BRIDGE DESIGN MANUAL

If you require assistance accessing this information or require it in an alternative format, contact the Michigan Department of Transportation's (MDOT) Americans with Disabilities Act (ADA) coordinator at www.Michigan.gov/MDOT-ADA.

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CHAPTER 6 • REHABILITATION PROJECTS

6.00 REHABILITATION PROJECTS

(revised 5-25-2026)

In accordance with the 7th edition of AASHTO's *Policy on Geometric Design of Highways and Streets* ("*Green Book*" or "*GB7*"), and RDM Chapter 3, MDOT classifies rehabilitation projects into distinct project types. For this volume, use the following project type definitions:

Capital Preventive Maintenance (CPM) work includes bridge activities that repair and preserve the bridge. Projects that perform only preventive maintenance do not need to include geometric enhancements. This approach assumes that future rehabilitation or reconstruction projects will provide appropriate safety and geometric enhancements; therefore, MDOT does not require Design Exceptions or Variances for preventive maintenance work. MDOT classifies Urgent Needs and Request for Action projects as preventive maintenance.

Construction on Existing Roadway (3R) consists of work undertaken to extend the service life of an existing bridge and to enhance highway safety. The intent is to restore the bridge to structural or functional adequacy. Work may upgrade geometric features—such as roadway (bridge) widening without increasing the number of through lanes, flattening curves, or improving sight distance.

Reconstruction (4R) involves substantial changes to the existing structure such as bridge deck replacement or greater. See BDM Chapter 7 for reconstruction (including deck replacements) projects requirements.

Bridges to remain in place criteria occurs when a bridge carrying road project traffic falls within a road project and no work is planned for the bridge (see the AASHTO *Green Book*). If the bridge does not meet the criteria to "remain in place" the Road Designer must submit any necessary design exceptions or design variances for the bridge.

For projects that include structure resurfacing, railing upgrading and joint replacement projects evaluate the structural adequacy of the superstructure.

For structures scheduled for hydrodemolition, painting (constructed prior to 1978) or for any scope that includes removal of hazardous material, obtain a Michigan Department of Environment, Great Lakes and Energy (EGLE) hazardous waste number. If a number exists in MiBRIDGE (web based structure management application) and begins with anything but "MIG", "MIE", "MIH" or "MIT" use this number on project Title Sheet (note 8.02 I.). If number doesn't exist or begins with "MIG", "MIE", "MIH" or "MIT" request a new number from the Bridge Management Section, Bureau of Bridges and Structures data request email, MDOT-Bridge-Data-Request@michigan.gov. See also BDM Section 12.04.

6.01 SCOPE OF REHABILITATION PROJECTS

(revised 10-23-2017)

The Region Bridge Engineer creates the scope for rehabilitation projects by the using the Bridge Deck Preservation Matrix (BDM Section 6.09.02) and Steel Bridge Girder Coatings Repair Matrix (BDM Section 6.07). As soon as possible after assignment, the bridge design engineer should schedule a scope verification meeting. At this meeting, the scope of the project will be reviewed.

If a project is classified as Construction on Existing Roadway (3R) and Reconstruction (4R, BDM Chapter 7) work, the applicable standards are governed by the standards that correspond individually to each work type (3R or 4R). Work type overlap within a structure may cause a default to 4R standards within the overlap (entire structure). Identify each work type on the project information sheet to distinguish where 3R guidelines and 4R standards are separately applied.

When other work types are combined with 3R or 4R projects, they are also governed separately and identified as such on the project information sheet.

Projects categorized as CPM projects are governed by guidelines that differ from 3R and 4R Guidelines. When CPM work types are packaged with a 3R or 4R project, the portion of the project that is outside the 3R or 4R work limits is governed by the guidelines that pertain to CPM work type. When describing the work type in the request for Plan Review Meeting, identify the work type separation so that the appropriate requirements are considered within each structure. Work type overlap within a structure may cause a default to 3R or 4R requirements.

Treat cross-road overpasses as individual segments regardless of the project work type.

In addition to any concerns the designer may have over the project scope, the following design elements must be reviewed to determine conformance with both MDOT's 3R criteria (see RDM Chapter 3) and AASHTO standards (see also BDM Section 6.02). For specific controlling geometric design elements, a formal design exception must be submitted and approved when the standards cannot be met. Other specific elements and conditions will require a less formal design variance when standards cannot be met. These elements are listed below with their corresponding level of documentation and/or approval.

The Geometric Design Unit, Design Division, Bureau of Development will review plans and identify the need for Design Exceptions (DE) or Design Variances (DV) when standards are not met for specified geometric design elements. See also BDM Section 6.03.

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Applicability of Design Exception (DE) and Design Variance (DV)

Non-Standard Design Element (NHS and Non-NHS)	Design Speed ≥ 50 MPH	Design Speed < 50 MPH
Design Speed < Posted Speed	DE	DE
Lane Width[1]	DE	DV[2]
Shoulder Width	DE	DV
Horizontal Curve Radius[1]	DE	DV
Superelevation Rate[1]	DE	DV
Superelevation Transition Length[1]	DV	DV
Maximum Grade[1]	DE	DV
Stopping Sight Distance (HSO and K-value Horizontal and Vertical)[1]	DE	DV
Cross Slope	DE	DV
Vertical Clearance	DE	DE
Design Loading Structural Capacity	DE	DE
Ramp Acceleration / Deceleration Lanes Length[1]	DV	DV

[1] *Values based on design speeds less than posted.*

[2] *Lane width reductions from existing conditions on National Networks require the Design Exception process be followed regardless of design speed. See RDM* Section 3.08.01 G. (11-28-2022)

For more detailed information/definitions of elements, see the Road Design Manual.

6.01.01 Structures Carrying Pedestrian or Other Mode of Transportation

(revised 1-23-2023)

Where pedestrian traffic exists across a structure having sidewalks less than 4ft-0in wide, an evaluation must be made to determine the hazard involved and to consider practical improvements.

See RDM Section 6.08 for information related to MDOT's position on sidewalk construction. All structures carrying pedestrians need to be evaluated for conformance with the Americans with Disabilities Act (ADA) requirements and Public Right-of-Way Accessibility Guidelines (PROWAG).

Regardless of project work type, expansion joints located on sidewalks must be fitted with cover plates to eliminate vertical depressions caused by the joint. Cover plates may be galvanized steel (AASHTO M270, Grade 36) or steel encapsulated in EPDM rubber or neoprene A(polychloroprene). Cover plates must meet all the requirements set forth by ADA. See BDM Sections 6.06.01 & 7.02.27, EJ3 & EJ4 Sheets and BDG 6.28.06. Detail cover plates that require a length greater than 11ft to be fabricated from two equal length pieces with a joint located at the centerline of the sidewalk or path. Provide a ¼ inch wide gap at the joint that is parallel to the centerline of the sidewalk or path.

Where recommended by the Region Project Development or Bridge Engineer, rehabilitation projects should include pedestrian fencing. In Metro Detroit, all rehabilitation projects, including painting projects, over freeways should include pedestrian fencing. For limits of the metropolitan area in Metro Region contact the Metro Region Project Development or Bridge Engineer.

For information regarding MDOT fencing policy and design criteria see BDM Section 7.02.29 and BDM Section 7.05.

Where other modes of transportation (pedestrian, bicycle, multi-use paths, etc.) exist across a structure, an evaluation must be made to consider practical improvements.

6.01.02 Historic Bridges

(2-21-2017)

Consideration must be given to preserving structures designated as "historic bridges." The project engineer can find a bridge's historical significance from MiBRIDGE (web-based structure management application).

When a project is to rehabilitate historically designated bridges, contact the Cultural Resource Coordinator in the Environmental Services Section of the Bureau of Highway Development to determine which preservation measures are practical and justified to preserve the historical value. If the project is insufficiently scoped for the proposed work and the added effort significantly increases the project cost, request that the Region Project Development Engineer appropriate additional funds from the region's bridge budget.

6.02 GEOMETRIC CRITERIA

(revised 1-26-2026)

While it is desirable to improve all structures to current design standards, upgrading to this extent may not be considered cost effective where a project is otherwise programmed for only rehabilitation. Criteria for roadway widths and design loading structural capacity have been established in A Policy on Design Standards – Interstate System, 2016, the 7th Edition of AASHTO's Policy on Geometric Design of Highways and Streets ("Green Book" or "GB7"). These criteria are based on the type of roadway carried by the structure and are summarized in BDM Appendix 6.02. Criteria for structures carrying interstate freeways are provided in AASHTO's 2005 edition of A Policy On Design Standards - Interstate System. The policy states: "The standards used for horizontal alignment, vertical alignment, and widths of median, traveled way, and shoulders for resurfacing, restoration and rehabilitation projects may be the AASHTO interstate standards that were in effect at the time of the original construction or inclusion into the interstate system." Non Interstate structures must adhere to the GB7. Therefore, if a bridge on a road project is not altered it is subject to design exceptions or design variances for full new/reconstruction standards.

6.02.01 Vertical Clearance

(revised 5-27-2020)

For Design Exception Requirements for Vertical Clearance see BDM Appendix 6.02.01.

For Construction on Existing Roads (3R) freeway projects, if the existing vertical clearance is not reduced and a crash pattern involving high load hits does not exist, the vertical clearance may be retained without a design exception. However, if the vertical clearance is reduced to a value less than the standard (table value in BDM Section 7.01.08), a design exception will be required. The format for the design exception does not require a detailed evaluation but should include the basis for the request and review of the accident history and high load hits for the structures in the immediate vicinity of the structure.

