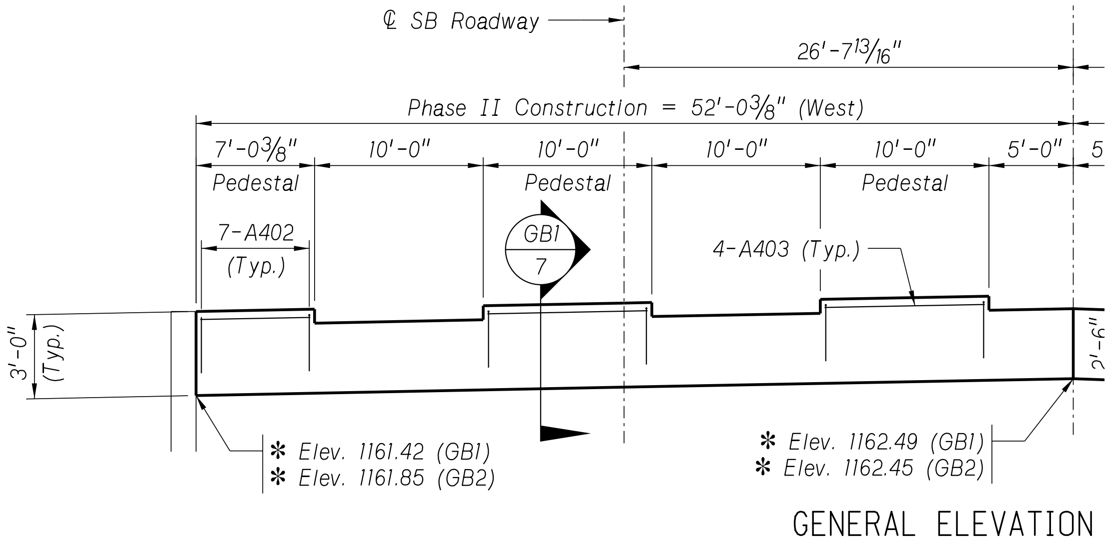


Figure 7.18— Stepped Grade Beam to Guide Expansion for High Skews without Pedestals at Abutments (example taken from S080 40350, CN 13111, 2016)

7.3.1.5—Adding Turndowns

7.3.1.5.1—Full Depth Turndown

Turndown details should closely follow the examples shown in §9.5.2.

Blockouts shall be detailed around girder bearings with anchor rods. The depth of the blockout shall be sufficient to accommodate the full range on anticipated movement

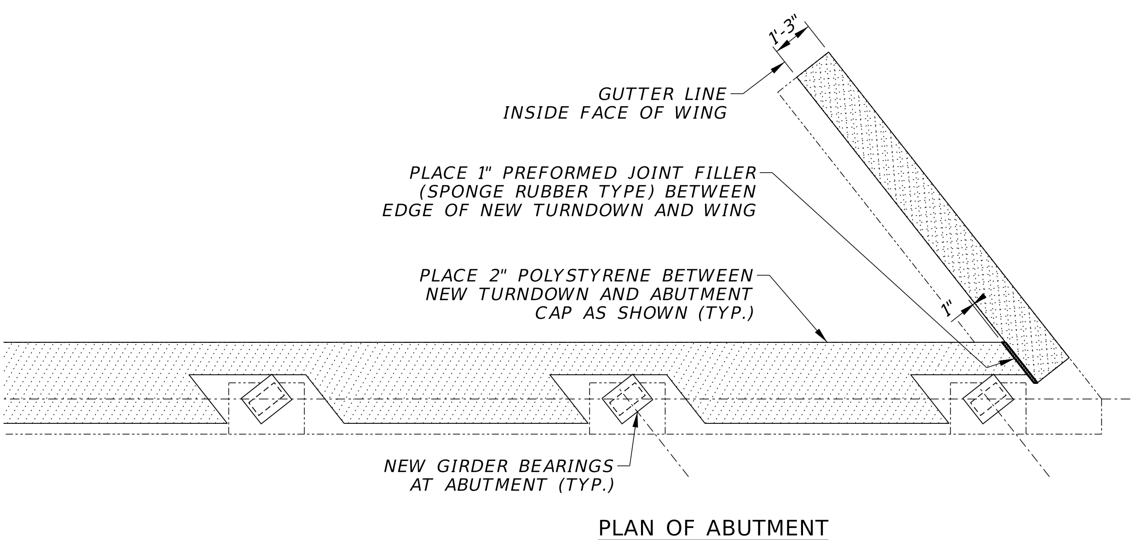


Figure 7.19—Joint Filler for Turndown Remodel

(example taken from S030 42623R, CN 22688, 2019)

at the support. The skew of the existing pedestals should also be considered see §9.5.1 for blockout dimensions.

Joint filler or Polystyrene (2 in. minimum on horizontal faces, 1 in. minimum on vertical faces) shall be installed between the turndown and abutment. Wings may also need to be remodeled/removed at the intersection of the abutment to accommodate the new turndown, see Figure 7.19.

7.3.1.5.2—Partial Turndown

A partial turndown provides the benefits of eliminating the joint at the end of floor without removing the back wall completely. It also avoids forming around/blocking out the existing girder pedestals and bearings.

Use of Partial turndown details are encouraged in cases of deep superstructures (depth greater than 3 ft.) with existing backwalls in good condition. Heavy skew angles with challenging abutment geometry are also good candidates for utilizing these details.

When using partial turndown details, High-Density Polyethylene sheets are used to provide a sliding surface is installed between the remaining backwall and new turndown, see Figure 7.20.

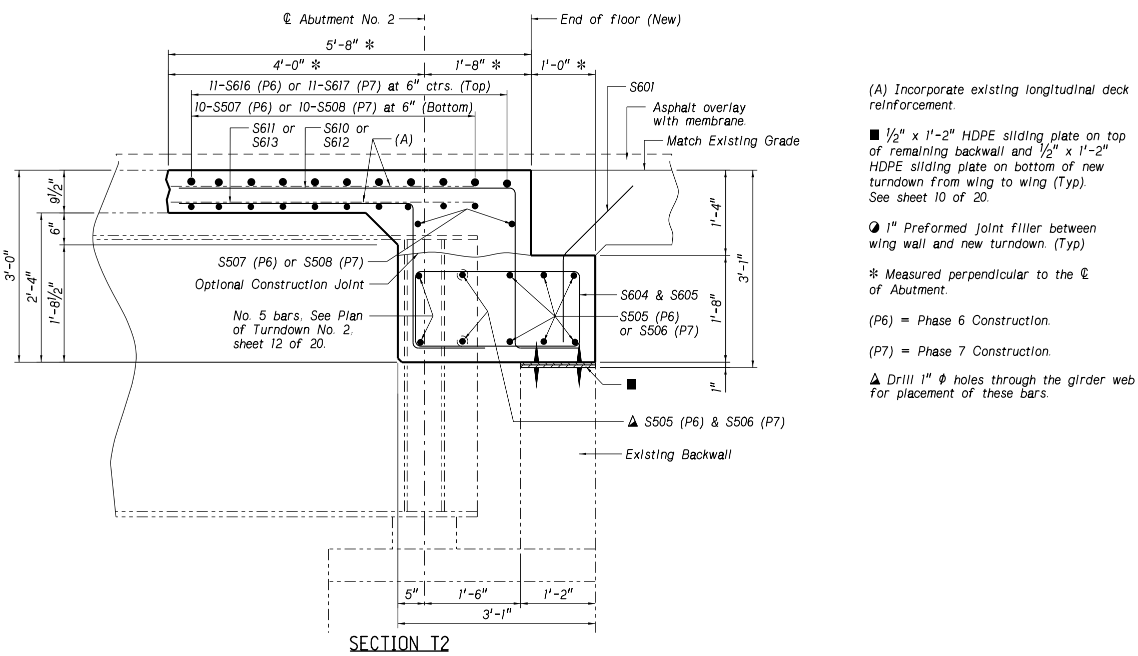


Figure 7.20—Partial Turndown with HDPE Sliding Plates
(example taken from S080 45314R, CN 22646, 2017)

7.3.1.6—Approach Seat Modifications

Typical bridge/abutment types that can be used in place for Approach Slab work are shown below.

- Existing Slab Bridge — May be used in place without need to remodel the deck side of the bridge. The minimum approach slab seat width is 7 in.
- Existing Turndown Bridge — May be used in place. Typically, only requires replacement if the existing turndown is in extremely poor condition. Most issues with existing turndowns are localized in nature and can be repaired with Concrete Patching.
- Existing Integral Abutment — May be used in place. Minor remodeling of the deck side may be required for situations where the existing joint is on the back face of the abutment at the end of floor. These joints should be moved to the Grade Beam.

For these cases dowel tie bars into the existing Approach Slab seat to tie in the new approach slab. Typically #6 @ 12 in. centers are used for the dowels.

7.3.1.7— Grade Beam

Grade Beams for Approach work on existing bridges shall follow the same criteria as Grade Beams on new Bridges, see §11.1.6. Live loading for new Grade Beam Piles shall be per §3.4.5.

In special replacement circumstances (MSE straps, utilities, etc.) Approaches may be replaced in kind, on top of an existing sleeper beam with Bridge Division approval.

7.3.1.7.1—Geotechnical Coordination

Pile recommendation from Geotech is necessary for approach slab projects. In many instances, Geotech will recommend the existing borings from the As-Built Plans be used on the geology sheet for approach work instead of taking new borings.

When this is the case, the boring information can be shown in the plans without developing a full geological profile. A line to approximate the bottom of the grade beam should be shown on the boring details as seen in Figure 7.21.

Until Chapter 3 is published, use the following for live loading:

Evaluate Grade Beam Piles for the live loading that was used when the bridge was constructed. For HS-25 and less, report the design pile bearing in tons. For HL-93, report the design pile bearing in kips.

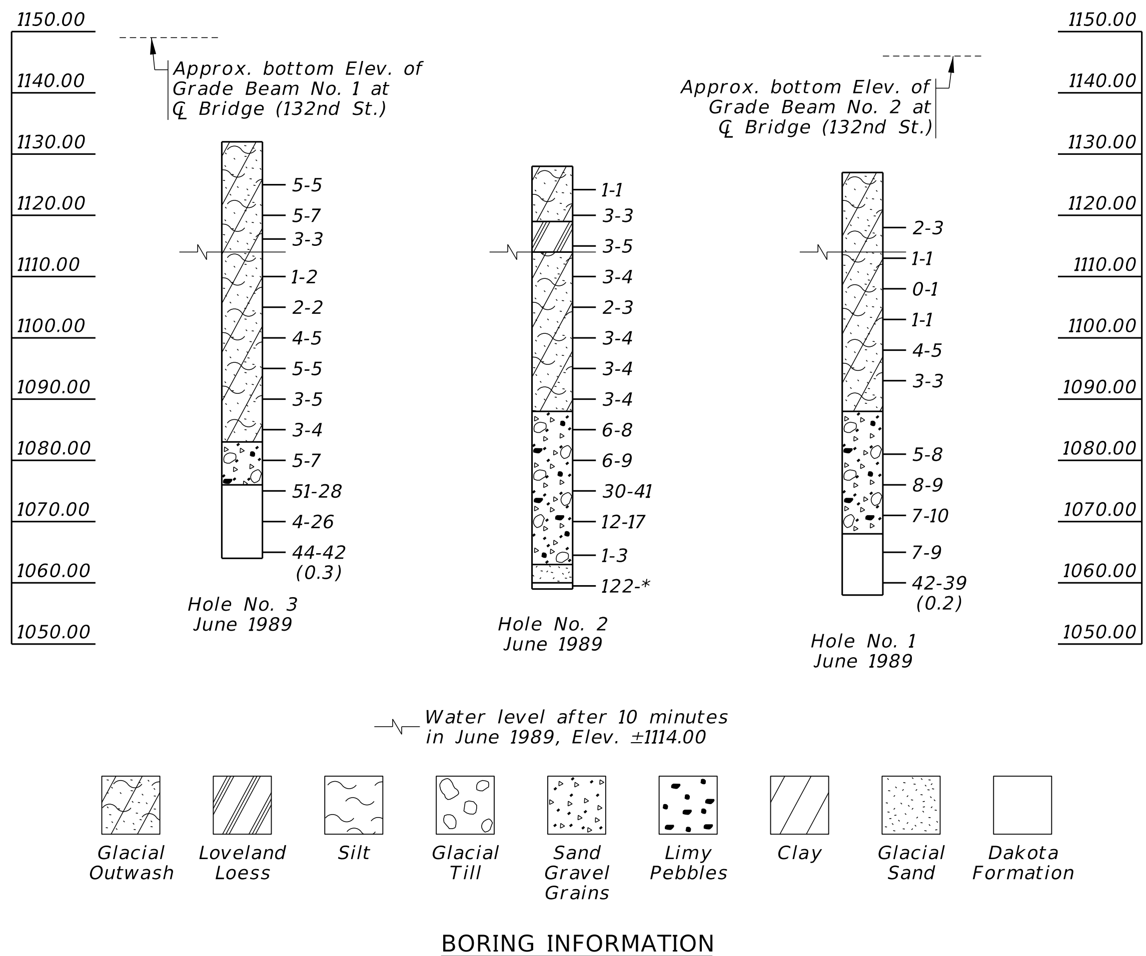


Figure 7.21— Reuse of Existing Borings for New Approach Slab

(example taken from S006 36293 CN 22812, 2023)

7.3.1.7.2—Helical Pile

Coordination with M&R Division Geotechnical Section will be required to check for location suitability. Geotechnical Section will not typically suggest helical pile, but will provide the information if requested, §10.4.

