BURGESS & NIPLE

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Mr. Tyler Bumbalough, PE
City Engineer
City of Urbana
205 South Main Street
Urbana, OH 43078

Mr. Louis Agresta
Transportation Director
Transportation Coordinating Committee
3130 East Main Street, Suite 2A
Springfield, OH 45505

Re: Inspection for Repair
Bridge: CHP-DUGAN-00001
SFN: 1160044
Gwynne Street over Dugan Run & IORY RR

August 5, 2022

Dear Mr. Bumbalough & Mr. Agresta:

Burgess & Niple (B&N) performed an inspection for preliminary repair recommendations and costs of the above referenced bridge on July 6, 2022. The bridge is a four-span structure **(photos 1 and 2)** with spans numbered west to east and consisting of:

Span 1: 45'-0" steel multi-beam
Span 2: 75'-0" steel multi-beam
Span 3: 88'-0" steel multi-beam
Span 4: 55'-6" steel multi-beam

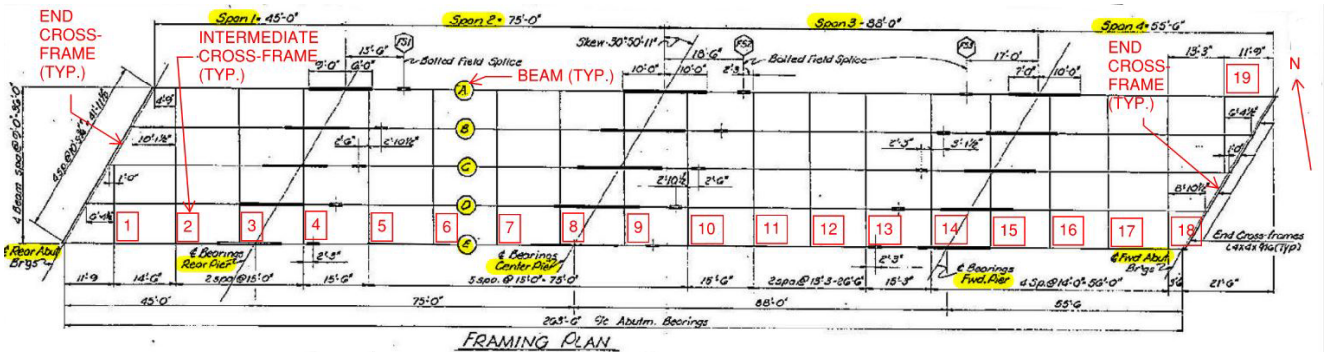
The steel beams are continuous with moment plates over the piers. The beams are non-composite with the concrete deck and are comprised of A588 weathering steel. The abutments are stub type abutments which are supported on 12-inch diameter cast-in-place reinforced concrete piles. The piers are hammerhead type piers which rest on footings supported on 12-inch diameter cast-in-place concrete piles.

This report includes appendices containing:

- Condition photographs
- Repair Recommendations

The limits of the inspection were from the rear abutment to the forward abutment. Inspection team members included, Craig Snively, PE and Luke Langdon, EI. The bridge was accessed from the ground and with a ladder.

Spans are numbered from rear (west) to forward (east), and beams are designated with letters A through E from left to right looking east. The intermediate cross-frames are numbered 1 through 19 from rear to forward. A Framing Plan from the original construction plan set is shown below.



RECOMMENDED ACTIONS/REPAIR ITEMS

The narrative below gives a brief explanation of the repairs required to extend the service life of the structure another 50 years. Repairs are categorized by priority level. Priority 1 being items we recommend addressing within 1 year, priority 2 we recommend addressing within 2-5 years and priority 3 we recommend addressing in 5 years or more. Please see the "Repair Recommendations" in the appendix for further details and cost estimates.

Priority 1

- Reweld the broken end cross-frame connections at multiple locations.
- Remove and replace the intermediate and end cross-frame angles at multiple locations.
- Extend the asphalt drains at multiple locations.
- Repair the sliding plate joints as outlined in ODOT BDM 403.7.2.
- Add slope protection to the embankments below both abutments.