For the remaining Construction on Existing Roads (3R) route classifications (BDM Section 7.01.08), existing vertical clearances greater than or equal to the minimums shown may be retained without a design exception. Vertical clearance reductions that fall below the minimums for new construction require a design exception.

6.03 DESIGN EXCEPTIONS / DESIGN VARIANCES

(revised 9-28-2026)

The GB7 classification of a project as defined by RDM Section 3.08 will determine whether a geometric review is required for a bridge project. The GB7 categorizes projects into three different project types, with the historic 3R/4R classifications following in parentheses:

- New Construction (4R)
- Reconstruction (4R)
- Construction on Existing Roads (3R)

If the project classification calls for a Design Exception/Design Variance, identify it during the Scope Verification Process or at Project Scoping. The table in BDM Appendix 6.03 includes common bridge projects and their associated project types. Submittals of Design Exceptions / Variances on a timely basis are essential to maintain the project schedule and provide an approved design where conditions may inhibit designers from meeting the required design criteria.

Additionally, Urgent Needs and Request for Action projects as defined in BDM Section 8.03, do not require geometrics review for design exceptions / design variances.

Design Exception (DE) - Design Exception requests are submitted on Form DE26 and require approval by the Engineer of Design. With the exception of low speed (< 50 mph) vertical clearance DE's, subsequent FHWA approval is required for DE elements specifically designated for federal approval in the Risk Based Project Involvement Stewardship and Oversight (RBPI S&O) plan.

Along with the justification for not meeting MDOT and/or AASHTO standards the design exception includes a site-specific Highway Safety Manual (HSM) Crash Analysis (if applicable) and the estimated total cost required to attain full standards compliance. If a specific HSM model does not exist for that roadway type, then perform a crash analysis using crash data for the existing conditions. Utilize the most recent 5 years of crash data available on RoadSoft for the requested Geometric element. The project Crash Analysis or Road Safety Audit (if required) are not applicable for design exceptions. See RDM Section 14.11 for design exception submittal procedures.

Design Variance (DV) – Design Variances are submitted on Form DV26. The procedures and conditions of design variances are as follows:

- Crash analysis review on the element in question.
- Simple justification for not meeting standards (cost, ROW, environmental, etc.)
- If the DV involves a geometric element affected by a bridge, coordination with the Chief Bridge Design Engineer is required.
- The DV is signed by the Associate Region Engineer of Development affirming that the DV is appropriate.
- The signed DV in ProjectWise completes the DV process.

During QA review of final plan package, if a DV is needed and not provided, the project will not proceed to letting until a DV is provided. If the DV is provided, then the project proceeds. Verification must be indicated on the Milestone Checklist and the Certification & Acceptance (CA) form.

See RDM Section 14.11 for additional information on design variances. When a proposed road rehabilitation project contains a bridge not conforming to minimum standards, and no work is proposed for the bridge, AASHTO “bridges to remain in place” criteria apply to the bridges. See AASHTO publication, ***A Policy on Design Standards-Interstate System,*** 2016 or the ***GB7***. The road Design Engineer/Project Manager will prepare the design exception / design variance request and areresponsible for submitting any necessary design exceptions or design variances for the bridge.

6.03.01 Requests for Traffic Volumes and Crash Histories

(revised 12-16-2019)

When requesting traffic volumes and crash histories, the Design Engineer should advise the appropriate Bureau, Division or Section as to when the response is needed to meet the schedule for plan preparation. The request should also identify any other work included within the project limits, e.g., additional bridges, road construction or other mode of transportation.

6.03.01A Traffic Volumes (Traffic Analysis Request)

(revised 9-28-2026)

Existing traffic volumes (ADT, DHV) for Construction on Existing Road project types should be requested from the Data Collection Section in the Bureau of Transportation Planning. Volumes from the latest available years should be included in the plans (Title Sheet). For more information on this process refer to RDM Section 14.23.

6.03.01B Crash Histories

(revised 9-28-2026)

Request a crash history from the Division of Operations Safety Programs Section or Region Traffic & Safety personnel on all projects. For more information on the Crash Analysis and Safety Review process refer to BDM Section 2.02.14 and RDM Section 14.24.

If a project has a design exception for underclearance, review the structure history of high load hits. This information is most expeditiously obtained from the Region Bridge personnel or Bridge Management Unit of the Bureau of Bridges and Structures by emailing MDOT-Bridge-Data-Request@michigan.gov.

6.04 STRUCTURE RESURFACING

(revised 6-28-2021)

Where the scope of work indicates an overlay, it will be for one of the following types:

- Shallow concrete overlay
- Deep concrete overlay
- Hot mix asphalt (HMA) wearing course

Shallow concrete overlays are either latex or silica fume. Use this option when additional deck work is anticipated in 10 to 15 years.

Deep overlays are silica fume modified mixes or Grade 4500 concrete with slag cement replacement. Use this option where the underside of the deck is sound and additional deck work is not anticipated for 25 to 30 years. See BDM Section 6.04.06 B.

Use an HMA wearing course on a waterproofing barrier - where additional deck work is anticipated within 5 to 10 years.

With all types of overlays, maintain an existing Thrie beam retrofit height of 34in to top of rail.

See the Bridge Deck Preservation Matrix (BDM Section 6.09.02) for further clarification.

See BDM Section 7.02.19 G when superelevations and parabolic crowns are encountered on an overlay project.

If feasible, place overlays to achieve a 2 percent cross slope; otherwise, a 1.5 percent slope is acceptable. Check the structural adequacy of the superstructure, and consider the composite action of shallow and deep concrete overlays in accordance with the AASHTO Bridge Specifications.

6.04.01 Origin of Projects

(revised 9-2-2003)

Resurfacing projects usually originate from the bridge maintenance programs of the Region/TSC. They may also originate from a road resurfacing project, since the FHWA requires all structures within the limits of such projects be considered for upgrading if there is a need.

6.04.02 Bridges Within Road Project Limits

(revised 9-2-2003)

Gap out concrete decks that are in good condition and have no existing hot mix asphalt (HMA) overlay from road resurfacing projects. If the deck is in poor condition or has an HMA overlay, treat it as follows:

A. If the deck is scheduled for a concrete overlay, include it in the project as a concrete overlay.
B. If the deck is scheduled for replacement within two years, the deck may be overlaid with HMA. Any existing HMA must be removed.
C. Gapping out the HMA overlay is not cost effective for very short structures. For these structures, the HMA overlay will be continued across the structure after placing a waterproofing barrier.

6.04.03 Concrete Removal

(revised 5-1-2000)

Decks which are to be overlaid with a concrete surfacing mixture will be prepared by scarification followed by two passes of hydrodemolition.

6.04.04 Hydrodemolishing

(revised 10-28-2024)

Normally, the entire deck surface will be hydrodemolished regardless of the apparent extent of unsound concrete. This will assure removal of any undiscovered delaminations along with the layer of concrete having the highest chloride contamination. Any existing overlays or hot mix asphalt (HMA) patches must be removed, and the deck scarified, before beginning the first pass of hydrodemolishing. Calculate area with limits as reference lines and toes of barriers/curbs. Eliminate area of link slabs if they exist and add note 8.09.02 I to plans.

Ideally, properly calibrated hydrodemolishing equipment removes the specified depth of sound concrete and all unsound concrete. Based on experience, some unsound concrete will remain after one pass, so the need for a second pass can be anticipated. Estimate the second-pass area at 4 percent of the first pass. If the deck to be overlaid has an existing latex overlay, estimate the second-pass quantity at 10 percent of the first pass due to the greater difficulty in identifying areas of unsound concrete.

Ensure that the structural capacity (design, legal and permit loading) for bridges during hydrodemolishing for rehabilitation/overlay projects will not be decreased. For further information regarding hydrodemolishing of variable depth concrete T-Beam bridges and precautions to take, please see the "Rehab Guidelines for T-Beam Structures" reference document, located at the Bridge Operations, Bridge Management and Scoping website.

Structures being hydrodemolished need a Michigan Department of Environment, Great Lakes and Energy (EGLE) hazardous waste number. If a number exists in MiBRIDGE (web-based structure management application) and begins with anything other than "MIG", "MIE", "MIH" or "MIT" use this number on project Title Sheet (note 8.02 I.). If number doesn't exist or begins with "MIG", "MIE", "MIH" or "MIT" request a new number from the Bridge Management Section, Bureau of Bridges and Structures data request email, MDOT-Bridge-Data-Request@michigan.gov. See also BDM Section 12.04.

6.04.05 Hand Chipping

(revised 9-1-1988)

When it is necessary to remove unsound concrete by hand chipping, the removal of the concrete will be divided into two categories:

A. Hand Chipping - Shallow:
    1. Where concrete removal is not required to be deeper than the midpoint of the top reinforcement, the concrete removal must be bid as "Hand Chipping, Shallow."
B. Hand Chipping - Deep:
    1. Where concrete removal is required to be below the midpoint of the top reinforcement, the concrete removal must be bid as "Hand Chipping, Deep."

Where bridge decks require hand chipping, the areas requiring it must be indicated in a diagram included on the plans. Normally, the Engineer should increase the total area of delaminations shown on the maintenance report by 50 percent to arrive at the plan quantity for hand chipping. However, if spalled or delaminated areas occur in clusters, each cluster should be enclosed in

an assumed area to be hand chipped. The total of the assumed areas should be increased by 20 percent to arrive at the plan quantity.