7.3.1.7.3—Field Measured Cut-off Elevations

When relative elevations are used and grade will be established in the field, report "Field Measured" for the cut-off elevations in the pile data table.

7.3.1.8—Granular Backfill

1 ft. 0 in. minimum of Granular backfill shall be placed under the Approach Section and Paving Section for Approach slab replacements and additions.

When remodeling the existing abutment for turndown, granular backfill should be called out to at least 6 in. below the lowest extent to the remodeling work. Use the shallow or deep detail as appropriate. See Granular Backfill Policy in §11.1.8.

7.3.1.8.1—Existing Granular Backfill

Some existing bridges have been constructed with granular backfill behind the pavement under the approach section. When replacing approaches on these bridges, backfill details acknowledging the existing backfill shall be provided, see Figure 7.22.

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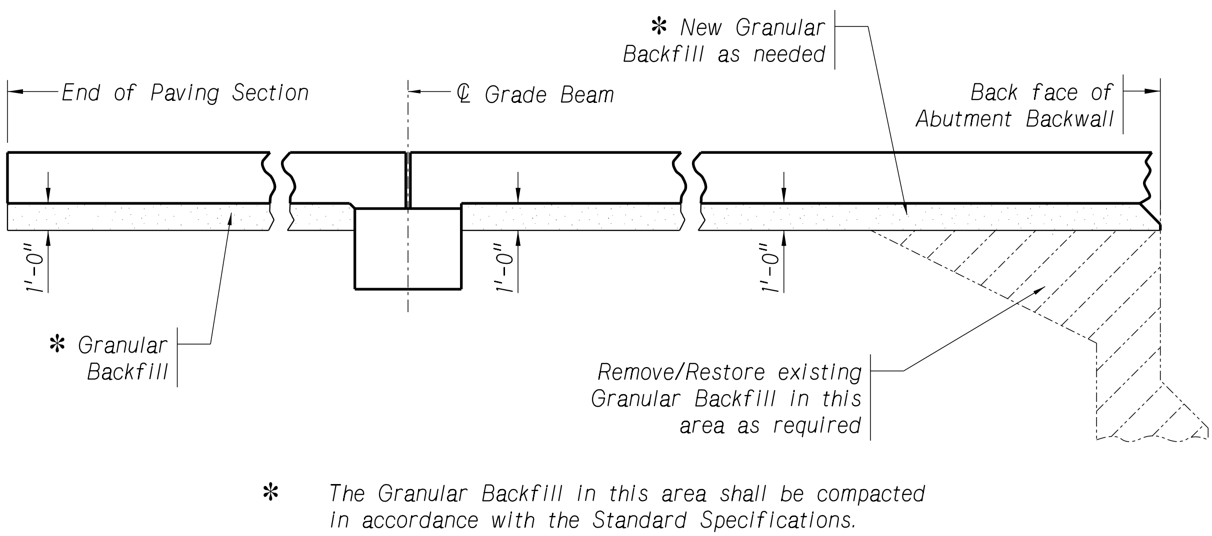

Figure 7.22—Section of Granular Backfill showing Extents of Existing Backfill
(example taken from S077 12752, CN 22762, 2022)

7.3.1.8.2—Drainage of Granular Backfill

Vertical drainage matting can be effective at preventing water from passing through the cold joint between the turndown and abutment. When remodeling the existing abutment for turndown or new approach slab seat, drainage matting shall be installed behind the turndown. Standard details may need to be modified to fit the particulars of the situation, see Figure 7.23 for an example.

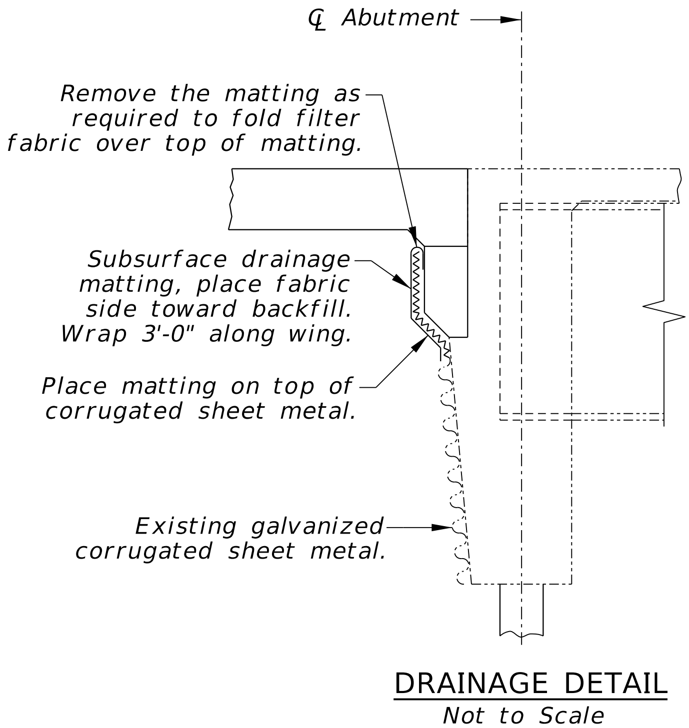

Figure 7.23—Abutment Drainage Detail with New Approach Slab Seat

(example taken from S075 09202, CN 22647, 2022)

If the designer wishes to install a transverse drainage system, it must be daylighted out of the granular backfill, see the example shown in Figure 7.24.

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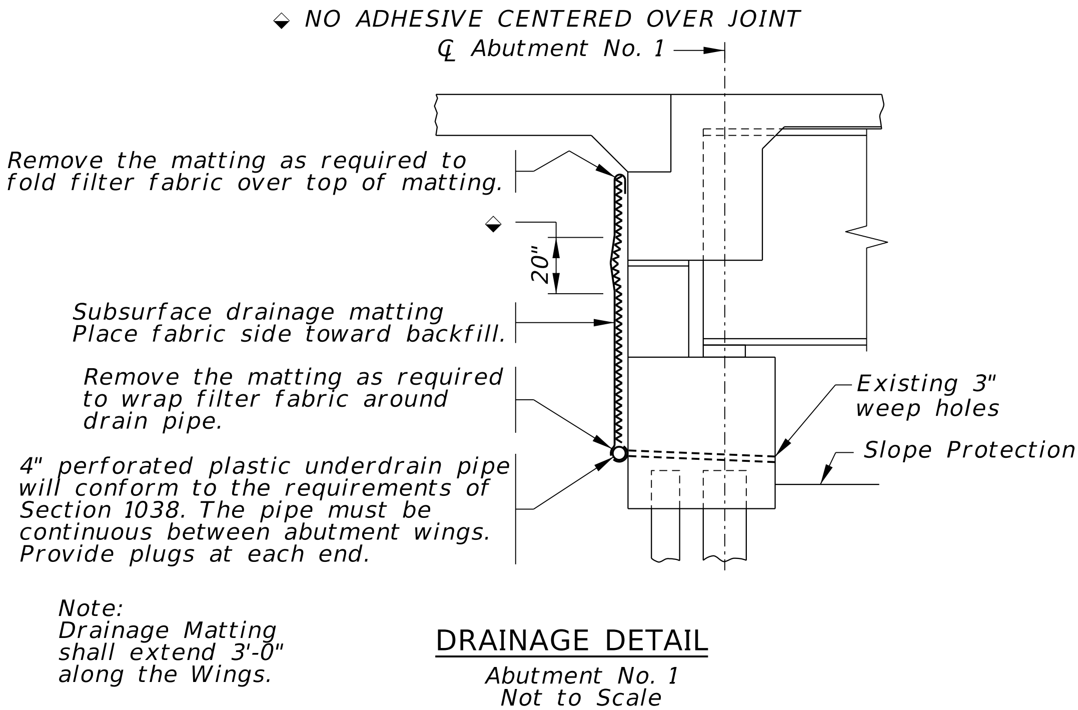


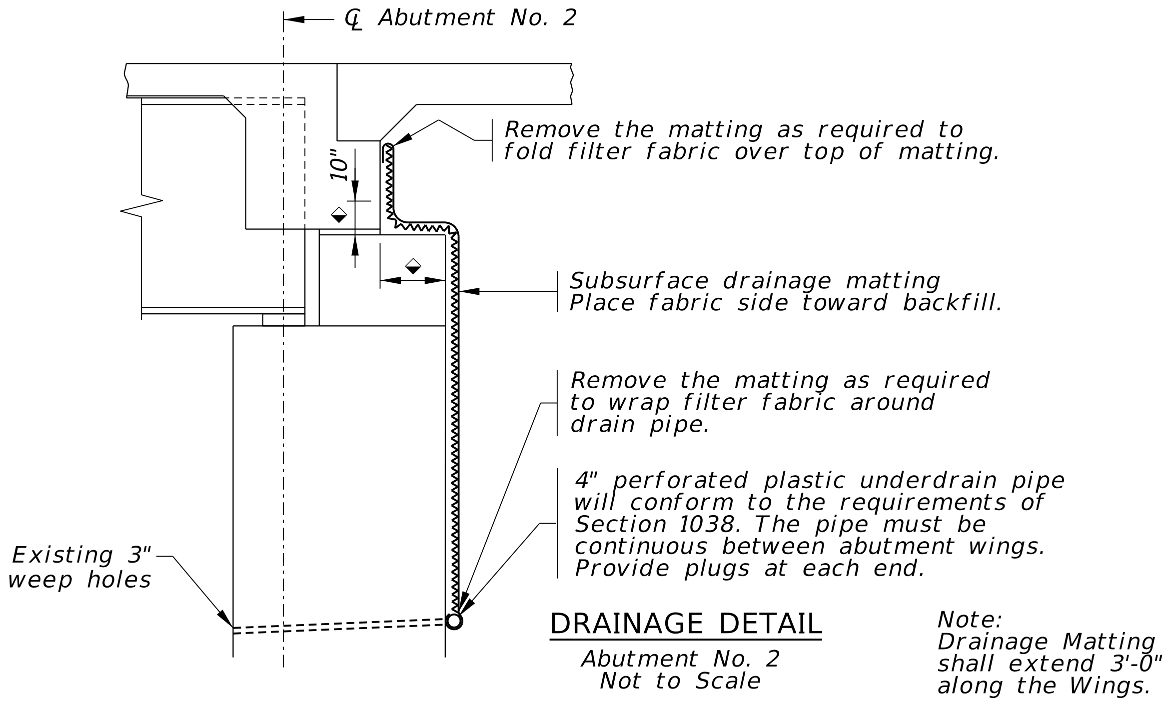


Figure 7.24—Abutment Drainage Details with Drainage Daylighting
(example taken from S075 09169, CN 22647, 2022)

7.3.2—Rail or Buttress Remodel

When scoping documents call for rail updates, the following guidelines should be followed.

Scoping documents use the following terminology to describe rail improvements:

- UPDATE RAIL – Work involving the removal of part or all the existing rail configuration and constructing a new concrete rail tied directly to the bridge deck. May include the term PARTIAL REDECK to include removal and replacement of the deck edge to facilitate the new rail. See §13.1 for more information.
- UPDATE BUTTRESS FOR MGS – Work involving the removal and replacement of the ends of the existing concrete rail to accommodate a new guardrail connection.

On 3R resurfacing projects, the guardrail will commonly be updated to MGS. The MGS will typically be installed with 34 in. guardrail height which requires the control bolt be located 24 in. above the top of deck. Most existing buttresses will need to be updated to satisfy these criteria. See NDOT Standard Plan 740-R1.