Priority 2

- Abrasively clean and paint the structural steel.
- Repair the spalls on the underside of the deck in accordance with ODOT standards.
- Clean and patch the delaminated and spalled concrete at the Rear Pier.

Priority 3

- Replace the deck, sidewalks, parapets, and approach slabs.
- Eliminate the expansion joint devices at the abutments and convert the structure to semi-integral.

We thank you for the opportunity to provide our engineering services. Please contact me if you have any questions or comments.

Sincerely,

BURGESS & NIPLE, INC.

Craig A. Snively

Craig A. Snively, PE
Bridge Engineer

SIGNIFICANT FINDINGS are as follows:

DECK SUMMARY

Deck

- Approximately 325 square feet of the 10,760 square foot deck underside exhibits spalling. Approximately 50 square feet of spalling exhibit exposed and corroded steel reinforcing bars with no measurable loss **(photo 3)**.
- Most of the spalls on the underside of the deck exist around the asphalt drainage pipes and heaviest near the piers **(photo 4)**. This indicates that water is seeping through the asphalt overlay and collecting on the top of the concrete deck prior to flowing through the asphalt drains. The water then saturates the bottom of the concrete deck around the asphalt drains, causing the steel corrosion and concrete spalls.

Wearing Surface

- The asphalt wearing surface is approximately 1 to 2 inch thick and appears to have been replaced multiple times **(photo 5)**.
- The asphalt on the outer 3 feet of the deck near the curb lines is unsound. This is most likely due to water being trapped between the sidewalk cold joint and the top of the concrete deck and moving under the adjacent asphalt (**photo 6)**.
- The wearing surface has sealed longitudinal and transverse cracking throughout all spans spaced approximately 3 feet apart.

Curbs/Sidewalk

- The sidewalk and curbs were repaired in 2019 and exhibit multiple locations of minor cracking **(photo 7)**.
- Multiple sections of the sidewalk have been repaired with fiber reinforced concrete **(photo 8)**.
- Span 3 south sidewalk has a 7-foot-long x full width section of the concrete sidewalk that is scaling **(photo 8).**
- Sidewalk exhibits hairline longitudinal cracking in unrepaired sections of concrete.

Bridge Railing

- The bridge railing consists of twin round aluminum rails anchored to a concrete parapet **(photo 9)**.
- No significant deficiencies exist to the bridge railing.

Deck Drainage

- The bridge deck drains into scuppers located on the edge of the wearing surface along both sidewalks **(photo 10)**.
- Asphalt drains are located along each curb line. The PVC drain pipes project through the concrete deck, from below the asphalt overlay to slightly below the bottom of the deck **(photo 4).**

Expansion Joints

- Sliding plate expansion joints devices exist over both abutments **(photo 11).**
- Compacted soil and debris exist in both expansion joints **(photo 12)**.
- The joints over both abutments leak allowing water to drip onto the abutment bearings, beam ends, and end cross-frames causing corrosion and section loss to these steel members **(photo 13)**.

SUPERSTRUCTURE SUMMARY

Steel Beams

- The floor system consists of five W36x94 wide flange beams spaced 9’ 0” on center with welded cross-frame bracing between beams **(photo 14)**.
- The end 4-feet of the beams at the Rear and Forward Abutments exhibit corrosion and minor section loss at the following locations. The section loss is heaviest in the webs and bottom flange.
    - Beam A at the Rear Abutment.
    - Beam D at both abutments.
    - Beam E at the Rear Abutment **(photo 15)**.
- Span 4, beam D at the Forward Abutment has laminar corrosion with up to 1/8-inch-deep section loss in the bottom flange to the end 15 feet of the beam.
- Span 4, beam D at cross-frame 17 exhibits surface corrosion and laminating corrosion due to flow from asphalt drains running onto the cross-frame and down onto the beam. This condition exists at multiple locations. Extending the drainpipes below the bottom of the beams will prevent water from draining onto the beams and cross-frames.
- 20-foot-long moment plates exist over the piers on the top of the top flange and on the bottom of the bottom flange **(photo 16)**. These plates are welded along their long edges and transversely along their ends. These welds are category E fatigue prone details **(photo 17)**.