6.04.06 Concrete Overlays

(revised 7-28-2025)

MDOT uses the following two strategies for concrete overlays (also see BDM Section 6.09.02 and the Bridge Deck Preservation Matrix):

A. Shallow Overlays

1. Shallow overlays are a medium term fix. They are designed to last approximately 10 to 15 years.
2. Remove a minimum of 1½” from the bridge deck. The removal must include scarifying the top surface of the deck a minimum of ¼". The final 1" of removal must be completed using hydrodemolition to achieve the desired surface profile.

Shallow overlays consist of a latex modified or silica fume modified concrete overlay mixture placed a minimum of 2 ¼" in thickness. If the thickness must be less than 2 ¼" contact the BOBS Construction Unit to discuss the appropriate plan details for the project.

B. Deep Overlays

1. Deep overlays are a long term fix. They are designed to last 20 to 30 years depending on the condition of the existing deck.
2. Deep overlays consist of a concrete overlay made of either silica fume modified concrete or Grade 4500 concrete with slag cement replacement. It is placed on the existing deck after it has been scarified and hydrodemolished.
3. It is desirable to completely encapsulate the top mat of reinforcing steel in the deep overlay. However, it is difficult to know the precise location of the mat before hydrodemolishing the deck. In addition, the thickness of the existing deck will influence the amount of concrete removed.
4. The deep overlay thickness and procedures varies depending on the thickness of the existing bridge deck (excluding any existing overlay).
5. For decks 7½in or less in thickness, the deck is scarified ¼in and hydrodemolished 2¾in or to ¾in below the top mat of steel, whichever is less. The overlay is a minimum of 3in in thickness.
6. For decks greater than 7½in in thickness, the deck is scarified ¼in and hydrodemolished 3¾in or to ¾in below the top mat of steel, whichever is less. The standard concrete overlay should use silica fume modified concrete with a minimum thickness of 4in.
7. Deep overlays for which 2/3 or more of the deck will be greater than 4in in thickness should use a Grade 4500 concrete that replaces 25 to 40 percent of the required cement content with slag cement. These overlays cannot become shallower than 2in. Additional chipping at the gutter line (toe of barrier or curb) may be detailed to accommodate this requirement. See the Special Provision for Deep Concrete Bridge Deck Overlays.

6.04.07 Hot Mix Asphalt (HMA) Overlays and Caps

(revised 3-26-2012)

In general, an HMA overlay or cap is not a preferred treatment for bridge decks. Where a bridge is scheduled for a deck replacement within two years, an HMA cap is an acceptable means of obtaining rideability.

Where HMA is used for a longer term overlay (five years or more) the designer must incorporate a waterproofing membrane in the design (see the Standard Specifications). Also see BDM Section 6.04.

Where an HMA mix has not been specified as part of a road project, the project manager should consult the Construction Field Services Bituminous Pavement Unit for an acceptable HMA.

6.04.08 Approaches

(revised 3-26-2012)

To eliminate approach pavement settlement, a concrete approach section will be used for all concrete overlays. For hot mix asphalt (HMA) deck overlays, a concrete approach is not necessary.

The details of the approach slab must be as specified on Standard Plan R-45-Series except on existing structures where the grade will not be raised; the length of the approach slab must match the existing approach slab joint.

The transverse limits of the approach section must extend to the concrete curb and gutter.

6.04.09 Metal Mesh Panels

(revised 2-22-2021)

Bridge deck deterioration and spalling concrete from the underside of bridge has led to the need to protect the roadways below bridges.

6.04.09A Considerations

(revised 2-22-2021)

Metal mesh panels should be considered for projects with full depth patching in spans over traffic, and projects with rigid (concrete) overlay projects, regardless of observed condition of deck underside. Panels should be added over the extents of all paved areas, including paved shoulders and sidewalks. For projects that require false decking, include quantities for false decking as usual. False decking will be removed upon completion of rehabilitation work, and metal mesh panels will be installed.

6.04.09B Limitations and Use Guidance

(revised 2-22-2021)

A. Metal mesh panel length is limited to 6ft-6in. Larger sizes become too heavy and too awkward for the average personnel to install. Larger sizes have not been impact tested. Longer sizes can be accommodated but require the width of the panel to be reduced from 48in. to 24in. Also require design checks on tube sizes and revision to Special Provision.

B. Metal mesh panels are not applicable on curved girder structures or superstructures with flared beam spacing.

C. Other Considerations

1. Variable depth steel girders would require a designed attachment.
2. Steel beams with full depth diaphragm connections or stiffeners require a modification to the panel.
3. Concrete T-Beams and spread box beams require a designed connection.

D. Fit and Installation Problems

In general, metal mesh panels are installed by placing one end of the metal mesh panel near the top flange (web fillet) until the other end clears the opposite bottom flange. Then rested on the bottom flanges. Installation is similar on PCI Beams.

1. Short beams need to be checked for feasibility of installation.
2. Check bays for utilities that would interfere with installation.
3. Check clearance between diaphragm and bottom flange.

Use wood false decking when metal mesh panels cannot be used on a project and circumstances warrant protection of roadways, shoulders, or sidewalks.

6.05 RAILING UPGRADING

(revised 11-25-2019)

A. Upgrade bridge railings when the existing facility is inadequate, either due to crash history or because it is not a current MDOT-approved railing. Schedule the upgrades according to the following guidelines:Railings must be upgraded at any location where a revised railing can be expected to reduce the severity of crashes.

B. Railings must be upgraded at any location within safety upgrading projects.

C. Railings must be upgraded when bridge reconstruction of any nature is planned.

D. Railings must be upgraded where pedestrian screening is added to a bridge.

The decision to retain, retrofit, or replace existing railing depends on the type and condition of the railing and the curb or sidewalk treatment.

Where replacement is required, the proposed railing must be a current MDOT approved railing.

6.05.01 Approved MDOT Railings

(revised 10-24-2022)

Current MDOT approved railings are:

A. Bridge Barrier Railing, Type 6 (B-29-Series)

B. Bridge Barrier Railing, Type 7 (B-28-Series)

C. Bridge Railing, Aesthetic Parapet Tube (B-25-Series)

D. Bridge Railing, 2 Tube (B-21-Series)

E. Bridge Railing, Thrie Beam Retrofit (B-22 & 23-Series)

F. Bridge Railing, 4 Tube (B-26-Series) (9-2-2003)

G. Bridge Railing, 3 Tube With Pickets (B-27-Series)

H. Bridge Railing, Concrete Block Retrofit (B-50-Series)

I. Bridge Barrier Railing, Type 6, Replacement[1-I] (B-29-Series and Bridge Design Guides)

[1-I] = **Type 6, Replacement (adhesive anchored) barrier must only be used for non-NHS routes.** Approval to use Type 6, Replacement (adhesive anchored) barriers on NHS routes must be requested from the Chief Structure Design Engineer if the deck overhang cannot be replaced AND the superstructure has appreciable life left (good or fair condition upon completion of the project). Other criteria/circumstances that make replacement of the barrier and necessary portions of the deck not technically feasible may be considered.

Adhesive anchored railings other than Bridge Railing, Conc Block Retrofit and Bridge Barrier Railing, Type 6, Replacement (subject to the specific conditions listed in the footnote above) are not permitted.

6.05.02 Existing Railings and Upgrading Options

(revised 10-24-2022)

Use the following table to determine the appropriate railing treatments for projects. The table provides minimum railing-upgrade criteria and identifies when conditions warrant replacing the railing rather than retrofitting or retaining it.

Table of Railing Treatment Options

<table>
<tr><th colspan="2">Option</th><th>Offset</th><th>Posted Speed</th><th>R4 Railing (concrete posts)</th><th>R5 Railing (metal posts)</th><th>Concrete Parapet Railing</th><th>Aluminum Railings (2&3 Tube)</th><th>R15 Railing (GM Shape), Type 4 & 5</th></tr>
<tr><td colspan="2">Reconstruction</td><td>All</td><td>All</td><td colspan="4">Replace</td><td>Replace</td></tr>
<tr><td rowspan="6">Rehabilitation[6]</td><td rowspan="3">Guardrail Retrofit</td><td>Sidewalk/ Brushblock ≤ 2’-6”[1]</td><td>All</td><td>Retrofit (Std B-22)</td><td rowspan="2">Replace</td><td>Retrofit[2] (Std B-23)</td><td rowspan="2">Replace</td><td rowspan="6">Replace or Retain[4]</td></tr>
<tr><td rowspan="2">Sidewalk/ Brushblock > 2’-6”[1]</td><td>≤ 40 mph</td><td>Replace or Guardrail[3]</td><td>Retain</td></tr>
<tr><td>> 40 mph</td><td colspan="4">Replace</td></tr>
<tr><td rowspan="2">Concrete Block Retrofit, B-50[5]</td><td>Sidewalk/ Brushblock ≤ 1’-6”[1]</td><td>All</td><td colspan="4">Remove Railing and Retrofit</td></tr>
<tr><td>Sidewalk/ Brushblock ≥ 1’-6”[1]</td><td>All</td><td colspan="4">Remove or Retain Railing and Retrofit</td></tr>
<tr><td>Type 6, Replacement (non-NHS only)</td><td>All</td><td>All</td><td colspan="4">Remove Railing and Replace[6]</td></tr>
<tr><td colspan="2">Preventive Maintenance</td><td>All</td><td>All</td><td colspan="4">Retain</td><td>Retain</td></tr>
</table>

Replace = Replace railing with Standard MDOT approved bridge rail.
Retrofit = Retrofit per Standard Plans B-22, B-23 or B-50 Series.
Retain = Retain existing bridge rail.
Guardrail = Attach Thrie-beam guardrail directly to concrete posts.