Responsibility for determining whether the existing Thrie Beam Connections need replaced rests with Roadway Design. See RDM Chapter 1 §6.C.2.a (Nebraska Department of Transportation, 2023). This will be determined during preliminary design or sometimes during the scoping phase of a project.

Due to the vast variety of existing rail configurations, it is not possible to explicitly address every possible configuration that may be encountered within the context of this policy. In the event an existing rail configuration is encountered that is outside the scope of this policy the appropriate rail remodeling strategy may be discussed with Bridge Division.

For many bridges built prior to 1980, the existing rail configuration consisted of a steel or aluminum handrail mounted to a concrete curb. When rail updates are scoped for bridges with this rail type, consideration should be given to replace the rail and deck edge to the same standards used for new construction.

Previous Bridge Division practice was to retrofit these rail types by construction of a concrete block type rail on top of the existing curb (referred to as a curb remodel), or by replacing the curb entirely with a new concrete block type rail connected to the deck is made using adhesive anchor bars. Few of the bridges of this type are still in service unaltered.

There is recently published research with Midwest Roadside Safety Facility and UNL to investigating options to retrofit existing buttresses for attachment of the MGS. More information can be found in Rosenbaugh et al., (2024). Bridge Division is currently investigating how to incorporate these devices into future plans.

7.3.2.1—Buttress Updates

See §13.3.2 for Standard End Section requirements for MGS Connections.

When the control bolt location is moved from its existing location, the new locations (Station & Offset) shall be coordinated with Roadway Design.

When using doweled in reinforcement as part of a buttress update plan, Special Provision 7-16 “Doweling into Concrete – Post Installed Adhesive Anchors” shall be used. In addition, a note regarding installation of these bars and the assumed hole depth shall be shown in the plans. These notes are available in the Repair cell library.

These scenarios are listed in order of preference. Flexibility for the exact location of the end of the Rail is required, depending on the configuration of each existing bridge project.

7.3.2.1.1—New Approach Slab

Place guardrail connection with the Standard End Section 6 ft. 6 in. from the centerline of the grade beam (Table 7.5).

Table 7.5—Examples of Buttress Update with New Approaches

Structure №	Existing Rail Type	Control №	Sheet №	Plan Year
S002 30589	29 in. Nebraska Rail	61596	4, 10	2017
S014 02929	32 in. NJ Barrier	42566	3, 11	2018

7.3.2.1.2—Existing Approaches with an Existing End Section on the Paving Section

Remove and remodel End Section on Paving Section Side of the Grade Beam (Table 7.6).

Table 7.6—Examples of Buttress Updates with Existing Approach Slabs and without At-Grade EJ Blockout

Structure №	Existing Rail Type	Control №	Sheet №	Plan Year
S080 42831L&R	34 in. NU Rail	13279	3, 5	2018
S080 11725	29 in. Nebraska Rail	61565	4	2018
S080 44292	42 in. NJ Barrier	22524	3, 5	2016
S080 45180R	42 in. NU Rail	22594	3, 5	2019

When encountering existing bridge rails ends with a 4 in. tall blockout above the deck on each side for the expansion joint, it is good practice to remodel the rail on both sides of the joint to eliminate the gap (Table 7.7).

Table 7.7—Examples of Buttress Updates with Existing Approach Slab and At-Grade EJ Blockout

Structure №	Existing Rail Type	Control №	Sheet №	Plan Year
S084 00825	29 in. Nebraska Rail	31923	3, 5	2017
S066 10571	29 in. Nebraska Rail	13100	4, 5	2017
S084 04418	29 in. Nebraska Rail	32064	5	2017

7.3.2.1.3—Buttress Mounted on Wings or on End of Bridge at End of Floor

No approach work scoped, existing bridge rail is mounted on U-type wing or ends on the Bridge at End of Floor

Widen the approach slab as required, and place guardrail connection with Standard End Section on Approach Side of the End of Floor Joint, on top of widened approach slab (Table 7.8). This will require breaking down the existing wingwalls (see §7.3.1.2).

Many existing bridges were constructed with the Guardrail connections mounted directly onto the Abutment wings. This is known by the Bridge Division to be an undesirable detail, as it creates a full depth joint between the wing and approach slab. This joint allows water to seep in behind the abutment, which can lead to damage of the substructure elements and loss of backfill.

Table 7.8—Examples of Buttress Updates With Existing Approach Slabs and with Existing Buttress Mounted to Deck or Wings

Structure №	Existing Rail Type	Control №	Sheet №	Plan Year
S034 36557	29 in. Nebraska Rail	12988	3, 4	2016
S030 42628R	32 in. NJ Barrier	22688	3, 6	2019
S283 04514	29 in. Nebraska Rail	71184	3, 5	2017

The designer can also choose to extend the rail along the full length of the Approach Section and construct a new Standard End Section on Paving Section Side of the existing Grade Beam in these situations.

7.3.2.1.3a—Collision Damage

In the case of collision damage for rails mounted directly on wings, It is acceptable to replace in kind the wing mounted rail and any damaged portions of the wing.

7.3.2.1.4—Flared Wings

No approach work scoped, bridge has flared wings, no existing approach slabs (or approach slabs unknown)

Place guardrail connection with either the Standard or Retrofit End Sections at End of Floor, on the Bridge itself (Table 7.9).

Table 7.9—Examples for Buttress Updates without Approach Slabs and with Flared Wings

Structure №	Existing Rail Type	Control №	Sheet №	Plan Year
S183 02243	29" Nebraska Rail	71189	2, 3	2019
S059 04555	29" Nebraska Rail	32126	3	2018

7.3.3—Bridge Joints Remodel—Repair or Replacement

The following guidelines apply for removing, repairing, and replacing joints on Bridge Preservation projects.

Expansion Joints for existing bridges are sized based on expected Temperature Movement at the joint location. See §3.10 for guidance on calculating the Temperature Movement (TM) for expansion joints.

7.3.3.1—Elimination of Deck Joints

Many existing bridges are configured with Expansion Joints placed at the end of bridge deck adjacent to an abutment backwall, or an integral abutment with the joint oriented between the bridge and approach at the end of floor. If scoping documents call for addition or replacement of Approach Slabs, these joints should be moved to the gap between the Approach Section and Paving Section. See §15.1 for more information.

This mainly applies to joints near the end of floor. Existing Bridges with interior deck joints are more complicated to eliminate, as they are typically only on long span bridges with high TM, on bridges with simply supported superstructures, or on Pin & Hanger type bridges that would require replacement of the existing bearings to reconfigure the expansion movement. For these reasons interior deck joints are typically maintained in their existing location.

Some DOTs have had good results using UHPC link slabs to eliminate deck joints, but these generally call for bearing replacements (Haber et al., 2022). Discuss the use of UHPC link slab with the Bridge Division.

7.3.3.2—Expansion Joint Remodeling

The following guidance applies for joints that are scoped to remain in their existing location.

If an existing joint, the concrete surrounding the joint, or both are in poor or severe condition due to advanced deterioration, the expansion joint location should be remodeled.

The designer will make this determination during design of the repair plans by performing a visual assessment of the joint. Table 7.10 can be used as a guide to aid the decision-making process.

The decision whether to remodel the surrounding expansion joint concrete is subjective, and can be influenced by several factors, including joint age, overlay type, and location on the structure.

The terms "Good", "Fair", "Poor", and "Severe" are terminology found in NBI and the NDOT BIP Manual.

See §14.1 for guidance when remodeling existing Large Movement Bridge deck joints.

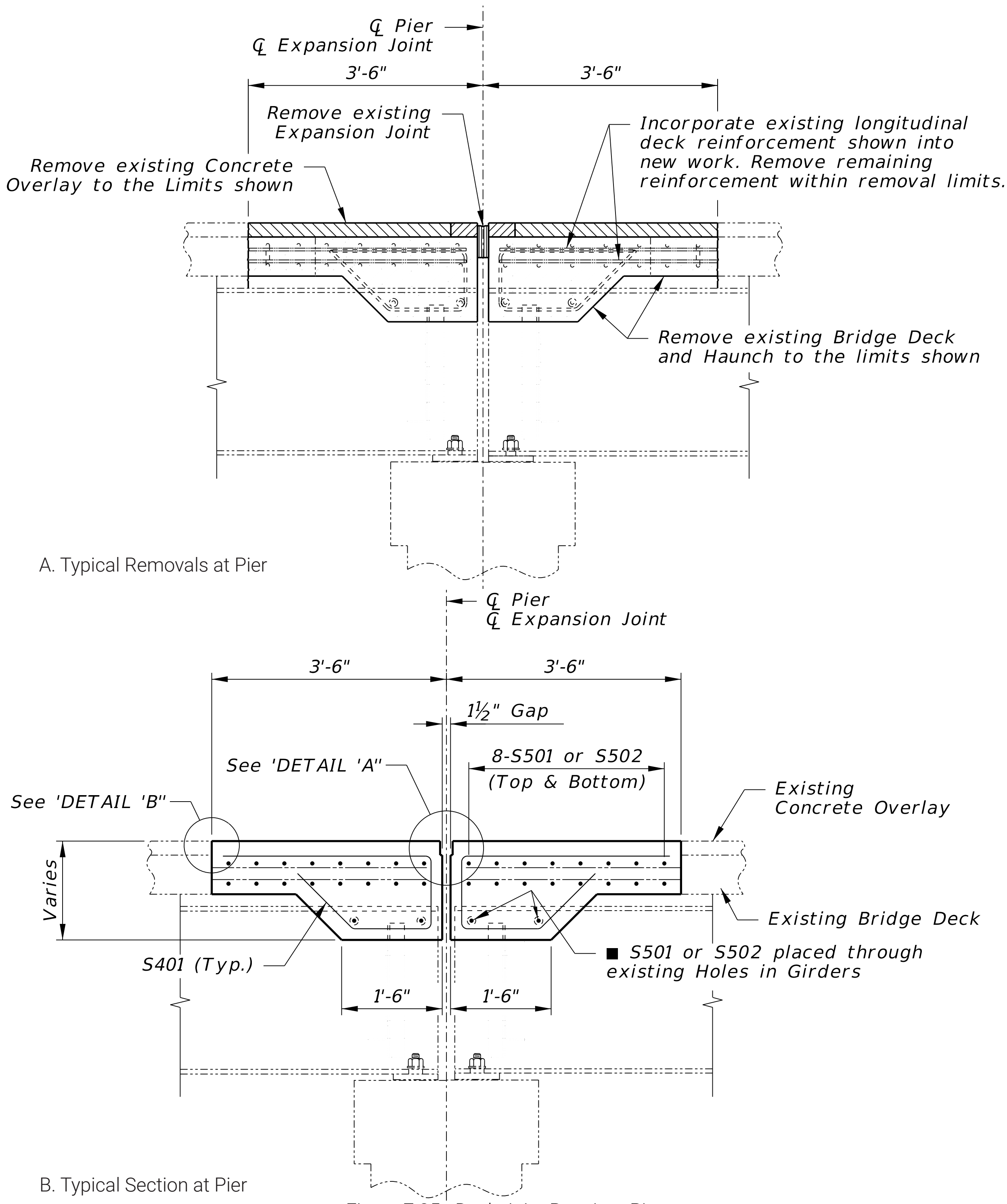
Table 7.10—Guidance For Expansion Joint Remodeling

Condition of Existing Joint and Surrounding Concrete	Recommendation
Good - Fair	Perform Minor Repairs*
Poor - Severe	Remodel Concrete

* Bridge Deck or Approach Slab Repair Pay Items can be used to repair the concrete surrounding the existing joint. It can also be used to replace damaged portions of existing steel armoring.

7.3.3.2.1—Expansion Joint at Intermediate Supports

Figure 7.25 shows a remodel at a Pier Deck Joint. The deck concrete shall be broken back the distance needed to achieve a full development length, l_d, on the existing longitudinal bars into the new concrete. Edge Beams (Thickened haunches on each side of the joint) should be used.



