Road & Bridge Design Publications

Monthly Update – April 2023

Revisions for the month of **April** are listed and displayed below and will be included in projects submitted for the **August** letting.

E-mail road related questions to MDOT-Road-Design-Standards@michigan.gov.

Special Details

R-32-SD: Approach Curb and Gutter Downspouts (For Safety Shape Bridge Barriers & Railings): Revised the subtitle to reflect its use with safety shape bridge barriers and railings.

R-44-G: Concrete Pavement Repair: Revised the details to eliminate lift pin requirements, make the sawing diagram applicable to all full depth cast in place repairs, allow a 3" overcut into adjacent reinforced concrete pavements only, and revise the minimum length of concrete repairs from 4' to 5'. Also, revised the Detail 7 and Detail 8 repairs to require vertical edges by saw cut or other approved methods.

R-56-F: Guardrail Median Object Protection: Revised the details on Sheets 5 & 6 to show the "guardrail with direct connection to pier" using the standard Detail M9 anchorage instead of the former T6 anchorage.

R-67-SD: Guardrail Anchorage, Bridge, Details (For Safety Shape Bridge Barriers & Railings): Eliminated details regarding connections to vertical walls since the details in R-67-series are the standard. Revised the subtitle to reflect its use with safety shape bridge barriers and railings.

Road Design Manual

7.01.01: References: Eliminated references to two outdated barrier guides.

7.01.05: Basic Concepts for Roadside Control: Revised section to eliminate references to Standard Plan R-59-series. Eliminated former section F. In section E, added text to differentiate between flared and parallel guardrail installations.

7.01.06: Guardrail Worksheet: Updated worksheet to include mentioning the flare rate is zero for tangent runs of guardrail (eliminated formulas for X & Z for Type 2 terminals), provided an explanation for determining the (L1) distance, updated the deduction table and notes, modified (simplified) the formula for "Z", and modified the name of the guardrail pay item. The worksheet itself was also upgraded to a fillable form.

Road & Bridge Design Publications

Monthly Update – April 2023

7.01.11: Current Clear Zone Criteria: Added a paragraph regarding methods for determining clear zone values.

7.01.11D: Curve Correction Factors Table: Added the formula to determine clear zone correction to the top of the table.

7.01.13: Curved Beam Elements: Provided additional detail regarding curved beam elements.

7.01.16I: Curved Guardrail Bridge Anchorages: New Section.

7.01.17: Strength Requirements of Steel Beam Guardrail: Eliminated outdated verbiage regarding the use of National Cooperative Highway Research Program Report 350 (NCHRP 350) approved devices.

7.01.20: Guardrail Deflection: Minor editorial revisions were made to the first paragraph.

7.01.23: Function of Guardrail Components: Simplified and updated the "Beam Height" definition. Updated the "Post Bolt Washer" definition to eliminate the use of washers at posts. Made a minor wording modification to the "Rail Splice" definition.

7.01.25: Guardrail Approach Terminals: Minor wording revisions were made to this section to update the terminals/components to current usage. Additional detail was added to section D regarding the beginning length of need (BLON) point.

7.01.29A: Flare Rate: This section was updated and expanded to provide more detail on the subject, along with the addition of a flare rate table for both concrete barrier and guardrail.

7.01.29B: Uniform Flare from Structures: Referenced section 7.01.30E instead of Standard Plan R-59-series to determine the length of need of guardrail at the structure. Updated the drawing in this section for the same purpose.

7.01.30: Guardrail at Embankments: Added a statement that a minimum 10' wide clear run out area should be provided at the bottom of traversable, non-recoverable slopes.

7.01.30G: Placing Beam Guardrail on a Downslope: Added a requirement for placing guardrail on 1:8 slopes. Simplified the description pertaining to placing guardrail on 1:6 slopes.

Road & Bridge Design Publications

Monthly Update – April 2023

7.01.31: Shielding Bodies of Water: Eliminated a reference to an outdated AASHTO barrier guide.
7.01.32A: Attachments to Barriers & Closer Post Spacing: Referenced R-67-series for guardrail beam elements attached to concrete structures. Updated the information on the use of heavier beam elements (10 gauge & 12 gauge).

7.01.32B: Relationship Between Bridge Sidewalk & Approach Guardrail: Revised the paragraph dealing with guardrail placement at curbed bridge approaches to specify that guardrail must be properly anchored to the bridge railing and employ the guardrail in conjunction with curb guidelines when site conditions allow.