[1] Where sidewalks are required for pedestrian use, they must provide at least 4ft-0in clear distance between the bevel point and the retained, retrofitted or replaced railing.

[2] Normally, handrails should not be removed; however, if they are removed, anchor bolts should be left in place. This treatment is accepted as crash tested for Michigan Thrie Beam Retrofit (Std B-23).

[3] Replace railing if circumstances warrant, otherwise attach Thrie beam guardrail to railing (concrete posts) with ⅞in diameter bolts. Wood blocks and blockouts must not be used in guardrail attachment to posts. If approach guardrail is present or being installed, it must be attached to Thrie beam guardrail on bridge; use Thrie beam transition and expansion sections as required. If no approach guardrail is present or being installed terminate Thrie beam guardrail at end post of railing with Thrie beam terminal connector.

[4] Obsolete Standards R15 A - R15 N, X-17 and B-17 Series & X-20 and B-20 Series. Replace if warranted by the condition of the existing barrier and the crash history, retain otherwise.

[5] Sidewalk/brushblock height at curb must be ≥ 10in.

[6] Remove sidewalk width as needed for shoulder width

While a thrie beam retrofit, concrete block retrofit or Type 6, Replacement is an acceptable means of upgrading existing substandard railings, there will be locations where shoulder widths will be less than the minimums recommended for minor bridge deck rehabilitation. In these situations, the project manager must request a design exception or design variance for shoulder widths.

6.05.03 Horizontal Curvature

Where a structure is on a horizontal curve with a radius less than or equal to 950 feet, consideration should be given for a special railing system to accommodate sight distance. This may require the complete removal and replacement of the existing railing system.

6.05.04 Revisions to Guardrails

(revised 6-25-2018)

When a bridge railing is replaced with a new railing,

update the approach and trailing guardrails to meet current standards. Replace any guardrail that uses corrosion-resistant (rusty steel) beam elements. When obsolete guardrail extends a considerable distance from the structure, limit the replacement to 200 ft-0 in in each quadrant. See RDM Section 7.01.44 for guardrail upgrading on local roads.

6.05.05 Repairs to Existing Type 4 or Type 5 Railings

(revised 1-27-2025)

Many situations warrant repairs to portions of an existing bridge railing that is otherwise intended to be retained. The following requirements pertain to situations where deterioration of portions of existing Type 4 or Type 5 railings is such that portions must be removed and replaced.

Generally, the replaced portions of bridge railing may be attached to the existing bridge deck using adhesive anchored reinforcement. Guidance for adhesive anchoring of Type 4 barrier railing can be found in BDG 6.29.09A. These details can be adapted for Type 5 barrier railing repairs.

Do not use adhesive anchored reinforcement to replace portions of bridge railings in the following cases:

A. The existing deck at the fascia of the bridge is in poor condition.

B. The railing is being repaired due to damage caused by a vehicle collision.

C. The existing bridge railing is attached to the bridge deck using adhesive anchored reinforcement.

Exceptions to the cases listed above may be considered based on project specific conditions and must be approved by the Chief Structure Design Engineer. Projects requiring the replacement of Type 4 or Type 5 railing along a full fascia of the bridge must be replaced with a current MDOT approved railing and follow the requirements of the new railing.

6.06 JOINT REPLACEMENT

(revised 3-20-2017)

Deck joints of various types have proven ineffective and may require replacement on projects where other rehabilitation has been scheduled. Because of their poor performance, joints should be eliminated whenever possible. On painting contracts, leaking joints should be sealed. On overlay projects, even joints in good condition should be replaced to match the new deck grade.

A common treatment for the expansion joints at the abutments of continuous concrete T-Beam bridges built in the 1940s and 1950s was to support the sidewalk on a sliding steel plate over the independent backwall. On projects of this type, plans should call for removal of the plates at the independent backwall and the installation of the new expansion joint from fascia to fascia. Where existing railing is to remain in place, provision should be made for replacement of the end posts.

Generally, joint replacement should include replacement of the deck from fascia to fascia (including portions of the barriers) to ensure consistent opening for the entire width of the bridge. If sufficient opening exists, and barrier ends and fascias are in good condition, joint replacement may be terminated at the barrier.

6.06.01 Expansion Joint Devices

(revised 1-23-2023)

Where expansion joints require replacement, the deck concrete should be removed and replaced for the full depth, 1ft-6in either side of the joint. (See Bridge Detail EJ3)

Where expansion joint replacement is the only substantial work on the existing deck, and the deck concrete is sound, some proprietary joints can be replaced using the procedure shown on Bridge Detail EJ4. This replacement removes only enough concrete to remove the existing joint and to permit the casting of polymer or elastomeric concrete headers. Shallow depth strip seal anchorages are then embedded in the header material. This allows a fast joint replacement.

Replace the expansion device with a proprietary expansion joint currently approved by MDOT that has no single opening wider than 4 in. When openings greater than 4 in are required,a modular expansion joint may be used. See the Special Provision for Modular Expansion Joints for additional requirements.

When an expansion joint device is used on a sidewalk fit it with a cover plate as described and detailed in BDM Sections 6.01.01, 7.02.27, EJ3 and EJ4 Sheets and BDG 6.28.06.

6.06.02 Felt - Type Joints

Where felt - type joints ("Joint Filler") are to be removed, deck concrete should be removed and replaced for the full depth, 1ft-6in either side of the joint. Replacement will be with an expansion joint device, or, where possible, the joint eliminated.

6.06.03 Revisions to Deck Joints

(revised 5-1-2000)

When removing curbs or sidewalks from decks, it will be necessary to rehabilitate the existing deck joints.

1. Metal Expansion Joints. Where it is necessary to extend an existing metal floor joint or an expansion joint device after removal of the curbs, the plans must include a bid item for “Bridge Joint, Revise Expansion Device”.

2. Felt -Type Joints. Where it is necessary to extend a felt-type joint, either an expansion or a construction joint, after removal of the curb, the plans must include a bid item for “Bridge Joint, Revise Compression Seal”.

6.07 PAINTING

(revised 10-23-2017)

Projects for painting structural steel are requested by the Region/TSC. These projects may either be for the repainting of previously coated steel or the initial painting of A588 steel. For additional information, see BDM Section 7.02.17. The Steel Bridge Girder Coatings Repair Matrix also provides guidance on paint defects and recommended repairs.

6.07.01 Blast Cleaning

(revised 5-1-2000)

A. In addition to the normal precautions required during blast cleaning of existing steel, provisions must be made to properly confine and dispose of abrasive material and residue. These provisions are required whether the entire structure is to be cleaned or only isolated portions.
B. Some telephone ducts installed under bridges in the past have been Johns Manville Transite ducts, made in part of asbestos. These will have to be encased to prevent release of the asbestos into the atmosphere during blast cleaning for painting.
E. The bridge inspectors will identify ducts marked "Johns Manville" or "Transite" and record this information on their reports. If the telephone ducts are inaccessible and the material cannot be identified, this will be noted. We will then make the determination during a site visit.
F. These ducts and others not requiring painting should be encased in a protective shielding to prevent damage due to blast cleaning (see BDM Chapter 8, Note 8.09.04 C.).

6.07.02 Substructure Protection

(revised 12-27-2022)

To prevent deterioration, coat (seal) the top surface of all substructure units under superstructure transverse joints. For coating options (materials) see BDM Section 7.03.11.

6.07.03 Pins and Hangers

(revised 1-24-2024)

The pin and hanger assemblies of cantilever bridges are particularly susceptible to corrosion, and their replacement may have to be included in painting contracts. Region scoping engineers will designate which assemblies will have to be replaced. See BDM Chapter 7 for details.

Where steel beams of adjacent spans are in contact or insufficient expansion length is available between beam ends, consider addressing the closure and the cause of the closure.

If the webs are buckling at closed pin and hanger assemblies, the closure should be addressed.

There are several options to address the closure. Feasibility of various options is dependent on the proposed scope of work. The decision should also be based on the maintenance report and/or observations made during field reviews.

Often, pressure from approaching concrete pavements cause the superstructure to shorten and should be addressed by adding pavement relief joints.

The following repair methodology/criteria is relevant only for redundant structures:

1. If two pin and hanger assemblies exist between fixed bearings, the closed pin and hanger assembly can be fixed by adding a bolted stay plate and removing the stay plate at the opposing assembly. Substructures should be analyzed for additional loads, where applicable.
2. If the deck is being replaced, beams may be pulled back to their original location, restoring the opening between beam ends. Other work to the superstructure may be necessary.
3. If necessary, beam ends can be trimmed. To determine the feasibility of trimming, the capacity of the beam must be evaluated for the proposed edge distance between the pin holes and the cut surfaces. If pack rust exists between pin plates of built-up members, employ mechanical means of beam cutting.
4. If beams are in contact, and cutting or other methods stated above cannot be implemented to relieve the pressure and/or restore the opening between beam ends, an analysis should be performed to ensure that the beams can be left in contact until a project with sufficient scope to address the issue can be constructed.

The assessment and repair of non-redundant (fracture critical) structures should be handled on a case by case basis. It may not be prudent to leave girder ends in contact until a project with sufficient scope can be constructed since web buckling of a single member could have a larger impact on the overall performance of the superstructure.

Generally, the design of new pin and hanger assemblies result in dimensions that are different than those of the existing assemblies. The designer must ensure that the proposed pin and hanger assemblies do not conflict with existing elements and will fit within the confines of the existing superstructure while still meeting all applicable design requirements.

Use stainless steel for all new pins and pair them with nylon washers and nonmetallic bushings. Design new pin plates and link plates using an allowable bearing stress of 0.8 F_y. For non-redundant structures, use a reduced allowable bearing stress of 0.4 F_y.