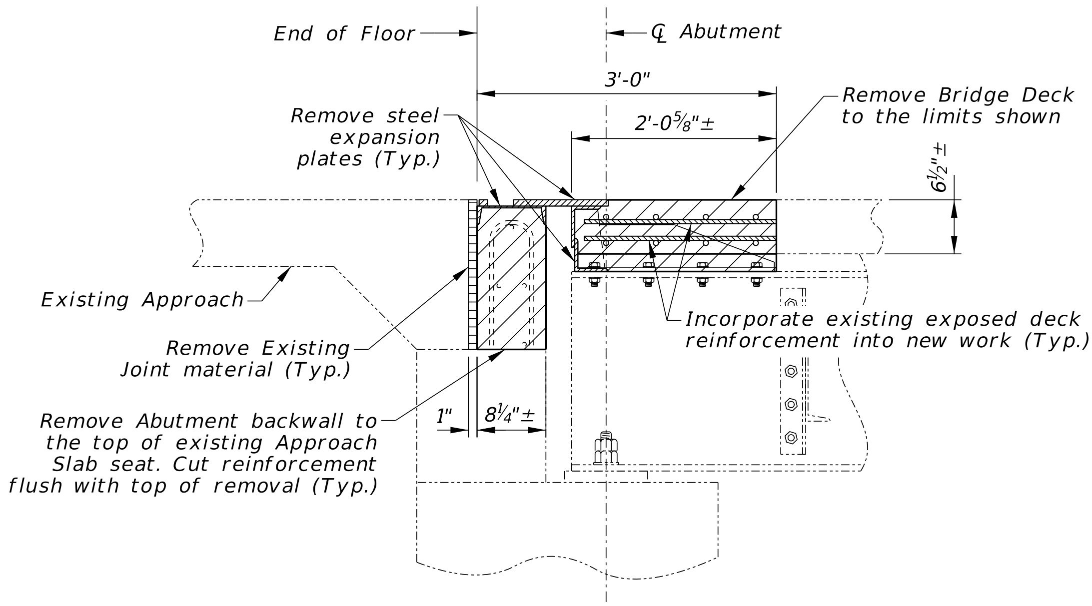
A. Typical Removals at Pier

B. Typical Section at Pier

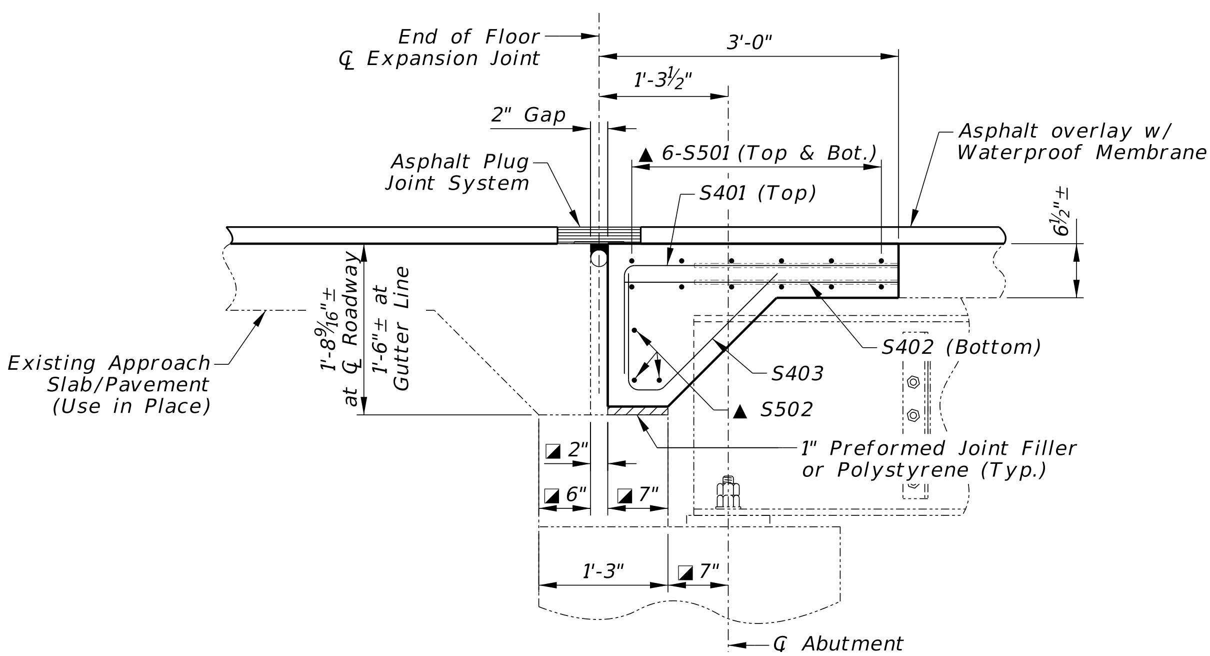
Figure 7.25—Deck Joint Repair at Pier
(example taken from S275 03900, Contract ID M3003, 2016)

7.3.3.2.2—Expansion Joint at EOF

When remodeling existing Expansion Joints at the End of Floor, two joints can be combined into one in certain situations by removing the top portion of the existing backwall and extending the deck, as shown in Figure 7.26.



A. Typical Removal at EOF



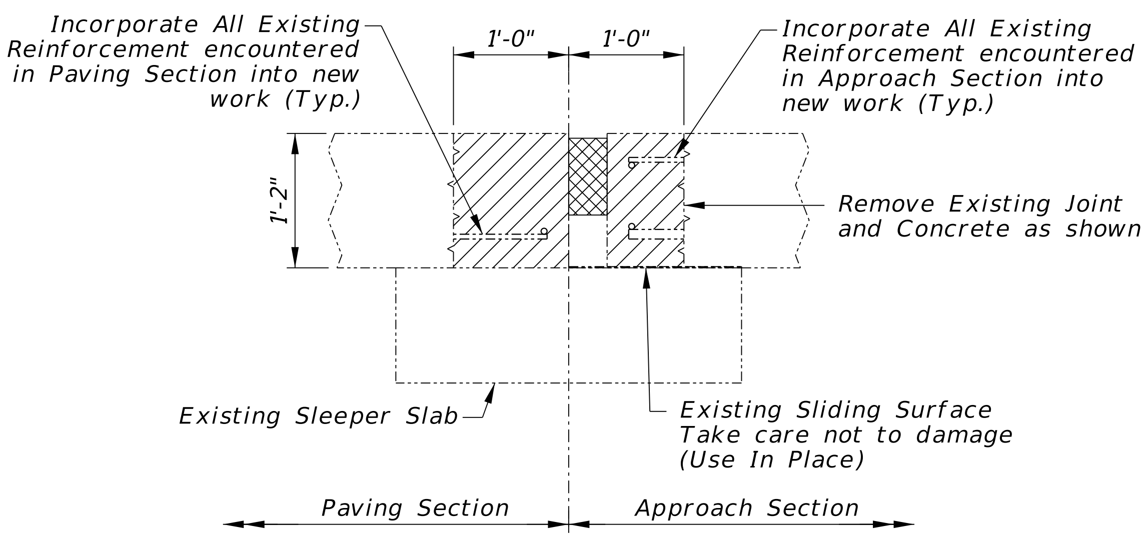
B. Typical Section at EOF

Figure 7.26—Joint Remodel at EOF with Backwall
(example taken from S025 03360, CN 70633, 2013)

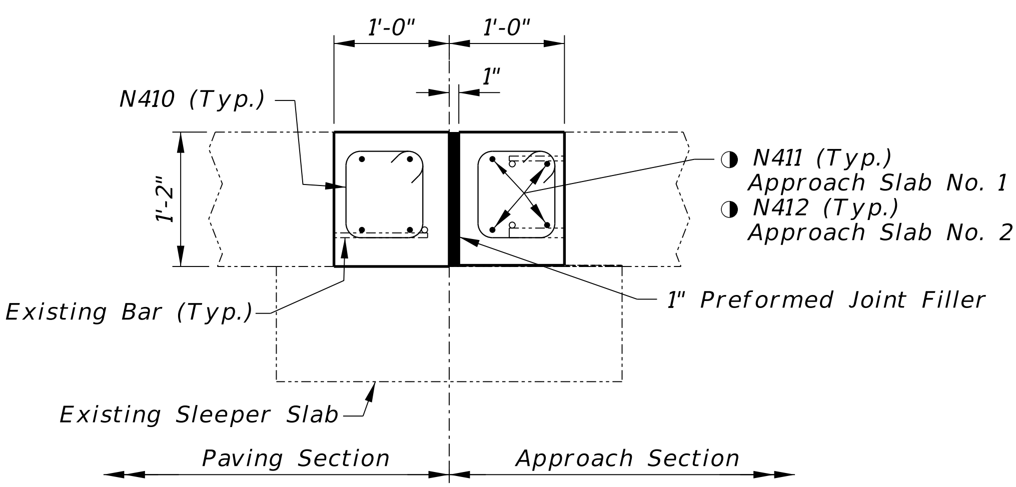
7.3.3.2.3—Expansion Joint at Grade Beam or Sleeper Slab

Expansion Joint Remodeling can be utilized at existing Approach Slab joints over the Grade Beam or Sleeper Slab if conditions warrant. To avoid loss of support for the approach slab, existing concrete shall be broken 1 ft. each direction of the existing joint. Figure 7.27 shows the remodeling of an existing oversized joint in poor condition to a new gap width more appropriate for the anticipated movement at the location.

A similar detail can be used to remodel existing strip seals to PPFs, when TM allows.



A. Removal at Existing Pressure Relied Joint



B. Final Condition with New Gap

Figure 7.27—Expansion Joint Remodel, Pressure Relief Joint over Grade Beam or Sleeper Slab (example taken from S080 45252, CN 22594, 2019)

7.3.4—Bearing Replacement

Existing bearings shall be replaced with the same type of Bearings used for new Bridges, see §14.2 for more information regarding new bearings. Refer to §3.4.5 for the live loading to be used for bearing replacement.

Rocker Bearings can be replaced in kind on an individual basis. This approach should be reserved for cases where only some of the existing bearings need to be addressed.

Until publication of Chapter 3, use the live loading for bearing replacement:

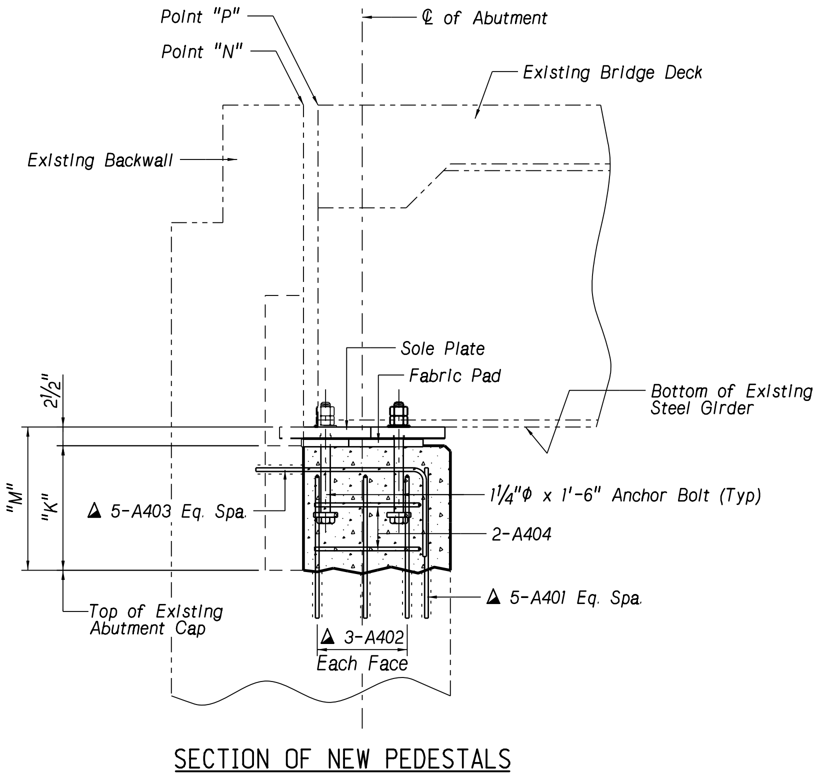
The live loading that was used when the bridge was constructed should be used for determining Bearing loads. For existing Bridges with less than HS20 design loading it is recommended to use HS20 loads.