7.01.32C: Barrier at the Trailing End of Overpassing Structures: Revised the wording in the section for clarification.

7.01.32E: Guardrail Median Object Protection: Eliminated a reference to Standard Plan R-59-series in favor of section 7.01.05F.

7.01.33: Maintaining Guardrail Strength when One or More Posts Must be Omitted: Made minor editorial changes.

7.01.41A: Guidelines for Upgrading or Replacing Guardrail: Revised section for current guardrail types and practice. Also, revised the maximum distance between the upper and lower guardrail post bolts from 5” to 4” for Type B and MGS-8 guardrail on both wood and steel posts.

7.01.41B: Upgrading Guardrail Terminals: Revised section for change in MDOT Policy regarding Breakaway Cable Terminals (BCTs).

7.01.41D: Guardrail Posts at or near the Shoulder Hinge Line: Added a reminder that post length requirements near the hinge line also apply to double sided guardrail.

7.01.41H: Type A Guardrail Parallel to Continuous Abutment, Twin Overpassing Structures: Added a statement indicating that replacing Type A guardrail in front of twin overpassing structures may be considered if deemed essential for mowing or other maintenance purposes.

Road & Bridge Design Publications

Monthly Update – April 2023

7.01.45: Alternate Barrier End Treatments: Eliminated the X-Tension/X-MAS guardrail terminals.

7.01.55A & B: Concrete Median Barrier & Double-Sided Steel Beam Guardrail: Added an advantage (to Double Sided Steel Beam Guardrail) and a disadvantage (to Concrete Median Barrier) to the discussion regarding barrier types.

7.01.55C: Cable Barrier: Updated the information on the three proprietary, high tension cable barrier systems. Added text indicating the two-mile maximum length between terminals for high tension cable barrier may be exceeded if approved by the local TSC. Added drawings for "cable barrier at bridge piers protected by guardrail" (one detail for cable barrier adjacent to guardrail and another detail for cable barrier terminating adjacent to guardrail).

7.01.56: Concrete Median Barrier: Eliminated the section on innovative concrete barrier as these are now standard median barriers.

7.01.57: Ending Concrete Barrier: Minor editorial changes were made.

7.01.58: Two Types of Concrete Median Barrier Footings: Eliminated the outdated requirement of calling for a Type B Median barrier on the plans and paying for it as a Type A.

7.01.60: Retrofitting Concrete Median Barrier: Added a statement indicating slopes leading to the face of concrete barrier should be 1:10 or flatter.

7.01.66: Concrete Barrier, Single Face: Minor editorial changes were made.

7.01.67A: Temporary Concrete Barrer & 7.01.68: Ending Temporary Barrier: Eliminated the requirement of FHWA approval for temporary barrier and end treatments.

7.02: Impact Attenuators & 7.03.03: Criteria for using Glare Screen: Minor editorial changes were made.

7.07.01: References: Revised the title of the MDOT Noise Abatement Handbook.

7.07.02: General: Added a paragraph regarding the suspension of the Type II Noise Abatement Program.

Road & Bridge Design Publications

Monthly Update – April 2023

Updates to the MDOT Cell Library, Sample Plans, and other automated tools may be required in tandem with some of this month's updates. Until such updates can be made, it is the designer's/detailer's responsibility to manually incorporate any necessary revisions to notes and plan details to reflect these revisions.