6.07.04 End Diaphragms

(revised 12-27-2022)

On field inspections of structures scheduled for painting, the designer should consider accessibility behind end diaphragms for cleaning and painting. If the end diaphragms are within 1ft-2in of an abutment backwall (or if the end diaphragms at a pier are too close) and the slab above the diaphragms is not to be removed, the diaphragms must be removed to permit proper cleaning and coating.

Plans must include an acceptable system for shoring the slab while the diaphragm is not in place. It should be noted that the contractor may use an alternate shoring system subject to the engineer's approval.

Where end diaphragms must be removed for cleaning and painting, place BDM Chapter 8, Note 8.09.04 G. on the plans and detail work according to Subsection 715.03 E. of the MDOT Standard Specifications.

6.07.05 Cleaning and Coating Exposed Steel

(revised 8-20-2009)

Where structural steel has been exposed by the removal of deck concrete, it must be cleaned and coated. Cleaning and Coating is to be according to the Standard Specifications for Construction or Special Provisions.

Construction sequencing (painting after casting deck) of deck replacement projects with steel beams requires the use of the pay item, “Top Flanges and Beam Ends, Clean and Coat”, even if the project requires total beam painting.

6.07.06 Performance Warranties for Bridge Painting

(revised 3-26-2012)

Require performance warranties on bridge painting contracts whenever possible. For non–National Highway System (NHS) bridges, the Design units must include the performance specification in the contract.A trunkline project can be considered non-NHS, even though it may have NHS funding, if the facility carried is non-NHS.

If the facility carried is NHS traffic, the performance warrantee specification may still be applicable. The Design units must contact the Construction Field Services Coatings Specialist, at the preliminary plan stage, to determine whether the bridge can be added to Special Experimental Projects list for warranty painting.

6.07.07 Paint Color

(revised 12-26-2017)

The standard color for MDOT bridges is Light Gray. The AMS-STD-595 number for this color is 16440. Previously, the MDOT standard color was Light Blue – number 15488. Other colors may be recommended by the Region.

6.07.08 EGLE Hazardous Waste Number

(revised 10-28-2024)

All structures scheduled for painting (constructed prior to 1978) need a Michigan Department of Environment, Great Lakes and Energy (EGLE) hazardous waste number. If a number exists in MiBRIDGE (web based structure management application) and begins with anything but “MIG”, “MIE”, “MIH” or “MIT” use this number on project Title Sheet (BDM Chapter 8, note 8.02 I.). If number doesn’t exist or begins with “MIG”, “MIE”, “MIH” or “MIT” request a new number from the Bridge Management Section, Bureau of Bridges and Structures data request email, MDOT-Bridge-Data-Request@michigan.gov. See also BDM Section 12.04.

6.07.09 A588 Steel Beams

(revised 9-23-2003)

The following rehabilitation situations exist for A588 beams:

1. Little or no section loss (< 20 percent), painting is not required.
2. Significant section loss (≥ 20 percent), the entire structure is painted. This includes projects with beam end repairs.
3. Pin and hanger projects where beams are otherwise in good condition (< 20 percent section loss), beams are zone painted (with the outside of the fascia beams top coated brown in the zone area).

6.07.10 Partial Painting

(revised 8-29-2022)

Where structural steel cleaning and coating involves only partial sections of beams or diaphragms the entire perimeter of the beams or diaphragms, less any portions encased in concrete, must be cleaned and coated. Cleaning and Coating must be according to the Standard Specifications for Construction or Special Provisions.

When temporary stiffeners are required, use the remaining life of the existing coating system to determine the appropriate cleaning and coating items to include. Generally, if a project to clean and coat the existing structural steel is not planned for 5 years or more, specify that the perimeter of the temporary stiffener be sealed using the Beam Plate, Seal Perimeter pay item and call for the cleaning and coating of the existing structural steel located within at least 3 feet of the temporary stiffener. If a project to clean and coat the existing structural steel is planned within the next 5 years, it is recommended to not include the sealing of the perimeter of the temporary stiffener or the cleaning and coating of the existing structural steel outside of the limits of the faying surface. In both cases, the treatment of the faying surfaces of the temporary stiffener and the existing structural steel and the coating of the temporary stiffener must be according to the Standard Specifications for Construction or Special Provisions.

6.07.11 Existing Bridge Sign Connections

(revised 2-24-2025)

For rehabilitation projects that do not include replacement of bridge mounted sign connections, the Bridge Engineer must visually inspect existing connections for evidence of beam overstress or distortion. If signs of overstress or distortion are observed, analyze the existing beam and include the installation of any measures needed to strengthen the existing beam/girder in the bridge rehabilitation project.

Where existing bridge sign connections are attached to the bridge or where existing signs prevent proper cleaning and coating of the structural steel, they must be removed to permit proper cleaning and coating. Contact the MDOT Signing Unit to determine if the existing signs and existing bridge sign connections should be replaced or salvaged and reinstalled.

After the existing structural steel has been cleaned and coated the signs will be installed. New and salvaged bridge sign connections must be installed in accordance with the requirements of the MDOT Sign Support Standard Plans. The work to remove, salvage, and install the bridge sign connections and signs will not be considered incidental to the work to clean and coat the structural steel. Include the appropriate pay items to cover the work as outlined in Subsection 810 of the MDOT Standard Specifications for Construction. If existing bridge sign connections

are to be salvaged and reinstalled, include the Special Provision for Bridge Sign Connection, Type (insert Type), Salvage, Erect in the Contract documents.

Where existing bridge sign connections or signs must be removed for cleaning and coating, add note 8.09.04 N. to the contract plans.

See Sign Design, Placement, and Application Guidelines for additional guidance.

6.08 MISCELLANEOUS REHABILITATION

(revised 5-27-2020)

Some miscellaneous rehabilitation is significant and is programmed for the specific purpose. More frequently, miscellaneous work is an adjunct to other work. As such, its nature and cost should be determined as early as possible so that the primary project programming can be adjusted.

Include saw cut depth dimensions when removing portions of abutments, piers and columns on the plans.

6.08.01 Field Inspections

(revised 5-27-2020)

The Plan Review Meeting with a field inspection should be conducted on all rehabilitation projects. This inspection should be made within six months of the contract letting to most accurately determine the extent of deterioration. If a project is postponed, it may be necessary to conduct a second inspection.

6.08.02 Concrete Repair - General

(revised 9-22-2025)

Embedded Galvanic Anodes for Concrete Repairs
Galvanic anodes consist of a cementitious shell encapsulating a zinc electrolyte. The embedded galvanic anodes serve to provide localized corrosion protection to existing steel reinforcement through the principles of electrochemistry. Often, when new concrete is placed adjacent to old concrete, corrosion in the old concrete is accelerated. This is the result of a difference in the electrolytic potential between the new and old concrete. By introducing zinc to the system through galvanic anodes, a new galvanic cell is created which results in the accelerated deterioration of the anodes rather than the existing reinforcement. This protection is directly related to the amount of zinc contained in the anodes as the protection lasts only until the anodes have fully oxidized.

The embedded anodes have a life expectancy of 15 to 20 years, which is dependent on anode spacing, environmental exposure, zinc content, and the amount of existing steel reinforcement in the structure element being repaired. Galvanic anodes must be specified with an adequate amount of zinc content per foot along the perimeter of concrete patches or along the interface between new/existing concrete to reach the desired service life.

Use galvanic anodes with uncoated and epoxy coated reinforcement. Embedded anodes must be tied to uncoated steel reinforcement for proper function. Where galvanic anode is connected to coated rebar the coating must be removed to ensure electrical connection between anode tie wire and reinforcing steel.

Use embedded galvanic anodes whenever existing reinforcement will be encased in both new concrete and existing concrete after the proposed work is completed. Suggested uses are as follows:

1. Bridge deck widening.
2. Deck joint replacement.
3. Substructure repairs.
4. Deck repairs, where greater than ten years patch service life is required.
5. Substructure widening.
6. Concrete superstructure repair and patching.
7. Concrete bridge railing repairs and/or replacements.

For items 1 thru 7, placement of anodes will follow the Frequently Used Special Provision for Embedded Galvanic Anodes, High Performing for Corrosion Control. Include Special Provision in proposal for all rehabilitation projects including concrete repair. The steel density of each bridge element being repaired utilizing galvanic anodes must be reported in the project plans.

6.08.03 Substructure Repairs

6.08.03A Patching

(revised 5-24-2021)

This work generally includes the sealing of cracks and patching of spalled areas. Designers should be aware that the cost of extensive substructure patching may be more than the cost of removal and replacement of a portion of the unit. Where removal of substructure portions is feasible it should be considered. A prime example of this is removing a portion of a pier cap on a project that includes superstructure replacement.

1. Removal of concrete is to be paid for as "Hand Chipping, Other Than Deck" and includes all areas excluding the top surface of the deck and sidewalk; i.e. all substructure units, the underside of the deck, and the barriers and fascias.
2. Patching mixtures include latex modified (LM) concrete as one of the choices. Since its bonding characteristics are superior to the others, LM concrete overlay mixtures (Table 1006-2 in the Standard Specifications) should be used for substructure repair where latex is relatively available. In the North and Superior Regions, this mixture should be used only where the project already includes LM concrete for a deck overlay. Otherwise, repairs should be made with a structure patching mixture from Table 1006-1.
3. When substructure units are patched, the entire surface of the substructure unit must be coated with "Penetrating Water Repellent Treatment" to prevent further deterioration. As an alternative, where aesthetics are important, an elastomeric concrete sealer may be used. See BDM Section 7.03.11.