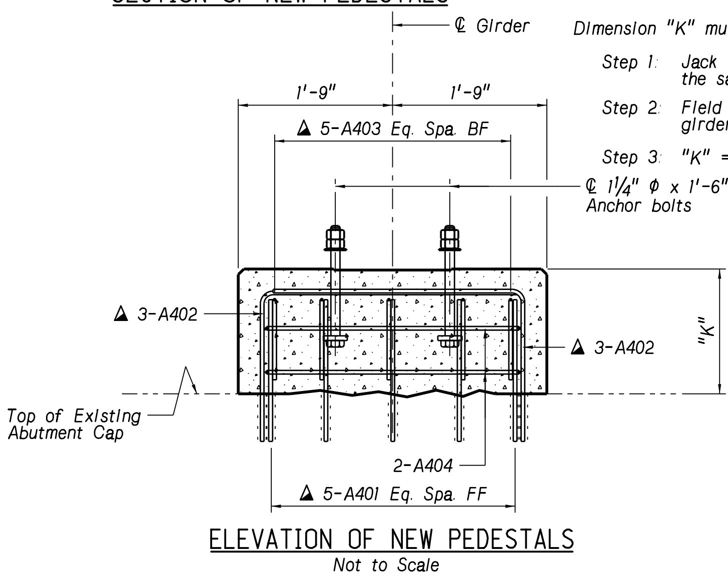
7.3.4.1—Pedestal Retrofit

When replacing rocker bearings, the depth difference between the existing and new bearing types allows for standard concrete pedestals to be doweled on to the top of the existing cap, see §14.2.9 for bearing pedestal policy.

The height of the new pedestals shall be determined by maintaining the depth between the bottom of the existing girder and top of existing cap, see Figure 7.28 for an example.

This is an ideal use case for UHPC for the pedestal material, particularly for emergency repairs.





Dimension "K" must be field calculated using the following formula.

Step 1: Jack the girder until Points "P" and "N" are at the same elevation.

Step 2: Field measure dimension "M" from bottom of existing girder to top of existing abutment cap.

Step 3: "K" = "M" - 2½".

Bars marked with ▲ indicate reinforcement anchored in ⅝" x 6" holes using an approved resin adhesive. Field clip these as needed to fit.

FF=Front Face
BF=Back Face

Figure 7.28—Pedestal Retrofit for Bearing Replacement

(example taken from SL55W00049L, CN 13224A, 2016)

7.3.4.2—Anchorage Considerations

Replacement Bearings shall follow the same criteria as Anchor Rods on new Bridges, see §14.2.10. One of the following two options should be used when installing anchor rods into existing concrete:

- Swedged anchor rods
- All-thread rod anchored with epoxy resin adhesive

Anchor Rods are not required when bearing replacement is performed in conjunction with remodeling the Abutment for full depth turndown.

7.3.4.3—Temporary Support for Bearing Replacement

When replacing Bearings on repair projects, a pay item for temporary support shall be included in the plans. Temporary Support will need to be furnished by the Contractor during the replacement operation. The contractor is responsible for designing the temporary support or sub-contracting the design. The contractor will be liable/assume responsibility for the accuracy and reliability of the design of temporary supports.

7.4—COMMON REPAIR GUIDELINES AND EXAMPLES

7.4.1—Bridge Deck and Approach Slab Repair

7.4.1.1—Concrete Repairs

Use the percentages in Table 7.11 for estimating repair quantities on the Bridge Plans. These quantities are often revised during PS&E when more accurate measurements are determined from field inspection.

In some instances, the district will perform pre-letting estimates of the amount of deck and approach repairs on a given project. In such an instance, the values in the table shall be superseded by actual field estimates.

For structures over 700 SY a more precise estimate should be produced rather than using these percentages.

Table 7.11—Deck Repair Area based on Condition

Deck Condition Rating (NBI)	Percentage of Deck Area
5	15%
6	10%
7	5%
8 or 9	2% (5 SY minimum to establish a bid quantity)

Use 3% (5 SY minimum) of approach slab area for preliminary estimates.

Class 47BD-4000 concrete is the default material used for deck and approach repairs.

Polymer Concrete should be used instead of 47BD-4000 where appropriate to reduce lane closure duration.

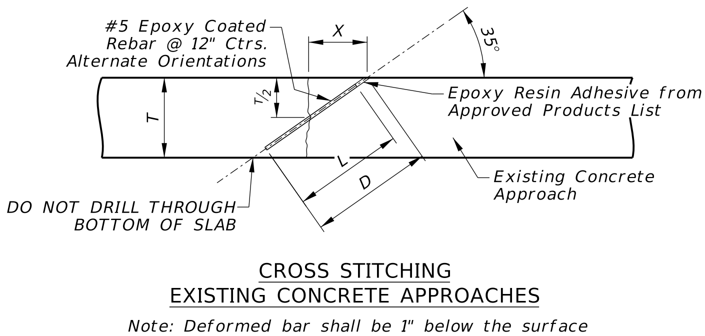
7.4.1.2—Crack Repairs with Cross Stitching

This procedure is used to stabilize and seal large cracks in approach slabs or paving slabs. For locations with a top mat of reinforcement, the bars shall be located using GPR or equivalent and existing reinforcement shall be avoided.

The Special Provision "DOWELING INTO CONCRETE STRUCTURES - POST INSTALLED ADHESIVE ANCHORS" shall be included when this repair is specified on a project.

Figure 7.29 shows the preferred detail and Figure 7.30 shows example of the appropriate and inappropriate level of cracking.

Cross Stitching is a detail that is typically used on concrete pavement. Consult Bridge Division for guidance on application to projects. At the time of publication, Cross Stitching Details have been shown on plans for S075 04868L (CN 13452) but have not been let.



"T"	"X"	"D"	"L"
8"	5¾"	12"	9¾"
9"	6½"	13½"	11½"
10"	7"	14"	12½"
11"	8"	16"	13"
12"	8½"	17½"	14"
13"	9½"	20"	18"
14"	10"	21"	18"

Figure 7.29—Cross Stitching Approach Repair Detail

A. Completed cross-stich repair (photo taken near SL28B00163L)

B. Completed cross-stich repair (photo taken near SL28B00163L)

C. Good candidate for cross-stitch repair (photo taken from S080 42697L)

D. **NOT** a good candidate for the cross stitch repair. The damage is much too extensive (photo taken from S081 04546R Approach)

Figure 7.30—Level of Cracking Appropriate for Cross-Stitch Repair as shown in Figure 7.29.

Red arrows on sub-figures A and B indicate locations where cross stitching repair has been completed.

7.4.2—Concrete Patching

7.4.2.1—Overview

When scoping documents call for repair of concrete bridge components, the following guidelines should be followed.

Concrete Patching is most suitable for repair of shallow deterioration caused by exposure to moisture and de-icing chemicals over time. This type of damage is considered nonstructural in nature. The core of the concrete element in most cases is sound.

Typically, concrete damage that is structural in nature will manifest itself by severe cracking or distortion. The Concrete Patching Special Provision is not the preferred method for repairing this type of damage.

In cases where the damage is considered structural, the damaged concrete should be removed and remodeled as appropriate, including detailed placement of new reinforcing steel.

7.4.2.1.1—Typical Locations

Repair work will typically be called out in the bridge determination as follows:

- Repair Abutment, Repair Wingwall, Repair Bent Cap, Repair Pier Column — In general, this is work to repair faces of deteriorated substructure components.
- Repair Bridge Rail — In general, this is work to repair faces of deteriorated curbs, barriers, or rails.
- Repair Deck Edge, Repair Deck Overhang – In general, this is work to repair deteriorated concrete along the deck edge or deck underside.

See §7.4.1 for Concrete Bridge Deck and Approach Repairs.

The need for repairs is determined by review of the Bridge Inspection Photos and a site visit when necessary. The construction procedures for performing these repairs are outlined in the standard Special Provision, “7.9 CONCRETE PATCHING OF STRUCTURES.”

Figure 7.31 to Figure 7.33 show examples of Concrete Patching with Shotcrete. Repair mortars or concrete may also be used. See Special Provisions and §7.4.2.3.1 for details.

Figure 7.31—Concrete Patching at Abutment with Shotcrete

(example taken from S089 00411)

Figure 7.32—Concrete Patching at Deck Edges, with Shotcrete
(example taken from S006 33065)

Figure 7.33—Concrete Patching at Bridge Rail, with Shotcrete
(example taken from S064 07011)

7.4.2.2—Plan Considerations

7.4.2.2.1—General

Concrete Patching is typically called out in the plans by inserting inspection photos of the damaged areas, along with an annotated or cross hatched callout of the damaged concrete to be repaired (Figure 7.34).

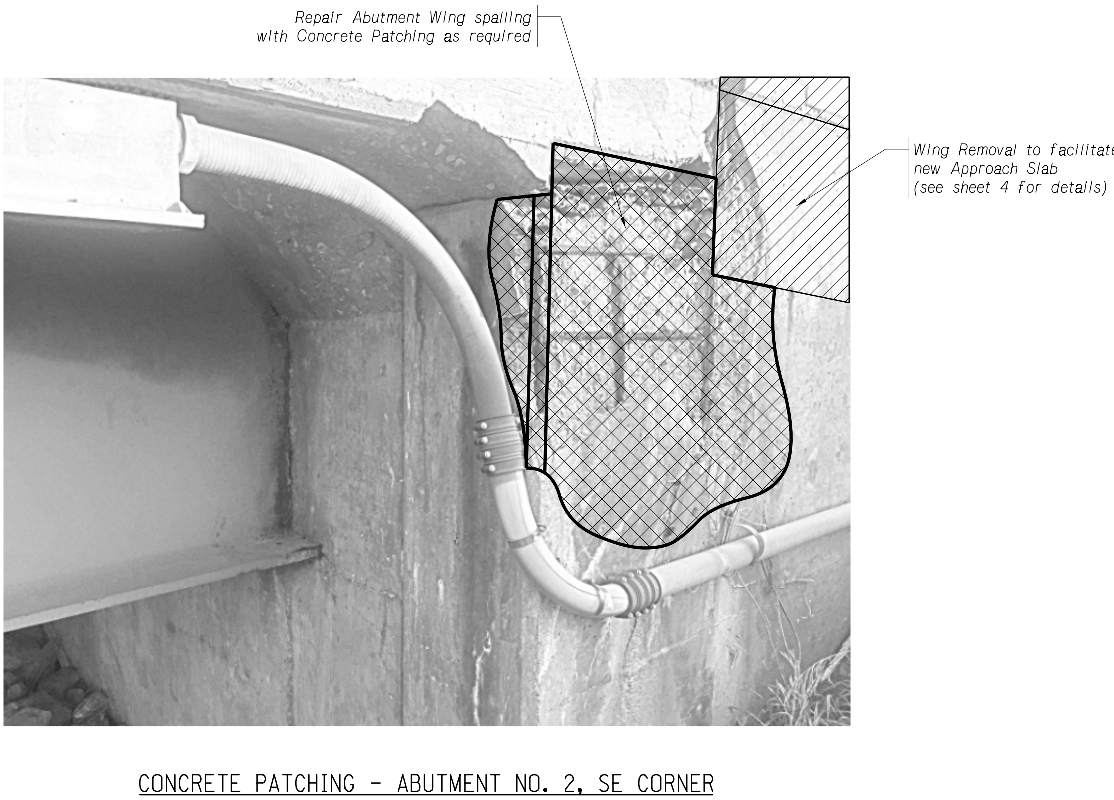


Figure 7.34—Concrete Patching as Shown on Plans with Hatching
(example taken from S275 17757, CN 22578A 2020)I

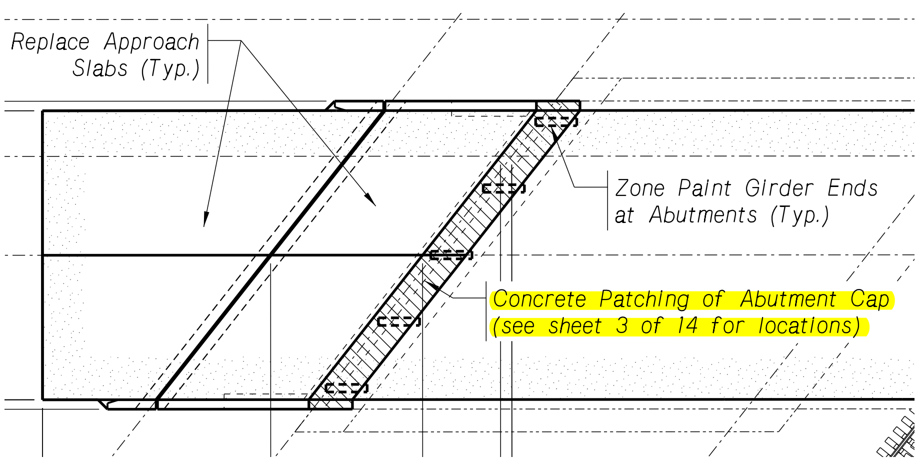


Figure 7.35—Concrete Patching Callout on General Plan

(example taken from S030 42623R, CN 22688, 2019)

Generally, each location that has been identified as needing repair with Concrete Patching is shown in the General Plan (Figure 7.35). If there are multiple areas on any given bridge of the same type of damage, a single photo illustrating the typical condition may be used.