Cross-Frames

- Intermediate cross-frames are comprised of end welded steel angles with two diagonals and one bottom horizontal **(photo 18)**. End cross-frames are comprised of multiple end welded steel angles with gusset plates and top and bottom horizontal angles.
- The intermediate cross-frames are perpendicular to the beams and not normal to the skew.
- The Span 4 end cross-frame between beam D and E is missing one diagonal angle **(photo 19)**. The angle appears to have fallen away due to pack rust breaking the welds.
- Multiple end cross-frames have broken welds **(photos 20 and 21)**.
- Multiple intermediate cross-frames are under asphalt drains and exhibit laminar corrosion with section loss **(photos 22 and 23).**

Bearing Devices

- Rocker bearings exist at both abutments and at the Rear and Forward Piers. Fixed bearings exist at the Center Pier.

- Rocker bearings at both abutments exhibit corrosion and minor section loss **(photos 24 and 25)**.
- The bearings are still functioning as intended.
- To prevent further corrosion the bearings at the abutments the bearings should be abrasively cleaned and painted. The expansion joints over the abutments should be replaced with sealed joints to help prevent deck drainage from draining onto the bearings.

Steel Protective Coating System

- The steel members are comprised of A588 weathering steel**.**
- The steel patina is effective along most of the steel surfaces other than at the abutments and at locations where the steel is under a joint or asphalt drain.

Utilities

- A water pipe exists between beams C and D for the full length of the structure and penetrates both abutments back walls **(photo 26)**. Sweating of the pipe during the summer months will cause deterioration of the adjacent cross-frames.

SUBSTRUCTURE SUMMARY

Abutment Walls

- Multiple full height vertical cracks up to 0.009-inch-wide exist in both abutment backwalls **(photo 27)**.
- The Rear (west) Abutment footer is exposed 3-feet-vertically for 10-linear-feet under beams 1 and 2 **(photo 28)**.
- Deck drainage passes through the expansion joint and onto the abutment backwalls at both abutments **(photo 29)**.

Pier Caps

- The hammer head reinforced concrete pier caps are in satisfactory condition **(photo 30)**.
- The south end, east face of the Center Pier cap exhibits multiple shear cracks emanating from below the beam E bearing **(photo 31)**.
- The southeast end, top edge of the Rear Pier cap between beams D and E exhibits a 2-foot-wide x 4-foot-long x 6-inch-tall delamination **(photo 32)**. A deck drain is directly over the pier cap exposing this area to moisture during rain events.
- Water staining exist on all faces of the piers under all five beams.

Pier Walls

- The south end, east face top of the Rear Pier wall exhibits a 4-foot-tall x 2-foot-wide delamination caused by drainage flowing down the face of the wall through an asphalt drain directly over the cap **(photo 33).**

Slope Protection

- Most of the slope protection is missing at the embankments at both abutments **(photo 28)**.
- Deep erosion ditches exist at both abutment embankments **(photo 34)**.

APPROACH SUMMARY

Approach Roadway Condition

- The approach roadway has sealed map cracking at both approaches **(photo 35).**
- The approaches to bridge deck transitions are smooth.

Approach Railing

- The approach railing has turn down end treatments at all four corners **(photo 36).**
- Minor impact damage exists to the northwest bridge railing **(photo 37)**.

Photographs

Photo 1 – End view looking east.

Photo 2 – Elevation looking north.

Photo 3 – Looking east at the typical underside of span 3.

Photo 4 – Looking west at the underside of the deck in span 3 bay 4 near the Center Pier. Note: two 5-foot x 5-foot spalls with exposed reinforcing steel in the underside of the deck.

Photo 5 – Looking northwest at the typical wearing surface in span 3.

Photo 6 – Looking southwest at the typical wearing surface condition in span 1. Note: sealed map cracking throughout. Multiple locations of concrete sidewalk repair throughout all spans.

Photo 7 – Looking south at the sidewalk repair in span 3.

Photo 8 – Looking west at the south sidewalk in span 3. Note: 7-foot-long section of the sidewalk is scaling.

Photo 9 – Looking northwest at the typical bridge railing in span 4.

Photo 10 – Looking south at typical deck scupper detail. Note: multiple asphalt overlays.