6.08.03B Column Wrapping

(revised 7-30-2012)

This work consists of repairing concrete pier columns by wrapping them with a fiber reinforced polymer (FRP) wrap (see the Special Provision for Column Wrapping with Fiber Reinforced Polymer (FRP) sheets and the Michigan Department of Transportation's (MDOT) Research

Report No. RC 1386, ***Repair of Corrosion-Damaged Columns using FRP Wraps*** for detailed information.)

Column wrapping should be considered as an alternate to the traditional chip, patch, and seal repair method for both square and round columns when only slight to moderate deterioration exists in the columns. Some concrete surface preparation is required prior to wrapping the column, but only to the extent necessary to obtain a flat surface. Blast cleaning, rounding corners, and patching spalls are all that is needed for the concrete surface preparation. Crack epoxy injection and concrete chipping behind steel reinforcement is not necessary. Criteria for using column wrapping in Capital Scheduled Maintenance (CSM) and Capital Preventive Maintenance (CPM) projects are as follows:

Column size

- No restrictions on column height. No restrictions on round column diameter. Width of rectangular columns must be limited to 3ft because the wrap is not as effective in confining the mid point of the side compared with a round column.

2. Filler walls

    - The presence of filler walls adjacent to a column prevents wrapping that portion of the column. Replacement of the adjoining portion of the filler wall decreases the cost effectiveness of the column wrapping. Filler wall replacement in conjunction with column wrapping is cost effective when the cost to replace the filler wall is small compared with the cost of column wrapping and needs to be considered on a case by case basis. Deteriorated filler walls would be cause for replacement, which would then enable column wrapping.

3. Column deterioration

    - In general, column wrapping is cost effective when the deteriorated areas are between 5 percent and 15 percent of the column area. When column deterioration exceeds 5 percent to 10 percent of the column area, column wrapping has a lower life cycle cost than the traditional chip, patch, and seal repair method. For practical considerations, column wrapping should not be used when the deterioration exceeds 15 percent of the column area because there is a concern that the deterioration has progressed too far for the wrapping to be effective. Deterioration in this case is considered to be delaminated areas, spalled areas, and incipient corner spalls. Corner cracks without delamination should not be considered deterioration for this case.

The life cycle cost for the column wrapping and traditional chip, patch, and seal repair methods used the following service lives; 10 to 15 years for patching, 3 to 5 years of sealing, and 30 years for column wrapping. Interest rates of 3 percent and 4 percent were used for the present value calculation.

6.08.04 Repair of Overhead Concrete Surfaces

(revised 5-1-2000)

Experience has shown we cannot patch overhead spalls that are deeper than 1in. Any spalls on the underside of the deck that are deeper will have to be repaired by full depth patching. Where we do patch the shallow spalls, we should call for an overhead patching material from the qualified products list. (5-1-2000)

6.08.05 Expansion Anchored Bolts

(revised 5-1-2000)

In addition to field testing, we will ensure sound anchorage by reducing allowable design loads. The values to be used will vary with the application as shown below:

PULLOUT VALUES OF EXPANSION ANCHORED BOLTS IN POUNDS						
Application	**Approx. Safety Factor**	**⅜in**	**½in**	**⅝in**	**¾in**	**⅞in**
Noncritical Design Loads (Including noncritical, static or shock loads)	4	875	1,620	2,565	3,775	5,240
Vibratory Loads (e.g., Sign Supports)	12	290	540	855	1,260	1,775

Design details should always call for two or more anchors for redundancy.

For additional information on other types of concrete anchors see BDM Section 7.06.02.

6.08.06 Deck Patching

(revised 5-1-2000)

Delaminated portions of the deck that show signs of imminent spalling are to be hand chipped. These areas and those that have already spalled are to be repaired with a latex modified concrete mixture.

In the Upper Peninsula and areas of the Lower Peninsula where the cost of latex modified concrete is high, bridges with traffic volumes less than 4000 ADT are to have decks repaired by applying a latex bonding slurry to the chipped areas followed by patching with a Concrete patching mixture.

See BDM Section 6.04.09 for the use of metal mesh panels with deck patching.

6.08.07 Temporary Support Systems

(8-6-1992)

Plans for rehabilitation may require details of a construction scheme as described in BDM Section 7.01.10. Without this concurrence, the contractor may attempt a procedure which would jeopardize the integrity of the structure during his/her operations.

6.08.08 Protection of Existing Piers in the Clear Zone

(revised 2-26-2024)

Retrofit the piers of existing bridges located within the clear zone, as defined in RDM Section 7.01.11, to account for the vehicle collision force (see RDM Section 7.01.04 K.) as part of any project that includes 3R or 4R work on the bridge or on the roadway under the bridge when any of the following conditions are met:

A. The pier has columns with a minimum width of less than 3ft-0in.

B. The pier does not have load path redundancy. This includes, but is not limited to:
   1. The pier has two columns or fewer.
   2. The superstructure beams are supported directly on the columns with no cap adjoining columns.

C. The pier has columns with a minimum width or diameter of 3 ft-0in or greater and the face of the pier is located 12ft or less from the edge of the lane (traveled way) of the roadway.

If an existing pier is located within the clear zone and meets one of the conditions listed above design and detail a strut between the existing columns based on the guidelines included in MDOT BDGs 5.22.02, 5.22.02A & 5.22.02B. The guidance included in the MDOT Bridge Design Guides have been developed based on the requirements in Section 3.6.5.1 and A13.3.1 of the AASHTO LRFD Bridge Design Specifications.

Verify that the existing pier foundation can support the additional dead load from the pier strut without exceeding the allowable bearing capacity or pile capacity. Perform this check according to AASHTO LRFD where practicable. If AASHTO LRFD cannot be applied, obtain approval from the MDOT Chief Structure Design Engineer for the design method.

Because of the short duration over which they would be applied, the forces used to design the pier strut do not need to be transferred to the pier footing or to the deep foundation supporting the existing pier. Neither the forces used to design the pier strut, nor the AASHTO LRFD vehicle collision force need to be applied to the existing pier columns.

Alternatively, the vehicle collision force can be redirected or absorbed with Type C single face concrete barrier in accordance with Standard Plan R-54-Series. Locate the barrier relative to the face of the pier in accordance with the requirements outlined in Section 3.6.5.1 of the AASHTO LRFD Bridge Design Specifications. Provide appropriate barrier end treatments in accordance with the MDOT Road Design Manual.

If the existing pier foundation is not capable of supporting the additional dead load from a pier strut or if the pile supports for a Type C single face concrete barrier conflict with the existing pier footing the existing pier can be protected with a Type B single face concrete barrier placed directly in front of the pier columns in accordance with R-54-Series. Use this option only if the barrier can be installed without the need for a design exception/design variance for shoulder width. Provide appropriate barrier end treatments (R-55, 67, etc.-Series) in accordance with the MDOT Road Design Manual.

As an alternative to retrofitting the existing pier, the Bridge Engineer can demonstrate through calculations that the existing pier has sufficient capacity to resist the vehicle collision force or that the superstructure will not collapse with one column missing as outlined in Section 3.6.5.1 of the AASHTO LRFD Bridge Design Specifications.

Where existing piers are to be widened, design the widened portions of the pier to account for the vehicle collision force as outlined in BDM Section 7.01.04.K. Account for the vehicle collision force at the portion of the existing pier to remain in place as outlined in the preceding paragraphs. If the existing portion of the pier is being protected with single face concrete barrier extend the concrete barrier to protect the proposed portion of the pier as well.

If site or project specific conditions make it unfeasible to retrofit the existing structure to account for the vehicle collision force, and calculations demonstrate that the existing pier does not have sufficient capacity to resist the vehicle collision force a request to waive these requirements must be submitted to the Chief Structure Design Engineer for approval. The request must

include a detailed justification for waiving the requirements, and once approved must be included in the project file.

Where filler walls have previously been constructed between the columns of a pier and the column width or diameter is less than 3ft-0in remove the filler walls in their entirety. Retrofit the existing pier to account for the vehicle collision force following the preference for existing piers to remain in place summarized above.

Where filler walls have previously been constructed between the columns of a pier and the column width or diameter is 3ft-0in or greater the existing filler wall may remain in place. If the height of the filler wall is less than 42 inches above the ground adjacent to the pier, increase the filler wall height to extend a minimum of 42in above the ground adjacent to the pier.

A Local Agency has the discretion to define their policy for accounting for the AASHTO LRFD vehicle collision force in the design of bridges within their inventory in accordance with Section 3.6.5 of AASHTO LRFD. In the absence of published guidance from a Local Agency the applicability of the AASHTO LRFD vehicle collision force must be determined using the same criteria that is used for classifying bridges under MDOT jurisdiction.

Bridges spanning over railroad right-of-way (ROW) must meet the requirements outlined in the AREMA Manual for Railway Engineering or local railroad company guidelines.

6.08.09 Rocker Realignment

(revised 7-25-2022)

The realignment of expansion rocker bearings should be considered as part of rehabilitation projects if the offset of the bearing has reached an unacceptable threshold. If expansion rocker bearings with excessive offset are left unaddressed there is an increased risk that the continued movement of the bearing could result in the rocker falling over and the beam being unsupported. The final decision to realign expansion rocker bearings will be made by the Bridge Design Engineer after a review of all available bridge inspection and bridge scoping reports, and a review of all the conditions that exist at a particular bridge.