Alternatively, if a single concrete component has multiple areas that need patching, a conventionally drawn elevation view outlining all the repair locations may be shown. Note that this method will still require the designer to approximate the damaged areas.

7.4.2.2.2—Quantity Estimates

A quantity for Concrete Patching, based on estimates of all patching work identified, shall be shown in the Bridge plans. This quantity is measured in SF, with a minimum of 5 SF.

Due to the approximate nature of such estimates, exacting quantities are not warranted. The actual quantity repair will be field determined during construction.

7.4.2.3—Material Considerations

The Special Provision allows the Contractor the option of three methods to perform the Concrete Patching. The three types are:

- Structural Patching Materials on the NDOT Approved Products List (APL). These materials are generally placed by hand with a trowel, without the use of forms.
- Shotcrete
- Portland Cement Concrete: Classes 47B, 47BD, and 47B-OL. Repairs with concrete generally require the use of forms.

Each method has its own benefits and drawbacks for a given application.

7.4.2.3.1—Option to Require Shotcrete for Patching

Shotcrete is well suited for vertical and overhead placements, particularly along deck edges. Shotcrete requirements are called out in Part B of the Concrete Patching Special Provision.

The designer has the option to specifically require that Shotcrete be used to perform a repair. This is done by adding a note to the plans (Figure 7.36).

Figure 7.36—Note on Plan for Requiring Use of Shotcrete
(example taken from S275 03181, CN 32267, 2016)

7.4.3—Crack Epoxy Injection

Cracks in existing concrete that are not of structural concern may be repaired with injection of Epoxy Compounds (Figure 7.37 and Figure 7.38). The construction procedures for performing these repairs are outlined in the standard Special Provision, "7-11 CRACK EPOXY INJECTION."

A quantity for Crack Epoxy Injection shall be shown in the Bridge plans. This quantity is measured in LF, with a minimum of 5 LF, estimated in a similar manner to Concrete Patching.

When appropriate, designers should consider specifying this repair method in addition to Concrete Patching.

The minimum crack width in order to feasibly inject epoxy is approximately 0.02 in., cracks narrower than this need not be addressed.

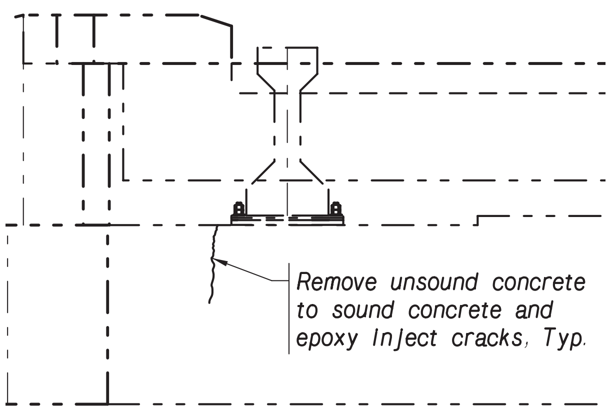


Figure 7.37—Epoxy Crack Injection Plan Note
(example taken from S283 05534 CN 71185, 2018)

Figure 7.38—Epoxy Crack Injection (Before on the Left, and After on the Right)

(example taken from S080 19045)

7.4.4—Girder Repairs

The following information applies to girder repairs. The examples have been assembled to aid designers in developing plans when conditions call for repairing steel or prestressed concrete girders.

7.4.4.1—Steel Girder Repairs

7.4.4.1.1—Pin and Hanger Repair

This repair may be specified when bridge inspection reports indicate cracked or broken pins. The typical repair requires the use of a temporary beam placed on the bridge deck, using tie rods through the deck, to provide girder support while pins are replaced.

Special Provision: Not created, see plan examples for notes (Table 7.12).

Table 7.12—Pin and Hanger Repair Examples

Structure №	Repair Type	Plan №	Repair Year
S077 11185	Replace Hanger Pins	77-3(1011)	1990
S180 00323L	Replace Hanger Pins	S180-3.23	1990

7.4.4.1.2—Fatigue Retrofit/Crack Repair

This repair is applied to existing steel girder webs where a crack is present. A crack arresting hole with a bushing should be installed at the end of the crack. This method appears to have been effectively used on floor beams.

Special Provision: "7.24 STEEL CRACK REPAIR" (Table 7.13).

Another fatigue retrofit method is Needle Peening. By needle peening, the material is plastically deformed at the weld toe in order to introduce beneficial compressive residual stresses. Peening has been shown useful at the base plate weld of sign structures to extend the fatigue life of the connection.

A similar method of repair used previously was holes drilled at the end of cracks without installing a bushing.

Table 7.13—Steel Crack Repair Example

Structure №	Repair Type	Control №	Repair Year
S012 00398	Floor Beam Crack Arrest	80799	2013

Figure 7.39—Crack Arresting Bushings on S012 00398

7.4.4.1.3—Heat Straightening of Steel Girders (Impact)

Heat straightening is the method used for repairing damage to steel elements caused by traffic impacts. Additional repairs such as removal of cross frames and welding backing plates to repairing gouges in the web may be necessary depending on the nature of the damage. If the flange, web, or both have been sheared, field splices will be needed in addition to heat straightening.

NOTE: When any girder has been impacted, a full review of the deck above the girder should be completed. Repairs to damaged decks, caused by the impact, must be performed.

In-service bridges section shall be made aware of damage and review the bridge prior to repairs being made.

Special Provision: Not created, see plan examples for notes (Table 7.14).

Heat straightening of steel I-beam and plate girder bridge members provides a viable repair method if impact distortion is not too severe (plastic strains less than $100\varepsilon_y$) and if primary members are not cracked or fractured (Geoghegan et al., 2023).

Heat straightening techniques may be used to repair any combination of the following distortions.

- weak axis distortion
- strong axis distortion
- torsional distortion
- local distortions such as
  - local flange buckling
  - web buckling
  - plate member bends or crimps

Table 7.14—Heat Straightening Girder Repair Examples

Structure №	RepairType	Plan №	Repair Year
S076 00176	Heat Straightening	Emergency Repair	2011
S076 00176	Heat Straightening	M6001	2022
S080 44827R	Heat Str. & Web Patch	M2080K	2018
S129 00039	Heat Str. & Web Splice	Emergency Repair	2002
S180 00079	Heat Str. & Web Patch	Emergency Repair	2020

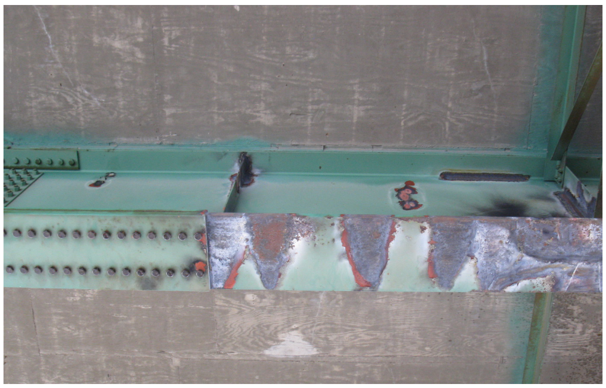


Figure 7.40—Girder after Heat Straightening on S129 00039

The following is taken from *Emergency Response Manual for Over Height Collisions to Bridges* (Iowa DOT Office of Bridges and Structures & HDR, 2016).

"Heat straightening is a repair procedure in which controlled heat is applied in specific patterns to the plastically deformed regions of damaged steel in repetitive heating and cooling cycles to gradually straighten the material. The process relies on internal and external restraints that produce thickening (or upsetting) in the heating phase and in-plane contraction in the cooling phase. When heat straightening is done properly, the temperature of the steel should not exceed what is referred to as the phase transition temperature, at which material properties of the steel can change significantly. Heat straightening generally requires multiple cycles of heat and restraint to incrementally return the member back to its original shape. Steel should be allowed to cool to 120°C (250°F) before reheating steel.

Research on material properties of steel exposed to strain ratios of 100 or less has indicated minimal change in material properties for steel members heat straightened two or less times.

Typically, two heat straightening repairs to the same section of beam will lead to a modest decrease in modulus of elasticity and ductility, but an increase in both yield stress and tensile strength. However, guidelines provided by the FHWA recommend that the same areas of steel members should not be heat straightened more than twice due to concerns over an increased loss of ductility and a substantial decrease in fatigue life (Geoghegan et al., 2023)

Prior to initiating heat straightening procedures, the damaged area of the beam should be thoroughly inspected to verify that it is free from cracks; the affected area of the beam should be blast cleaned to a bright metal finish and any gouges or nicks in the steel shall be removed by grinding to remove stress risers. For Grade 36 or 50 carbon steels, the maximum temperature used for heat straightening shall be 649°C (1200°F); for Grade 70W steel, the maximum temperature used for heat straightening shall be 565°C (1050°F); for Grade 100 and 100W steels, the maximum temperature used for heat straightening shall be 593°C (1100°F). Temperatures shall be monitored using temperature indicating crayons, a contact pyrometer (thermocouple with digital readout), or a bimetal thermometer. The use of heat straightening techniques typically includes the use of internal or external retraining forces. These forces shall be computed in advance and a constraint plan shall be established before applying heat, which defines the location of external jacks and the required bracing of undamaged members at jacking locations. Jacks, come-alongs, or other force application devices shall be gauged and calibrated so that the force applied can be controlled and measured. The load shall not be adjusted during heating or before the member has cooled to below 315°C (600°F)

Contractors who perform heat straightening services should have a minimum of 10 years of experience consisting of a minimum of three successful heat straightening projects. Heating shall be with an oxygen-fuel gas mixture using a #8 or smaller torch tip typically sized based on the thickness of metal being heated. Heating patterns may be triangular (vee-shaped), strip, or rectangular. Heating patterns that should be spaced and marked out along the length of the damaged area before starting. Quenching the heated area with water, mist, or an air-water mix to accelerate cooling is not permitted. However, after the steel naturally cools to a temperature below 315°C (600°F), cooling with dry compressed air is permitted.

Inspection of heat straightening work should include verifying that the straightened steel members meet tolerance requirements listed in the contract documents. Following completion of heat straightening, non-destructive testing, such as magnetic particle testing, may be needed to confirm that no cracks formed as a result of the straightening procedures."

7.4.4.2—Prestressed Concrete Girder Repairs

NDOT and UNL have published a synthesis report on the repair of precast/prestressed girders (Kodsy et al., 2020).

7.4.4.2.1—Crack Epoxy Injection

Epoxy crack injection may be used for repairing cracks in prestressed girders (Table 7.15, Figure 7.41, and Figure 7.42).

Special Provision: "7.11 CRACK EPOXY INJECTION".

Table 7.15—Girder Crack Epoxy Injection Examples

Structure №	Repair Type	Control №	Repair Year
S050 07686	Girder Crack Epoxy Injection	22456	2013
S070 10755	Girder Crack Epoxy Injection	42693	2018
S002 50816	Girder Crack Epoxy Injection	13371	2020

Figure 7.41—Crack Epoxy Injection on S070 10755

Figure 7.42—Crack Epoxy Injection on S002 50816

7.4.4.2.2—Concrete Repair (Deterioration)

When prestressed concrete girders have damage, due to expansion joint leaks or other exposure, concrete patching can be performed with a high strength concrete repair material compatible with the existing prestressed concrete strength (Table 7.16). See concrete patching guidelines outlined in §7.4.2.

Special Provision: "7-14 PRESTRESSED CONCRETE GIRDER REPAIR"

Table 7.16—Prestressed Concrete Girder Repair (Near Supports) Examples

Structure №	Existing Rail Type	Control №	Repair Year
S030 25933	Girder Patching	42571	2011
S070 10755	Girder Patching	42693	2018

Shotcrete repair has been found to be an effective repair when strands have not been damaged, see §7.4.2 for more details on Concrete Patching.

MnDOT has successfully used shotcrete at girder ends and experimentally validated the restoration of shear strength (Shield & Bergson, 2018).

7.4.4.2.3—Impact Repair

7.4.4.2.3a—Concrete Repair (Impact)

When prestressed concrete girders have minor delaminations, caused by traffic impacts, that do not affect the strands, concrete patching can be performed with a high strength concrete repair material compatible with the existing prestressed concrete strength (Table 7.17). See concrete patching guidelines outlined in §7.4.2.