Index to Special Details

4-24-2023

⑥

SPECIAL DETAIL NUMBER	NUMBER OF SHEETS	TITLE	CURRENT DATE
21	2	GUARDRAIL AT INTERSECTIONS	6-6-22
24	8	GUARDRAIL ANCHORED IN BACKSLOPE TYPES 4B, 4T, & 4MGS-8	12-6-22
99	2	CHAIN LINK FENCE WITH WIRE ROPE	12-6-22
R-32-F	8	APPROACH CURB & GUTTER DOWNSPOUTS	9-20-22
*R-32-SD	6	APPROACH CURB & GUTTER DOWNSPOUTS (FOR SAFETY SHAPES)	4-24-23
R-43-J	2	LOCATION OF TRANSVERSE JOINTS IN PLAIN CONCRETE PAVEMENT	1-4-22
*R-44-G	6	CONCRETE PAVEMENT REPAIR	3-14-23
R-45-K	2	PAVEMENT REINFORCEMENT FOR BRIDGE APPROACH	1-4-22
R-53-A	22	TEMPORARY CONCRETE BARRIER LIMITED DEFLECTION	8-14-15
*R-56-F	6	GUARDRAIL MEDIAN OBJECT PROTECTION	4-11-23
R-60-J	17	GUARDRAIL TYPES A, B, BD, T, TD, MGS-8, & MGS-8D	12-3-21
R-62-H	4	GUARDRAIL APPROACH TERMINAL TYPE 2M	6-16-22
R-63-C	17	GUARDRAIL APPROACH TERMINAL TYPES 3B & 3T	3-7-23
R-66-E	4	GUARDRAIL DEPARTING TERMINAL TYPES B, T, & MGS	9-28-18
R-67-G	16	GUARDRAIL ANCHORAGE, BRIDGE, DETAILS	12-6-22
*R-67-SD	6	GUARDRAIL ANCHORAGE, BRIDGE, DETAILS (FOR SAFETY SHAPES)	4-4-23
R-72-D	6	GUARDRAIL LONG SPAN INSTALLATIONS	8-23-22
R-73-F	3	GUARDRAIL OVER BOX OR SLAB CULVERTS	8-1-19
R-80-F	8	GRANULAR BLANKETS, UNDERDRAINS, OUTLET ENDINGS, & BULKHEADS	6-28-21
R-88-E	4	STEEL END SECTION	3-7-23
R-100-I	4	SEEDING AND TREE PLANTING	8-3-21
R-110-B	3	PAVEMENT SAFETY EDGE	6-14-21
R-112-J	10	SHOULDER AND CENTER LINE CORRUGATIONS	9-7-22
R-126-I	5	PLACEMENT OF TEMPORARY CONCRETE & STEEL BARRIER	8-25-15

*** Denotes New or Revised Special Detail to be included in projects for (beginning with) the August letting.**

Notes:

Former Standard Plans IV-87, IV-89, IV-90, and IV-91 Series, used for building cast-in-place concrete head walls for elliptical and circular pipe culverts, are now being replaced with plans that detail each specific size. The Bureau of Bridges & Structures, Structure Design Section, Special Structures Unit will provide special details for inclusion in construction plans for MDOT jobs. To assure prompt delivery, requests ***must*** **be made in advance.** Contact: MDOT-TriezenbergSquad@Michigan.gov

Former Standard Plans IV-93 and IV-94 series have been replaced with precast concrete box & three-sided culverts as per the 2020 Standard Specifications for Construction.

Index to Bridge Detail Sheets

4-24-2023

⑦

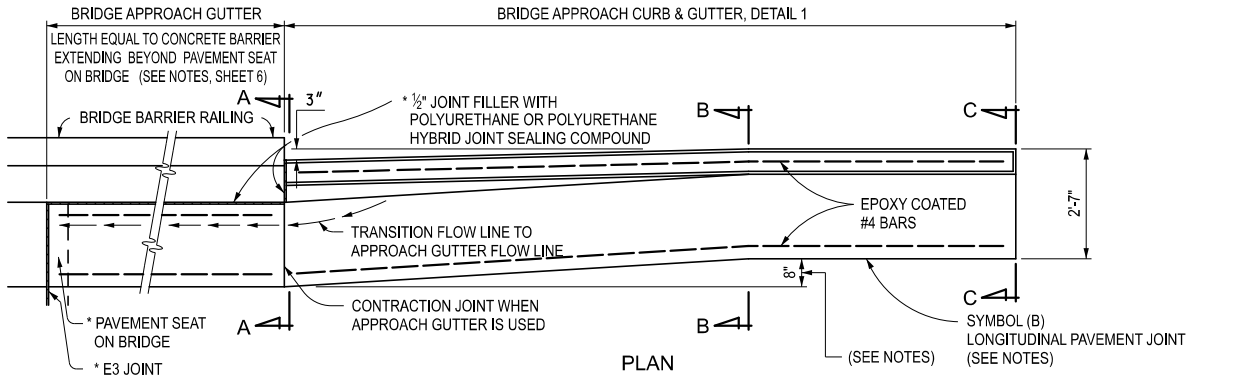
DETAIL NUMBER	NUMBER OF SHEETS	TITLE	CURRENT DATE
B-28-A	7	BRIDGE BARRIER RAILING, TYPE 7	9-2-20
B-29-A	8	BRIDGE BARRIER RAILING, TYPE 6	9-2-20
EJ3AF	1 to 4	EXPANSION JOINT DETAILS (See Notes)	1-23-23
EJ4S	1 to 4	EXPANSION JOINT DETAILS (See Notes)	1-23-23
PC-1N	2	PRESTRESSED CONCRETE I-BEAM DETAILS (See Notes)	11-28-22
PC-2I	2	70" PRESTRESSED CONCRETE I-BEAM DETAILS (See Notes)	11-28-22
PC-4G	2	PRESTRESSED CONCRETE 1800 BEAM DETAILS (See Notes)	11-28-22
PC-5A	2	PRESTRESSED CONCRETE BULB-TEE BEAM DETAILS (See Notes)	11-28-22