Photo 11 – Looking south at the sliding plate joint over the Rear Abutment. Note: soil and debris are accumulating in the joint.

Photo 12 – Looking south at the sliding plate joint over the Forward Abutment. Note: soil and debris are accumulating in the joint.

Photo 13 – Looking east at the end cross-frame between beams A and B at the Forward Abutment. Note: heavy surface corrosion exists on the end cross-frames due to water infiltration through the deck joint.

Photo 14 – Looking east at the underside of span 2.

Photo 15 – Looking southwest at span 1 beam E at the Rear Abutment. Note: laminar corrosion typical on the end 4 feet the steel beams at both abutments.

Photo 16 – Looking east at the moment plate on the bottom flange of beam A in span 1.

Photo 17 – Looking southeast at beam E in span 3. Note: moment plates are wider than the bottom flange.

Photo 18 – Looking southeast at the end cross-frame between beams D and B at the Rear Abutment. Note: up to 1/4-inch section loss to the bottom strut angle.

Photo 19 – Looking east at the end cross-frame between beams D and E at the Forward Abutment. Note: missing diagonal angle.

Photo 20 – Looking east at the end cross-frame between beams C and D at the Forward Abutment. Note: broken diagonal angle weld.

Photo 21 – Looking east at the end cross-frame between beams B and C at the Forward Abutment. Note: broken diagonal angle weld.

Photo 22 – Looking west at the scupper drain and asphalt drain in span 4 between beams D and E at cross-frame 17. Note: asphalt drain is directly over intermediate cross-frame and drainage flows onto diagonal member and down to the bottom flange of the beam.

Photo 23 – Looking at span 3 intermediate cross-frame 10 between beams B and C near the Center Pier. Note: bottom of concrete deck spall and full depth corrosion holes exist in the cross-frame diagonal due to flow from the asphalt drain.

Photo 24 – Looking north at the rocker bearing under beam A at the Forward Abutment. Note: laminar corrosion exists to the masonry plate due to a leaking expansion joint.

Photo 25 – Looking northwest at the beam A rocker bearing at the Rear Abutment. Note: laminar corrosion with up to 1/8 inch loss to the masonry plate and bearing interface.

Photo 26 – Looking east at the water pipe running between beams C and D.

Photo 27 – Looking southwest at the water staining and cracking in the Rear Abutment backwall.

Photo 28 – Looking east at multiple erosion ditches formed by scupper drainage in embankment in front of the Forward Abutment. Similar conditions are present at the Rear Abutment embankment.

Photo 29 – Looking east at active water leakage down the Forward Abutment backwall.

Photo 30 – Looking west at the elevation view of the Rear Pier.

Photo 31 – Looking west at the south end, east face of the Center Pier cap. Note: multiple shear cracks emanating from the beam E bearing.

Photo 32 – Looking south at the south end, east face top corner of the Rear Pier between beams D and E. Note: 2-foot-wide x 4-foot-long x 16-inch-tall delamination caused by asphalt drain located directly above the cap.

Photo 33 – Looking west at the south end of the Rear Pier wall. Note: 4-foot-tall x 2-foot-wide delamination caused by an asphalt drain discharging onto the top of the pier cap.

Photo 34 – Looking west at the scour hole at the end of an erosion ditch at the south end of the Forward Pier.

Photo 35 – Looking south at the west approach roadway. Note: multiple sealed transverse and longitudinal cracks in the approach roadway.

Photo 36 – Looking northwest at the northwest approach guardrail. Note: turn down end treatment.

Photo 37 – Looking west at the northwest approach guardrail. Note: 5-foot-long section of impact damaged guardrail and multiple twisted and loose timber block outs.