Generally, realignment of expansion rocker bearings should be considered if at least one of the following conditions have been observed:

A. The vertical line of the reaction falls outside of the middle half of the bearing surface for a majority of the expansion rocker bearings along a line of bearings. The vertical line of the reaction is to be taken as passing through the radius point of the bearing surface as is shown in the figure below. Maximum rocker offsets and rotations for various expansion rocker bearings are given in the table on following page.

   The bearing dimensions used to make the assessment should be the dimensions shown on the as-built plans for the bridge.

   If the offset was measured at a time of the year with either extremely high or low temperatures (over 100º F or below 0º F) it is recommended that the offset be checked again when ambient temperatures are more moderate to confirm that offset of the expansion rocker bearing is outside of the limits described above.

Rocker Bearing Offset (in) and Rotations (degrees)

"H" Dimension* (in)	Rocker Bearing Plate Width "A1" (in)	Max. Rocker Offset (in)	Max. Rocker Rotation (degrees)
8½	6	1½	10
8½	7	1¾	12
8½	8	2	14
12½	9	2¼	10
12½	10	2½	12
12½	11	2¾	13
12½	12	3	14
12½	13	3¼	15
12½	14	3½	16
12½	15	3¾	18

*Note: The "H" dimension is the vertical distance between the sole plate and the masonry plate. See the figure below.

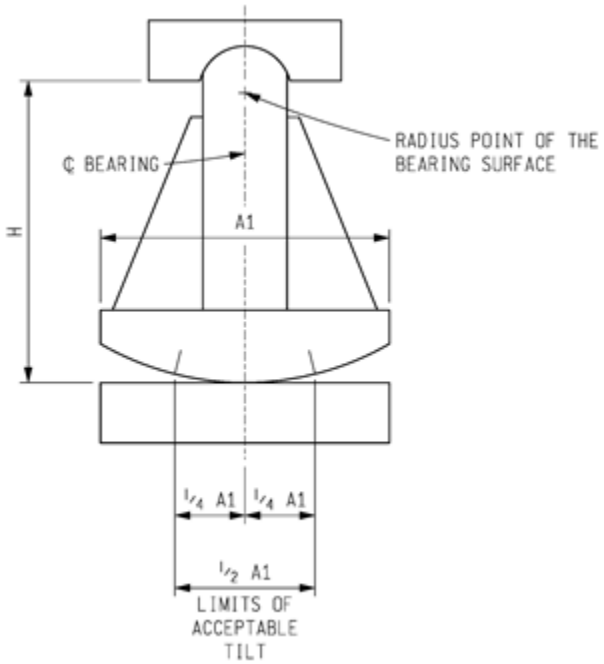


Figure 6.08.09 A depicts a rocker bearing with dimensions, detailing the limits of acceptable tilt.

B. If the vertical line of the reaction falls within the middle half of the bearing surface for a majority of the expansion rocker bearings along a line of bearing but the offset deviates from the calculated rocker offset for the temperature the alignment was checked at by more than ¾in realignment of the expansion rocker bearings should be considered.

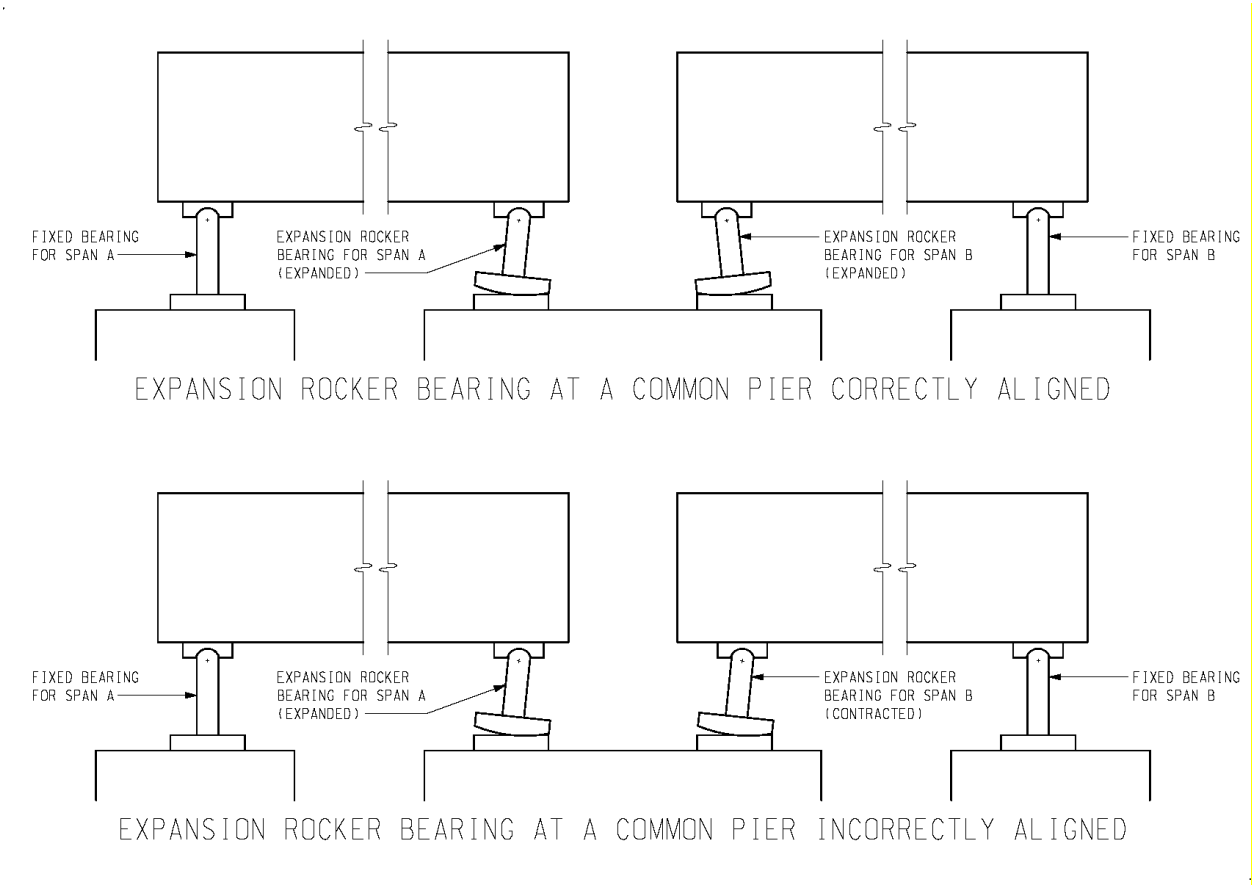


Figure 6.08.09 B shows two expansion rockers on a common pier supporting two spans with fixed bearings on the piers supporting the other ends of the spans. It details that correctly aligned rockers should not be tilting in the same direction but should be tilting toward each other.

C. When a substructure element supports two lines of expansion rocker bearings with an expansion joint in the bridge deck above the pier the bearings should be tilted in opposite directions, with both lines of bearings expanded/contracted relative to the fixed bearing for each span. If the bearing lines are tilted in the same direction the line tilted in the wrong direction should be realigned. This is illustrated in the figure below.

D. If there is more than 1,000 feet of concrete pavement adjacent to the bridge and pressure relief joints have not been installed the proposed scope of work should include the installation of pressure relief joints, a structural approach slab, or approach pavement according to MDOT Standard Plan R-45-Series. If pressure relief joints have previously been installed but have closed up the proposed scope of work should include recutting the pressure relief joints, installing a structural approach slab, or installing approach pavement according to MDOT Standard Plan R-45-Series.

E. The Bridge Design Engineer may consider other measures to address the excessive tilt of expansion rocker bearings when the scope of work includes a deck replacement. This may include but is not limited to returning the entire superstructure to its proper location based on the temperature at the time the work is being performed. Measures like this are desirable because not only do they adjust the bearing alignment to minimize the risk of further movement resulting in an unsupported beam, but it also helps to ensure the proper gap between beams ends at piers and/or pin and hanger assemblies is restored.

6.09 BRIDGE DECK REPAIR STRATAEGY

(revised 3-26-2012)

6.09.01 Deck Restoration

(revised 5-1-2000)

Restoration of deteriorated decks includes everything from crack sealing to complete replacement. The alternative selected will be influenced by the factors listed in the Bridge Deck Preservation Matrix (BDM Section 6.09.02) and by judgment. The Construction Engineer should be consulted in most cases as he/she is aware of current costs, equipment, and contractor capability.

At locations where traffic volumes are high, the maintenance of traffic may influence the selection of the restoration treatment.

The Region Project Development Engineer will consider future work in the area. This may influence the repair strategy. It should be recognized that several years will elapse between the inspection/scoping and the work of rehabilitation. Allowance for additional deterioration during this period should be made when selecting an appropriate rehabilitation measure.

6.09.02 Expansion Anchored Bolts

(revised 5-28-2013)

The Bridge Deck Preservation Matrix (Uncoated Black Bar or Epoxy Coated Rebar), gives recommended repair methods for various deck conditions. The repair strategies are based on National Bridge Inventory ratings provided from bridge inspection and scoping documents.

In general, the condition of the underside of the deck is of primary concern. Deck with sound undersides can be rehabilitated to a nearly “new” condition. The repair strategies for these structures will vary from patching and crack sealing for decks with good top surfaces, to deep overlays for decks with poor top surfaces.

Decks with undersides in poor conditions are either replaced, or repaired with a shorter term “fix.” This fix varies from a shallow concrete overlay to a hot mix asphalt (HMA) cap.