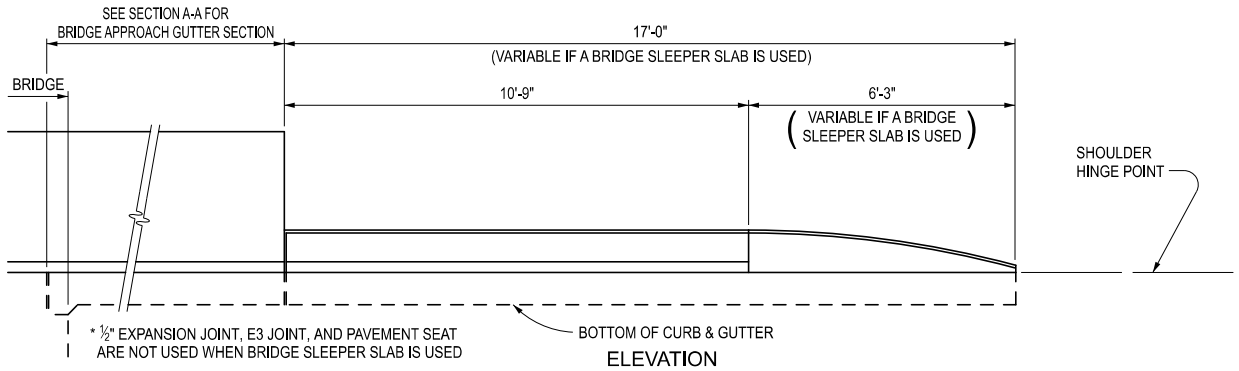
*** Denotes New or Revised Special Detail to be included in projects for (beginning with) the August letting.**

Notes:

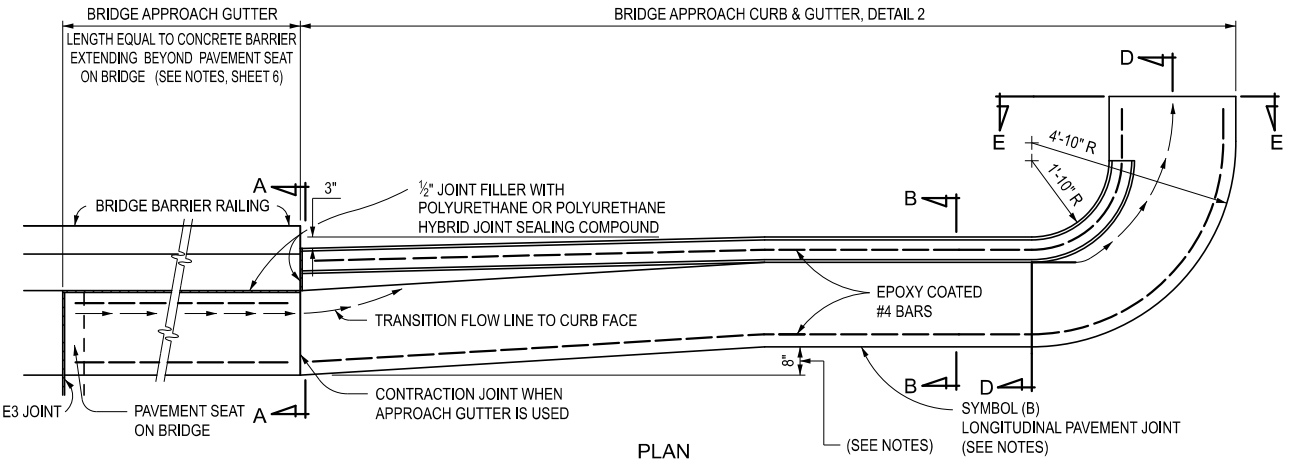
Details EJ3AF & EJ4S are interactive, i.e., designers and detailers choose details based upon railing type and angle of crossing and fill in the project specific dimensions for the end plate. Place all details appropriate for the project (including the end plate), structure specific information, and the Expansion Joint Device quantity on the sheet. Add the sheet to the plans as a normal plan sheet. Call out and designate the location of the expansion joint device and the end plate on the Superstructure Sheet in the plan set.