Repair Recommendations and Cost Estimates

Repairs have been categorized according to the following:

Priority	Time Frame
1	within 1 year
2	within 2-5 years
3	5 years or more

Priority 1 repairs are recommended for the following items:

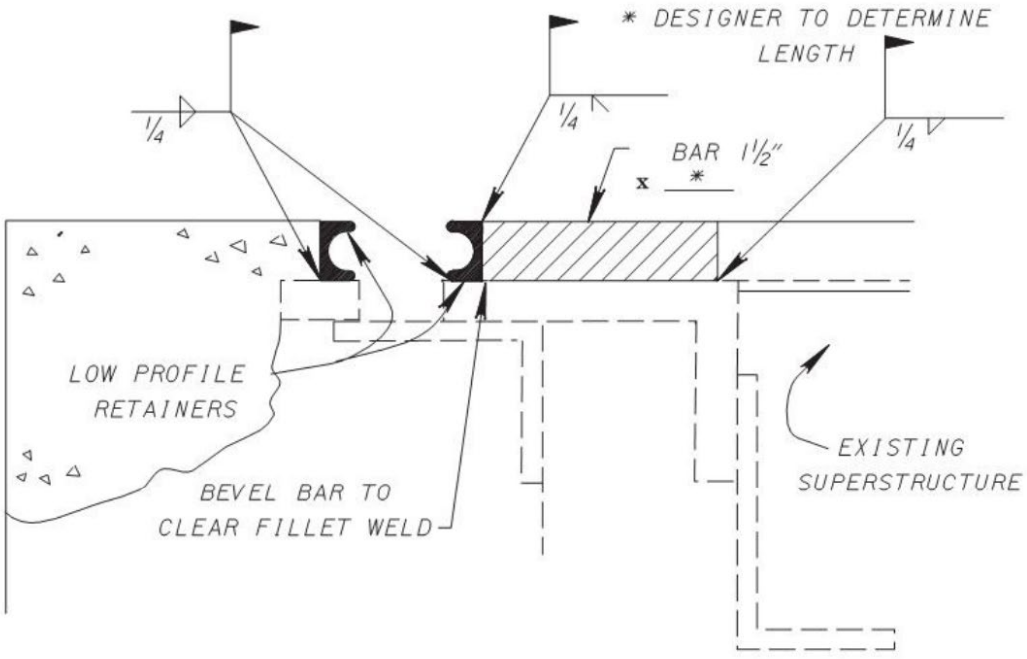
End cross-frames – Deck drainage leaking through the sliding plate expansion joints at the abutments has caused corrosion and section loss to the end cross-frames. Several of the welds attaching the cross-frame angles to the connection plates are broken. At locations where the existing angles are in good condition with broken connection welds, the existing welds should be removed by grinding and the existing angles should be re-welded. Existing angles with holes and section loss should be removed and replaced with new angles.

Asphalt Drains - 1 inch diameter PVC deck drain pipes are located at the curb line on both sides of the bridge. The original construction plans do not show these pipes. Pipes were probably added when the first asphalt overlay was constructed (date unknown). Pipes are spaced at approximately 6 feet on centers at the edge of both sidewalks and project through the concrete deck. The purpose is to allow any drainage that seeps through the porous asphalt overlay to drain through the deck. At many locations the bottom of the concrete deck is spalled and delaminated around the pipes. Two of the pipes are located over intermediate cross-frames where outflow has caused corrosion and section loss to the cross-frame angles and adjacent beams. At one location the pipe is directly over the concrete cap at the south end of Pier 1 and outflow has caused delaminated concrete on the top and side of the concrete cap. At the three locations where outflow is pouring/spraying onto the superstructure or substructure elements, the drain pipes should be extended to outlet the drainage below the bottom of the cross-frames or pier cap. A 2-inch diameter PVC flange fitting should be attached to the bottom of the concrete deck with concrete anchors (Tapcon or equal). A 2-inch diameter section of Schedule 40 pipe with fittings to offset the cross-frames or cap and of sufficient length (approximately 4 foot long at the cross-frames and 9 foot long at Pier 1) should be glued to the flange fitting. A flexible strap attaching the pipe to the pier cap should be provided to accommodate superstructure movement and brace the pipe.

Intermediate cross-frames – At Beam 1, Span 1, Cross-Frame 1.3 and Beam 4, Span 4, Cross-frame 4.3 the intermediate cross-frame angles have corrosion and section loss due to drainage from the asphalt drains. The existing cross-frame angles should be removed and replaced with new angles.