NOTE: When any girder has been impacted, a full review of the deck above the girder should be completed. Repairs to damaged decks, caused by the impact, must be performed.

Special Provision: "7-14 PRESTRESSED CONCRETE GIRDER REPAIR".

Table 7.17—Girder Impact Repair Examples

Structure №	Existing Rail Type	Control №	Repair Year
S030 42866	Girder Patching	22582	2020
S080 06462	Girder Patching	51431	2010
S080 34413	Girder Patching	District Plan	2021

7.4.4.2.3b—Strand Repair (Impact)

When traffic impacts cause the prestressing strands to be severed, the stands may be repaired using strand couplers to re-tension the prestressing strands prior to restoring the concrete. Figure 7.43 shows the process of splicing strands in the field after an impact (Enchayan, 2010).

NOTE: When any girder has been impacted, a full review of the deck above the girder should be completed. Repairs to damaged decks, caused by the impact, must be performed.

Special Provision: Not created, see plan examples for notes (Table 7.18).

. Table 7.18—Girder Strand Splice Repair Examples

Structure №	Existing Rail Type	Plan №	Repair Year
S006 35981	NU - Strand Repair	AFE-B028	2015
S071 05850L	NU - Strand Repair	51409	2009
S680 00713	NU - Strand Repair	M2004	2019

A. Strand Impact Damage

B. Concrete Removal

C, Cutting Damaged Strands

D. Strand Splicing

E. Splices Installed

F. Finished Grout

Figure 7.43—Strand Repair Method after Impact
(example taken from S680 00713, 2019)

7.4.4.2.4—UHPC Repairs

Ultra-High Performance Concrete (UHPC) may be used to replace damaged concrete in precast/prestressed concrete girders.

UHPC allows for both increased shear resistance of the girder as well as increased bearing resistance at the support. Experimental studies showed that girder ends repaired using this concept could meet or exceed their intended capacity at the ultimate limit state.

7.4.5—Steel Pile Repair and Preservation

The use of field painting is an option when FRP jackets or Encasement options are not feasible. Open steel bents with welded bracing are not good candidates for FRP due to the bracing. Painting can be the most affordable option when concrete for a large encasement is not readily available due to the remoteness of the location. Refer to §7.5.3 for more information about painting of existing piling.

7.4.5.1—Concrete Encasement

The use of reinforced concrete is a preferred treatment of steel piles that are moderately to severely deteriorated or damaged. Encasement can also be used for preservation, however requires similar work space as needed for FRP jacket. Encasement is an option to fully or partially encase open pile bents without bracing. Large encasements require the dead load to be considered.

7.4.5.2—FRP Encasement

The use of FRP jackets or sleeves is a preferred method of preservation. However, other methods may be more suitable when access to the pile is limited, especially at abutments with low clearance. Ample space is necessary to prepare the pile surface and handle the FRP segments. The surface preparation needs to be clean, but not to the extent required for painting

7.4.6—Resetting Rocker Bearings

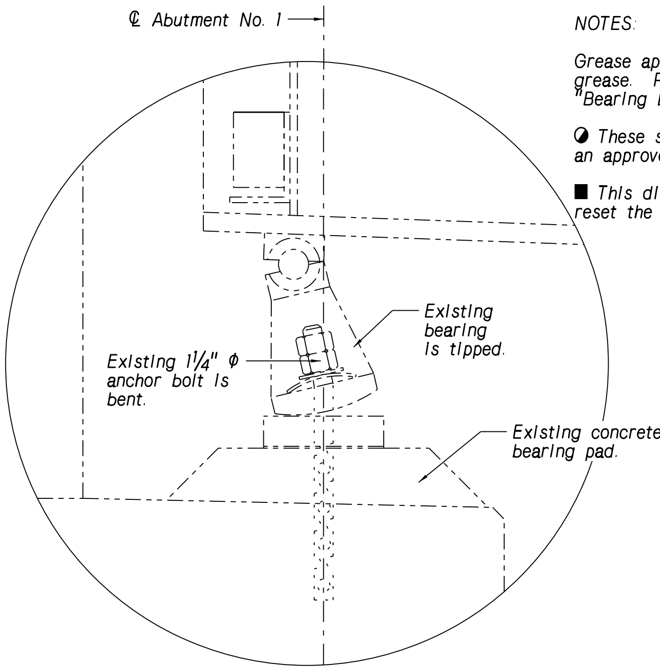
When Rocker Bearings have become tipped but are otherwise in good condition, resetting of the existing bearings can be performed instead of full bearing replacement, an example detail can be seen in Figure 7.44.

NOTES:

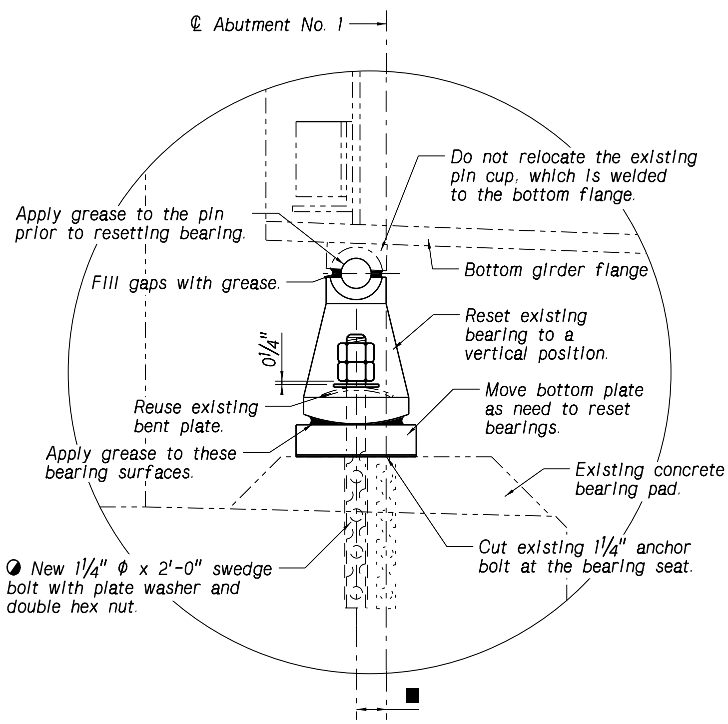
Grease applied to bearings shall be a suitable automotive bearing grease. Payment for labor and materials shall be subsidiary to "Bearing Device Repair"

◑ These swedge bolts shall be anchored in 1⅜" x 10" holes using an approved epoxy resin adhesive.

■ This dimension will be field determined as needed to reset the bearing.



DETAIL OF EXISTING BEARING CONDITION AT ABUTMENT NO. 1



DETAIL OF BEARING RESET AT ABUTMENT NO. 1

Figure 7.44—Rocker Bearing Reset and Lubrication
(example taken from S137 01328, 81001, 2017)

7.4.7—Floor Drain Retrofits

The construction procedures for performing the repair are outlined in the standard Special Provision, “7-20 REPAIR FLOOR DRAIN”.

7.4.7.1—Drains in Closed Rails

Standard structural tubing of 3⁄16 in. thickness shall be used for the drainpipe. The tube shall be sized to fit into the existing drain opening (Figure 7.45).

The existing deck and/or curb may need to be broken out to install the drain retrofit. Repair of the underside of the deck around the existing drain outlet is also typically required.

It is acceptable to slope asphalt overlay to drains contained in rails, see overlay base sheet. Where possible do not slope overlay beyond the edge of the shoulder into the driving lanes.

Many existing bridges in the State of Nebraska were constructed with open holes in the deck at the gutter line to facilitate drainage. Over time, the concrete around the open hole becomes significantly deteriorated due to constant exposure to moisture. The most common technique to repair these types of floor drains is to install a drainpipe to keep the moisture off the concrete.

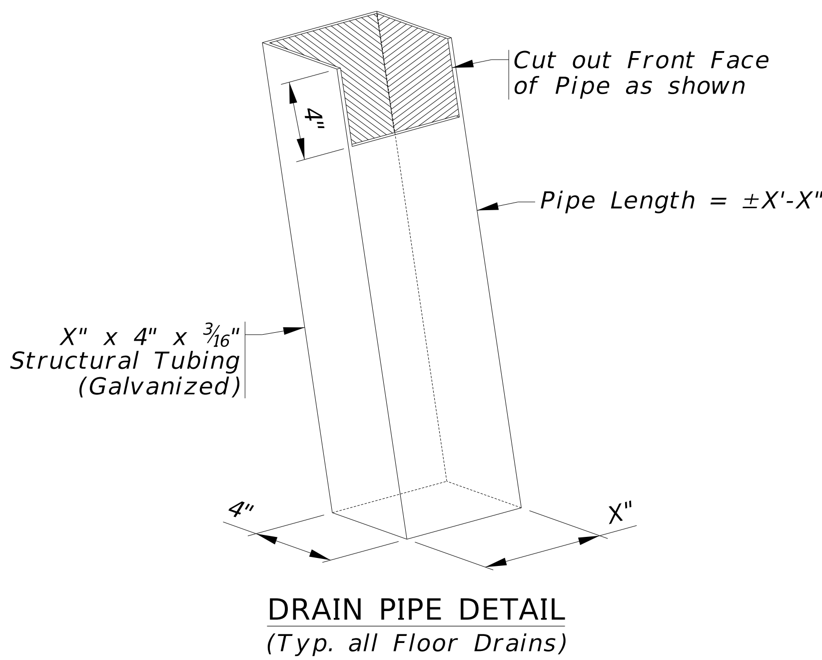


Figure 7.45—Retrofit for Drain in Closed Rails
(Available as Cell “017A-Drain Pipe Detail”)

7.4.7.2—Drains in Shoulders

When doing a repair in conjunction with an Asphalt Overlay w/Membrane, the use of new frame and grates shall be considered to eliminate large dips encountered when the asphalt is simply sloped to the drains (Figure 7.46).

A. Shoulder Drain With Frame Prior to Overlay

B. Shoulder Drain With Frame After Overlay

Figure 7.46—Shoulder Drain with Frame on S480 00310B

It is preferred not to slope overlay to drains in shoulders unless the shoulder width is adequate to keep entire depressed area out of the driving lane. Details similar to Figure 7.47 should be avoided where ever possible.

Figure 7.47—Drain in Driving Lane

(example from S180 00323LR)

A typical Floor Drain Repair detail is shown in Figure 7.48. This detail shall be modified as needed for use in the plans when doing floor drain repairs.