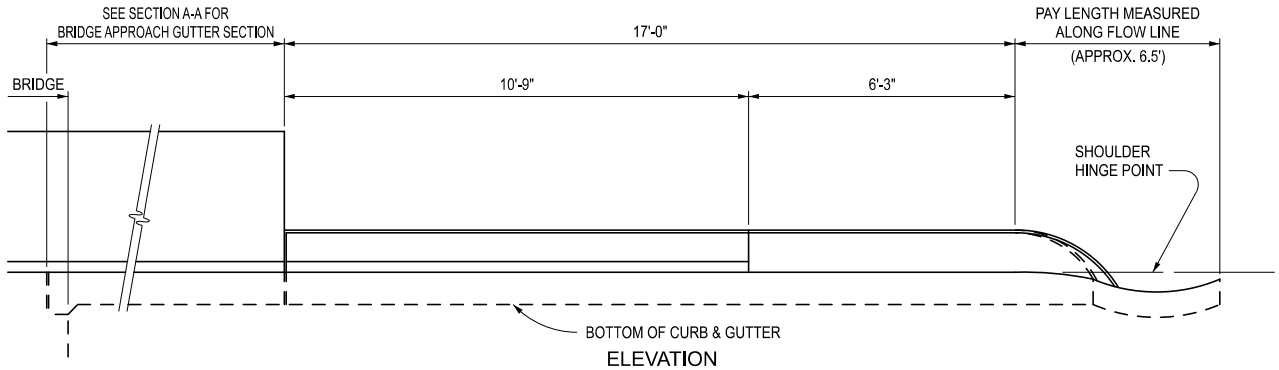
Details PC-1N, PC-2I, PC-4G, and PC-5A shall have structure specific information and quantities added to the sheet. The sheet shall then be added to the plans as a normal plan sheet.





BRIDGE APPROACH CURB & GUTTER, DETAIL 1





BRIDGE APPROACH CURB & GUTTER, DETAIL 2

MDOT Michigan Department of Transportation

PREPARED BY DESIGN DIVISION

DRAWN BY: B.L.T.

CHECKED BY: W.K.P.

ACTING DEPARTMENT DIRECTOR
Bradley C. Wiieferich

APPROVED BY: _____
DIRECTOR, BUREAU OF FIELD SERVICES

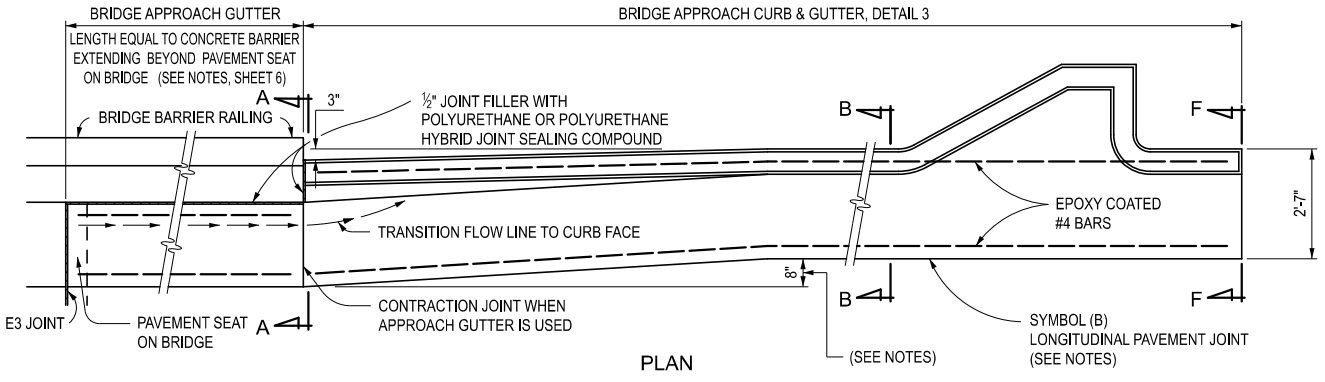
APPROVED BY: _____
DIRECTOR, BUREAU OF DEVELOPMENT

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

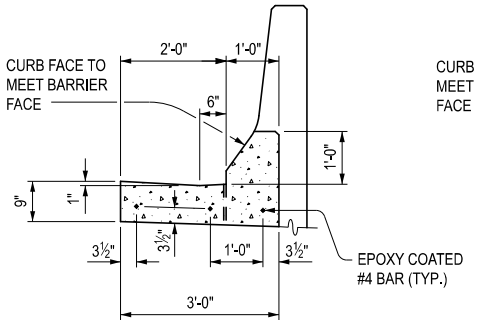
APPROACH CURB & GUTTER DOWNSPOUTS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