End Dam (sliding plate expansion joint) – The sliding plate expansion joint devices are leaking and allowing drainage to saturate the concrete substructures and weathering steel superstructure members. A repair that provides a watertight expansion joint device should be

considered. One solution is the repair recommended by the Ohio Department of Transportation (ODOT) Bridge Design Manual (BDM) 403.7.2. This repair should be performed at the existing sliding plate expansion joints at the Rear and Forward Abutments. The repair adds 1 ½ inch thick retainers with elastomeric strip seals, a steel plate and additional overlay material to ramp up to match the new raised strip seal. The repair is illustrated in BDM Figure 403-3 shown below (elastomeric strip seal is not shown but is placed in the retainers).



VERTICAL EXTENSION OF STRUCTURAL EXPANSION JOINTS INCLUDING ELASTOMERIC STRIP SEALS

Figure 403-3

Slope protection – The original crushed aggregate slope protection is in poor condition. Erosion is present below the deck drain down spouts. Larger aggregate should be used to minimize erosion due to the quantity of the deck drain flows. Ditches constructed of ODOT Type B Rock Channel Protection with Filter Fabric should be constructed (5'-0" wide by 1'-6" thick) at four locations below the deck drains from the face of the abutments to near the bottom of the 2 (horizontal) : 1 (vertical) slopes, ending at the Ordinary High Water Mark (OHWM).

Priority 2 repairs are recommended for the following items:

Clean and paint portions of superstructure – The beam ends, end cross-frames and bearings at the abutments should be cleaned and painted with a three coat system as recommended by ODOT BDM 702.9, Partial Painting of A709 Grade 50W Steel, which recommends painting 10 feet of each beam end adjacent to the abutments including all cross-frames and other steel within these limits. The steel should be abrasively cleaned according to ODOT Construction and Material Specification (C&MS) 518 and a prime coat applied according to C&MS 708.01. An intermediate coat shall be applied and the topcoat color shall closely approach Federal Standard No. 595B - 20045 or 20059 (the color of weathering steel). The corroded areas of Beam 1, Span 1 and Beam 4, Span 4 at the deterioration due to drainage running down the intermediate cross-frame diagonal angles from the asphalt drains should also be cleaned and painted.

Bottom of Deck – Repair the bottom of deck concrete at locations where spalled concrete and delamination is present around the asphalt drains and at other miscellaneous locations as recommended by ODOT BDM 403.2.2. ODOT recommends for repair of an under-deck spall with exposed uncoated reinforcement, to remove all loose concrete, mechanically clean the reinforcing steel and coat with paints containing zinc dust. Provide galvanizing material conforming to ASTM A780 except aerosol spray applications will not be permitted.

Patch substructure concrete – The south end of the cap at Pier 1 is delaminated due to outflow from an asphalt drain. The unsound concrete should be removed and patched according to C&MS 519.

Priority 3 repairs are recommended for the following items:

Moment plates - The steel beams have welded top and bottom moment plates at the piers. Section 404.1.2.4.a of the ODOT BDM provides guidance on rehabilitating structures with moment plates. If cracked welds are not visible, the bridge is not located on a principle arterial road and the average daily truck traffic is less than 500 vehicles per day, a fatigue analysis and retrofitting the ends of the moment plates are not required. The structure appears to meet these requirements, so alterations to the moment plates are not anticipated to be necessary. However, if a future deck replacement is performed, the welds at the ends of the top flange moments plates should be carefully inspected. The inspection will need to occur after the deck is removed. If cracks are found, moments plates should be retrofitted according to ODOT details. Costs for retrofitting moment plates have not been included in the estimated repair costs below.

Deck, Sidewalks and Parapets – The condition of the top surface of the 49-year-old concrete deck is unknown due to the presence of an asphalt overlay. It appears that two asphalt overlays have been constructed in the past, with the first probably removed prior to the placement of the second. The top surface of the concrete deck may be in poor condition due to initially requiring an asphalt and due to water penetrating the current asphalt overlay. The bottom of the deck has several spalled and delaminated areas concentrated around the asphalt drains. The sidewalk has been patched several times and is delaminated in several areas. Since the beams and substructures appear to be in good condition, consideration should be given to replacing the deck, sidewalks and parapets in the near future. The 8-inch diameter water main could be removed and replaced during the deck replacement if necessary. Eliminating the expansion joint devices at the abutments and converting the structure to semi-integral as shown below in Figure 404-6 from the ODOT BDM should be considered. The beams at the abutments would need temporarily raised by jacking and the rocker bearings replaced with elastomeric bearings. The approach slabs would need to be removed and replaced with new approach slabs with sleeper slabs. Expansion joints located above sleeper slabs would allow for thermal movement. The steel beams could be made composite with the concrete deck if additional load carrying capacity is required.