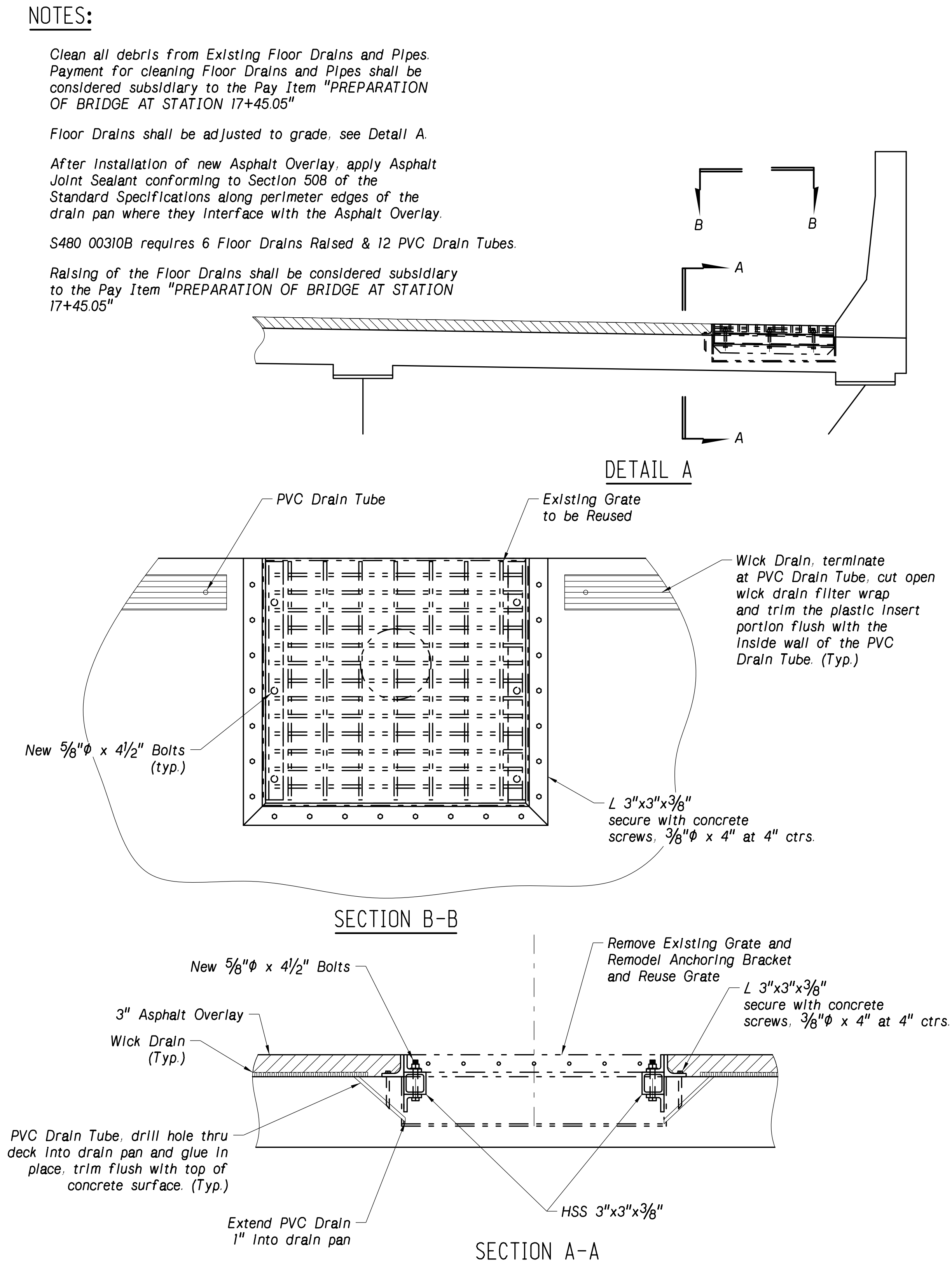


Figure 7.48—Frame Detail Around Shoulder Drain for Overlays
(example from S480 00310B, 22611, 2023)

7.5—STEEL PAINTING GUIDELINES AND EXAMPLES

When scoping documents call for repainting of the entire existing steel superstructure of a bridge, this is considered major work. This section focuses on the three main types of minor painting work typically called out in the plans for Bridge Preservation projects.

The construction procedures for performing painting of this nature are outlined in the standard Special Provision, "7.19 PAINTING STEEL".

7.5.1—Zone Painting of Girder Ends

Existing Steel Girders (weathering steel or with existing coatings) that are discontinuous at intermediate supports, pin & hangers or abutment joint locations should be considered for zone painting.

Zone painting limits should be shown on the plans but typical paint zone is 6 ft. to 10 ft. along the girder.

Bearing devices if not specifically described in the work description should be included in the paint quantity.

When existing steel girders are painted, the new zone painting shall be detailed to show existing coatings feathered surrounding the end of the new zone painting.

All painting shall be in accordance with section 709 of the standard specification.

7.5.2—Painting Existing Bearings

Painting existing bearings is typically called out in the plans by inserting an inspection photo of a typical Bearing to be painted, along with an annotated or cross hatched callout to clean and paint the bearings, see Figure 7.49.

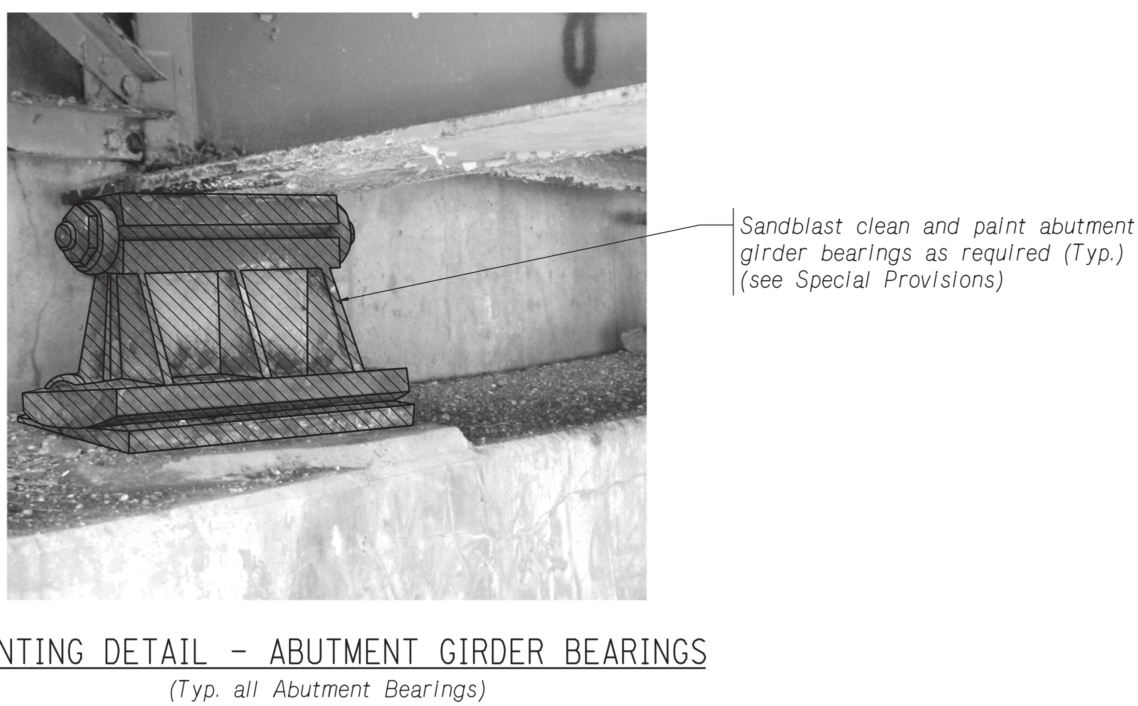


Figure 7.49—Painting Existing Bearing

(example taken from S050 07712, CN 22456, 2014)

7.5.3—Painting Piles

Painting of existing steel pile is not believed to be a cost-effective strategy. Surface preparation can be very challenging due to limited access and the need to excavate piles below the current ground line to expose susceptible areas. Following surface preparation, the Contractor shall test for the presence of soluble salts. If salts are detected, the substrate shall be pressure washed with a solution in accordance with manufacturer's recommendations until the salt is removed.

7.6—SPECIAL CONSIDERATIONS FOR HISTORIC BRIDGES

In compliance with the Section 106 of the National Historic Preservation Act which declares that any project involving Federal funds must take into consideration the impact that the project might have on properties eligible for or listed on the National Register of Historic Places. Since Federal funds are often involved in aid to highway and road improvements in Nebraska, the provisions of Section 106 apply to most highways and many county bridges in the state.

Responsibility for administering Section 106 rests with Nebraska SHPO, and when Federal funds are involved, negotiation is conducted between the FHWA and the SHPO to verify resource consideration and protection. Even if Federal funds are not involved in a project, it is good stewardship of these important historic resources to preserve them for future generations.

In addition, Section 4(f) of the U.S. Department of Transportation Act protects historic sites from highway project effects unless there is "no feasible and prudent alternative". If the project cannot avoid affecting a historic property, the project must be planned to minimize the damage. The Surface Transportation and Uniform Relocation Assistance Act of 1987 goes further. Asserting that it is "in the national interest to encourage the rehabilitation, reuse, and preservation of bridges significant in American history, architecture, engineering, and culture". The Act permits the Federal Government to reimburse costs associated with preserving historic bridges or mitigating unavoidable damage.

7.6.1—Priorities for Treatment of Historic Bridges

The preferred treatment for a historic bridge is to have it continue to carry vehicular traffic at its original site with minimal modification.

If it is not feasible to keep the bridge at its original site, every effort should be made to find an appropriate site to which it could be relocated for vehicle use. There is a marketing and advertising requirement in the agreement between the FHWA, NDOT, and the Nebraska SHPO to notify the public and other government entities of the availability of the bridge for reuse.

If the bridge can no longer carry vehicular traffic or could do so only at the expense of its historic integrity, the next best solution to evaluate is non-vehicular use at its original site with minimal modification (e.g., pedestrian or bike bridge).

If the bridge can no longer carry vehicular traffic, no "as is" use is feasible, or it cannot be left in place, adaptive uses should be evaluated, with preference given to reuse that retains the bridge at its original location. If no suitable in-situ adaptive use can be found, the bridge can be relocated to a less demanding vehicular crossing or adapted for non-vehicular use at the new location (preferably in the public domain).

If the bridge cannot remain at its original site and cannot be moved, it shall be documented to the standards of the Historic American Engineering Record before demolition, disassembly, or modifications that will destroy its historic integrity. If possible, the structure should be disassembled carefully and stored until a new location for it can be found or significant components should be incorporated into any new bridge at the site or salvaged for educational purposes.

7.6.2—Alternative Evaluation and Documentation – A Requirement

When a project will affect a historic bridge, the FHWA and the Nebraska SHPO will judge whether the project will adversely affect the structure, and whether adequate alternative evaluations have been conducted to avoid or minimize the effect. It is the responsibility of the NDOT and/or the county to provide a report containing a full description of all alternatives considered, to avoid, minimize or mitigate affects to the structure. (Example of such analysis is available upon request from NDOT). When documenting the need for replacing or preserving a bridge, technical, legal, financial, and safety considerations must be weighed in reaching the final decision. The problem with the structure must be clearly stated, be it structural or functional.

The following range of alternatives (listed by priority) must be considered carefully before plans to alter or remove a historic bridge are finalized.

- Continued use of the bridge for vehicle traffic at its original location, with restoration and rehabilitation.

- Passive, non-structural actions to lower the live load on a bridge should be considered as a first alternative when load is of concern. Lowering the posted load limit and restricting traffic to one direction are examples of ways to retain a bridge in service without structural modification.
- Use of the bridge for non-vehicular traffic at the site.
  - Issues involved with this option include what to do with vehicular traffic. This may be a considerable problem at an important crossing when there are no alternate bridges convenient or capable of handling greater traffic loads.
  - It may also be problematic if physical or economic considerations require use of the existing bridge site for a new bridge.
  - One alternative that has been used is to build a new bridge alongside the old one, altering alignment to properly accommodate the new location.
  - The existing bridge may be closed to vehicular traffic but is reserved in place for public viewing.
  - Some counties have been provided historical markers and pathways to display the bridge.
  - One suggestion has been made that the bridge can be retained for vehicle crossing if it meets structural sufficiency, so that the traveling public can experience driving over the old bridge if they so choose.
  - Every effort should be made to keep the bridge in public ownership, either through continued use by the current owner or another government agency.
  - If marketing of the bridge to private ownership is necessary, protective covenants must be put in place for the bridge's preservation.
- Relocation of the bridge.
  - When a bridge must be moved to a new site, provisions must be made for maintenance, damage protection (natural and man made), and public accessibility.
  - The abutments or intermediate supports at the new site should match the original configuration, if possible.
  - Issues of ownership and marketing, as described above, must be considered
- Destruction of historic character, demolition.
  - This option includes rehabilitation without consideration of historic integrity. Work that harms the historic integrity of the bridge should be undertaken only if it is not possible to make the bridge safe and efficient and it cannot be moved.
  - In this event, the bridge shall be documented for the Historic American Engineering Record prior to the onset of work, unless an emergency exists.
  - If demolition is to occur, significant and ornamental features should be salvaged and reused to assist the preservation of a similar structure or for educational purposes or should be mothballed for reuse in the future.

The information presented herein is offered to assist early evaluation of alternatives for historic bridge preservation. The Nebraska Department of Transportation helps in this process through our Historic Bridge Program Office. If Federal funding is to be used in the proposed project, its availability will be dependent upon proper completion of the paperwork and processes described in this document. For additional information or assistance, please contact Environmental Section Manager.

7.6.3—Maintenance Activities on Historical Bridges

The following repairs and bridge maintenance, necessary to keep the bridge functioning, will not change the appearance or character of a bridge.

- Bridge deck patching or placing of concrete overlay.
- Replacing of truss or other structural members in kind.
- Redecking or replacing bridge rail.
- Painting of structural steel or railing.
- Rebuilding of abutment or intermediate support caps.
- Replacing of bearing devices in kind.
- Replacing of bridge expansion or fixed devices.
- Backfilling erosion around abutments.
- Providing scour protection at intermediate supports or abutments.
- Providing additional bracing to bents.
- Reestablishing berm, as needed.
- Repairing collision damage, as needed.

7.7—REFERENCES

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