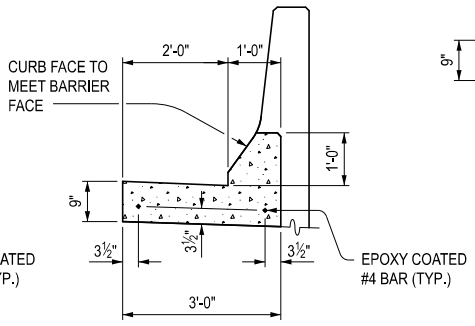
F.H.W.A. APPROVAL	4-24-2023 PLAN DATE	R-32-SD	SHEET 1 OF 6



BRIDGE APPROACH CURB & GUTTER, DETAIL 3

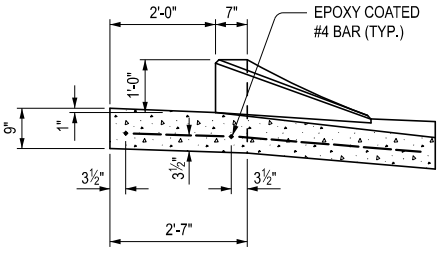


CROSS SECTION WHEN APPROACH GUTTER IS USED

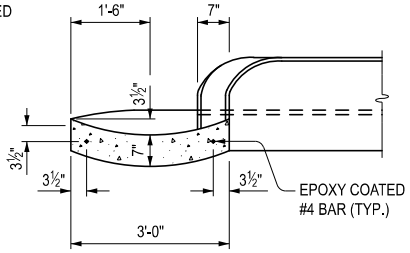


CROSS SECTION WHEN APPROACH GUTTER IS NOT USED

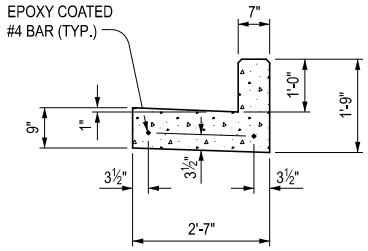
SECTION A - A
(SEE NOTES, SHEET 6)