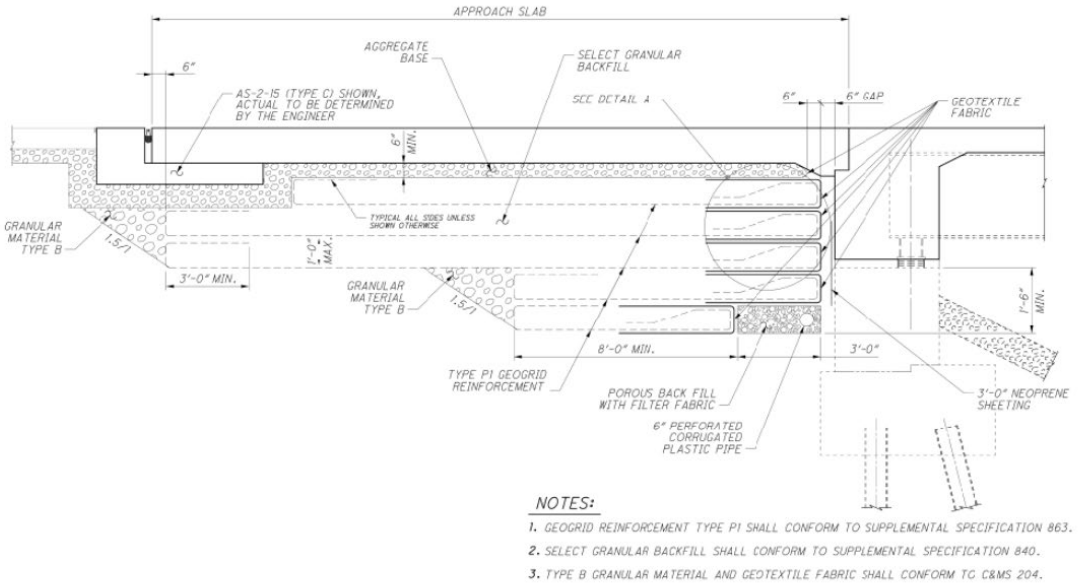


Figure 404-6

Estimated Repair Costs

Costs are in 2022 dollars. Costs will need to be adjusted for future work.

Priority 1

Re-weld brokens welds at end cross-frames	$9600
Remove and replace end cross-frame angles	$7800
Asphalt drain extensions	$1800
Remove and replace intermediate cross-frame angles	$6800
Vertical extension of structural expansion joints	$16,000
Rock channel protection, Type B with filter	$8400
15% contingency	$7600
Total Priority 1	**$58,000**

Priority 2

Surface preparation of existing structural steel	$14,600
Field painting of existing structural steel, prime coat	$3700
Field painting of structural steel, intermediate coat	$3700
Field painting of structural steel, finish coat	$3700
Underdeck spall repairs	$40,700
Patch Pier 1 cap concrete	$1000
15% contingency	$10,100
Total Priority 2	**$77,500**

Priority 3

Remove wearing course	$10,100
Remove approach slabs	$22,700
Removal of portions of the structure	$274,000
Unclassified excavation	$55,500
Concrete deck	$315,000
Concrete sidewalk	$164,800
Concrete parapet with twin steel tube railing	$147,000
Semi-integral diaphragm guides	$6,000
Epoxy coated reinforcing steel	$163,500
Elastomeric bearings at abutments	$26,000
Jacking and temporarily supporting superstructure	$15,000
Reinforced concrete approach slabs	$60,300
Sleeper slab Type C installation	$14,000
Select granular backfill	$12,000
Geogrid, Type P1	$10,000
Welded stud shear connectors	$5,800
Remove and install new 8” ductile iron water pipe with push-on joints and bridge hangers	$128,000
15% contingency	$215,300
Total Priority 3	**$1,645,000**