Appendix 6.02

CLEAR ROADWAY WIDTHS AND DESIGN LOADING STRUCTURAL CAPACITY FOR BRIDGES BEING REHABILITATED (9-28-2026)

Type of Roadway	Minimum Clear Roadway Width	Minimum Design Loading Structural Capacity
Non-Interstate Freeway	A, B	HS-20
Interstate Freeway	A, B	HS-20
Rural Arterial (Non-Freeway Trunkline)	C	HS-20
Urban Arterial (Non-Freeway Trunkline)	D	HS-20
Rural Collector (Non-Trunkline)	Exhibit 6-7.	H 15
Urban Collector (Non-Trunkline)	Table 6-5, E	H 15
Rural Local (Non-Trunkline)	Exhibit 5-7.	ADT≤50:H 10 ADT>50:H 15
Urban Local (Non-Trunkline)	Table 5-5, E	ADT≤50:H 10 ADT>50:H 15

(A) As constructed.

(B) Consideration should be given to carrying the full shoulders of the approach roadway across the structure if it is cost effective to do so.

(C) The minimum clear roadway should accommodate the traveled way plus 2ft-0in on each side. (12-5-2005)

(D) The minimum clear width on the bridge must be the same as the curb-to-curb width of the street.

(E) The minimum clear roadway must be the traveled way plus 1ft-0in to each curb face. However, consideration should be given to providing the same width as the curb-to-curb approach width if it is cost effective to do so.

The following tables referenced are from A Policy on Geometric Design of Highways and Streets, 2018, 7th Edition, published by AASHTO and do not include clearances for bridge rail offset. See the Bridge Design Guides for MDOT offset criteria.

a. Table 6-5. Minimum Width of Traveled Way and Shoulders

b. Table 5-5. Minimum Width of Traveled Way and Shoulders for Two-Lane Local Roads in Rural Areas

Exhibit 6-7 **STRUCTURAL CAPACITIES AND MINIMUM ROADWAY WIDTHS FOR BRIDGES BEING REHABILITATED CARRYING RURAL COLLECTOR ROADS**

Design Traffic Volume (veh/day)	Design Loading Structural Capacity	Minimum Clear Roadway Width (ft)[(a)]
Under 400	H 15	22
400 to 1500	H 15	22
1500 to 2000	H 15	24
over 2000	H 15	28

[(a)] Clear width between curbs or railings, whichever is the lesser, shall be equal to or greater than the approach traveled way width, wherever practical.

The values in Exhibit 6-7. do not apply to structures with a total length greater than 100 ft. These structures should be analyzed individually by taking into consideration the clear width provided, safety, traffic volumes, remaining life of the structure, design speed, and other pertinent factors.

Exhibit 5-7. **MIINIMUM STRUCTURAL CAPACITIES AND MINIMUM ROADWAY WIDTHS FOR BRIDGES BEING REHABILITATED CARRYING RURAL LOCAL ROADS**

Design Traffic Volume (veh/day)	Design Loading Structural Capacity	Minimum Clear Roadway Width (ft)[(a)(b)]
0 - 50	H 10	20[(c)]
51 - 250	H 15	20
250 - 1500	H 15	22
1500 - 2000	H 15	24
over 2000	H 15	28

[(a)] Clear width between curbs or railings, whichever is the lesser.
[(b)] Minimum clear widths that are 2 ft narrower may be less than the approach traveled way width.
[(c)] For one-lane bridges use 18 ft.

The values in Exhibit 5-7. do not apply to structures with total length greater than 100 ft. These structures should be analyzed individually, taking into consideration the clear width provided, traffic volumes, remaining life of the structure, pedestrian volumes, snow storage, design speed, crash record, and other pertinent factors.

Appendix 6.02.01

Design Exception Requirements - Vertical Clearance

(9-28-2026)

Design Exceptions are needed where proposed vertical clearance does not meet the minimum clearance requirements provided in BDM Section 7.01.08

Type of Project	Design Exception Required	Coordination with ARTRANSTEA Required	MDOT approval required by Engineer of Design Programs	FHWA Approval Required
New and 4R reconstruction work on Interstate greater than $1,000,000	Yes	Yes	Yes	Yes
New and 4R reconstruction work on Interstate less than $1,000,000	Yes	Yes	Yes	No
New and 4R reconstruction work on Non Interstate Freeways greater than $1,000,000	Yes	No	Yes	Yes
New and 4R reconstruction work on Non Interstate Freeways less than $1,000,000	Yes	No	Yes	No
New and 4R reconstruction work on NHS Routes other than Freeways greater than $1,000,000	Yes	No	Yes	Yes
New and 4R reconstruction work on NHS Routes other than Freeways less than $1,000,000	Yes	No	Yes	No
New and 4R Reconstruction on Non-NHS Routes	Yes	No	Yes	No
3R Work on Interstate System	Yes	Yes	Yes	[A1]
3R Work on Non Interstate Freeways	Yes	No	Yes	[A1]
3R Work on Non-Freeway Routes	Yes	No	Yes	[A1]
Preventative Maintenance Work	No	No	No	No

[A1] = Only if negotiated oversight is assigned to FHWA on NHS projects > $5 million.

ARTRANSTEA - Army Transportation Command – Transportation Engineering Agency[A2]

[A2] = Formerly the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA)

PROJECTS REQUIRING DESIGN EXCEPTION/DESIGN VARIANCE

Major Project Scope of Work	AASHTO Green Book (7th Edition) Project Classification	DE/DV Required
New Bridge	New Construction	Yes
Bridge Replacement	Reconstruction	Yes
Complete Superstructure Replacement	Reconstruction	Yes
Partial Superstructure Replacement without Additional Lanes	Construction on Existing Roadway	Yes
Partial Superstructure Replacement with Additional Lanes	Reconstruction	Yes
Bridge Widening to Accommodate Additional Lanes	Reconstruction	Yes
Deck Replacement with Bridge Widening to Accommodate Additional Lanes	Reconstruction	Yes
Bridge Widening without Additional Lanes	Construction on Existing Roadway	Yes
Deck Replacement without Additional Lanes	Construction on Existing Roadway	Yes
Partial Substructure Replacement (can include the complete removal of an entire substructure element but not the replacement of all the substructure elements)	Construction on Existing Roadway	Yes
Barrier Replacement[1]	Construction on Existing Roadway	Yes
Deep Overlay[2]	Preventive Maintenance	No
Shallow Overlay[2]	Preventive Maintenance	No
Epoxy Overlay	Preventive Maintenance	No
Deck Patching	Preventive Maintenance	No
Healer/Sealer	Preventive Maintenance	No
Sealing Cracks in the Bridge Deck	Preventive Maintenance	No
Installing Cathodic Protection on the Bridge Deck	Preventive Maintenance	No
Joint Replacement or Joint Resealing	Preventive Maintenance	No
Elimination of an Existing Joint on the Bridge	Preventive Maintenance	No
Cleaning Joints	Preventive Maintenance	No
Repair or Replacement of Deck Drains	Preventive Maintenance	No
Cleaning or Flushing Deck Drains	Preventive Maintenance	No
Replacing Bridge Approach Slabs	Preventive Maintenance	No
Barrier Patching or Repair	Preventive Maintenance	No
Sealing Cracks in Barrier	Preventive Maintenance	No
Silane Treatment of Concrete	Preventive Maintenance	No

PROJECTS REQUIRING DESIGN EXCEPTION/DESIGN VARIANCE (CONTINUED)

Major Project Scope of Work	AASHTO Green Book (7th Edition) Project Classification	DE/DV Required
Structural Steel Repairs	Preventive Maintenance	No
Fatigue Crack Mitigation	Preventive Maintenance	No
Retrofitting Non-Redundant Steel Tension Members (formerly known as Fracture Critical Members)	Preventive Maintenance	No
Cleaning and Coating Structural Steel	Preventive Maintenance	No
Pin and Hanger Replacement	Preventive Maintenance	No
Bearing Realignment or Replacement	Preventive Maintenance	No
Heat Straightening of Existing Steel Superstructure	Preventive Maintenance	No
Concrete Beam Repairs or Overcasting	Preventive Maintenance	No
Coating/Sealing Concrete Beams	Preventive Maintenance	No
Repair or Maintenance of Moveable Bridge Machinery	Preventive Maintenance	No
Repair or Maintenance of Movable Bridge Electrical Components	Preventive Maintenance	No
Cleaning or Washing of the Bridge	Preventive Maintenance	No
Substructure Patching	Preventive Maintenance	No
Coating/Sealing Substructure Concrete	Preventive Maintenance	No
Installing Cathodic Protection on the Substructure	Preventive Maintenance	No
Foundation Pile Preservation (Jackets/Wraps/Cathodic Protection)	Preventive Maintenance	No
Channel Clearing or Debris Removal in the Channel	Preventive Maintenance	No
Installing Scour Countermeasures	Preventive Maintenance	No
Request for Action Project	Preventive Maintenance	No
Urgent Need Project	Preventive Maintenance	No

[1] Barrier replacement projects involve the removal and replacement of the barrier along the full length of the bridge. Removal and replacement of a portion of the bridge barrier are considered barrier repair. The guidance included in Section 6.05.05 of the Bridge Design Manual must be considered when deciding between a barrier replacement project and a barrier repair project. Appropriate judgement must also be used to ensure that limits of a barrier replacement do not leave a short section of the existing bridge railing that will warrant a barrier replacement project in the future.

[2] A safety review must be completed as part of projects where the major project scope of work includes either a deep overlay or a shallow overlay. Examine the existing cross slope or superelevation and follow the guidance in Section 3.08.01 of the Road Design Manual to determine whether a Design Exception/Design Variance Request must be prepared and submitted.