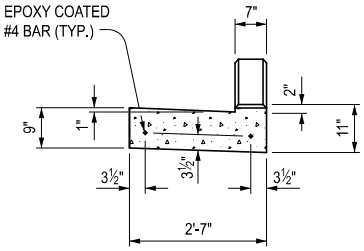
SECTION D - D



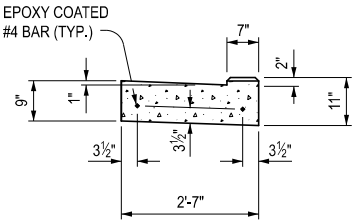
SECTION E - E



SECTION B - B



SECTION C - C



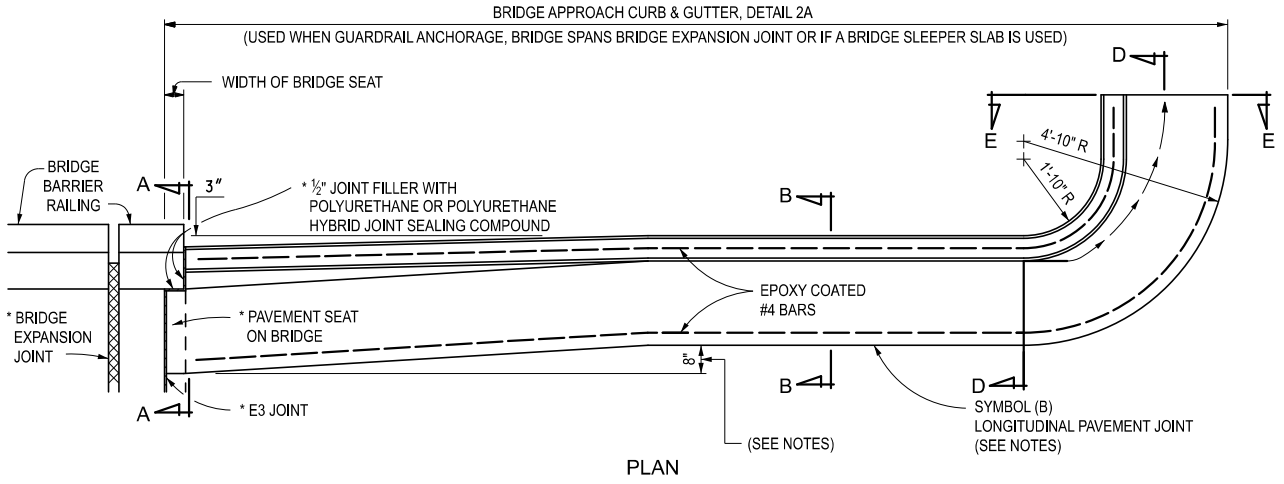
SECTION F - F

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

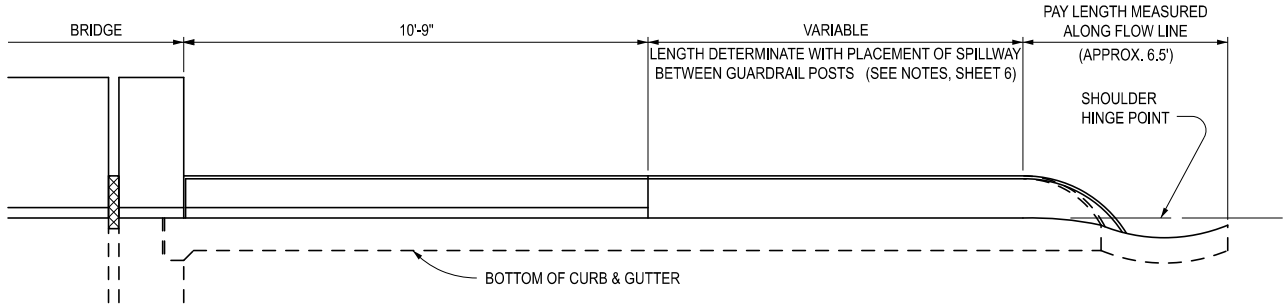
APPROACH CURB & GUTTER DOWNSPOUTS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

F.H.W.A. APPROVAL	4-24-2023 PLAN DATE	R-32-SD	SHEET 2 OF 6

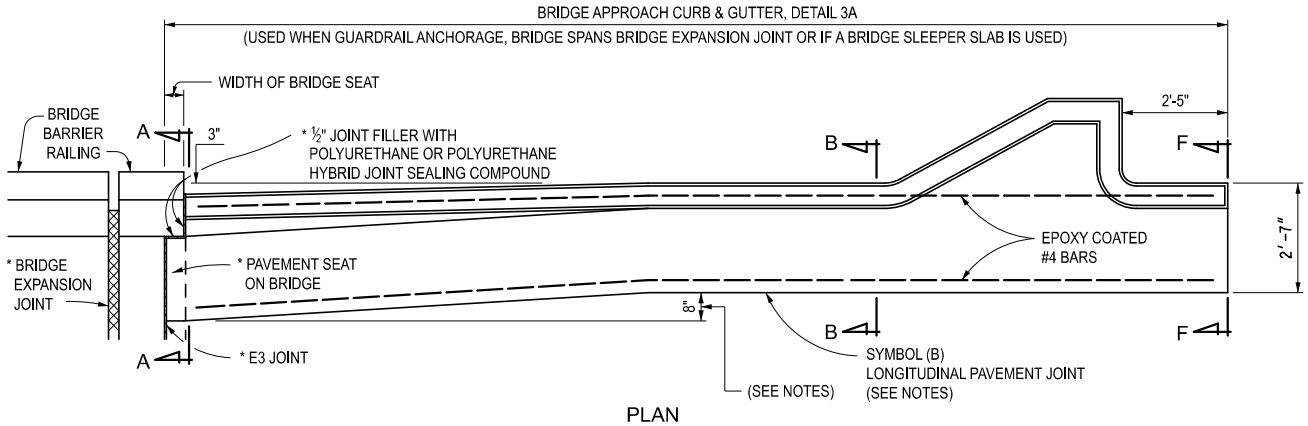


PLAN

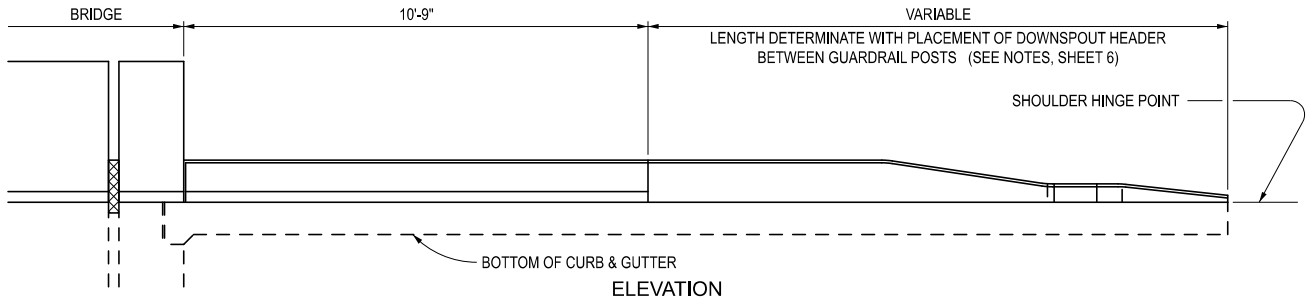


ELEVATION

BRIDGE APPROACH CURB & GUTTER, DETAIL 2A



PLAN



ELEVATION

BRIDGE APPROACH CURB & GUTTER, DETAIL 3A

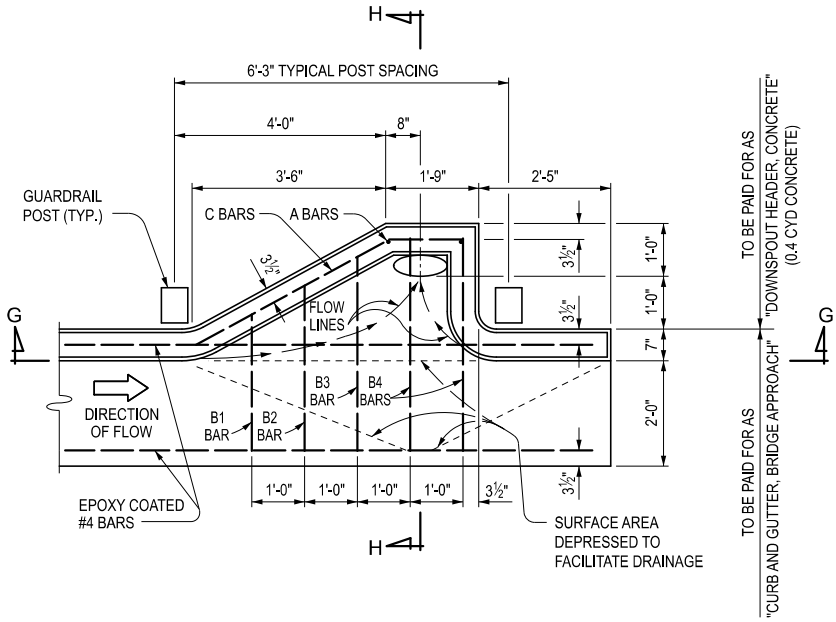
* BRIDGE EXPANSION JOINT, ½" EXPANSION JOINT, E3 JOINT, AND PAVEMENT SEAT ARE NOT USED WHEN BRIDGE SLEEPER SLAB IS USED

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

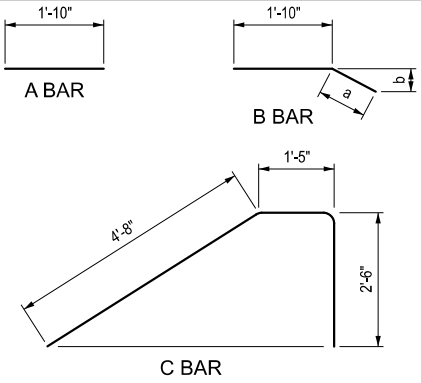
APPROACH CURB & GUTTER DOWNSPOUTS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

F.H.W.A. APPROVAL	4-24-2023 PLAN DATE	R-32-SD	SHEET 3 OF 6



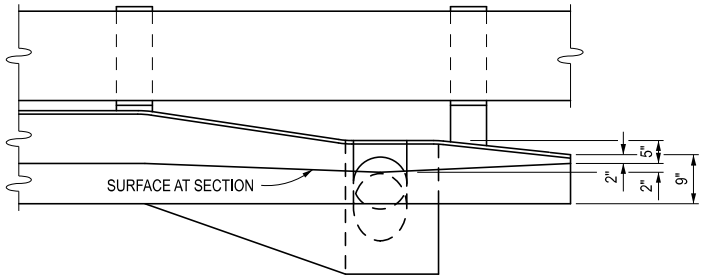
PLAN OF CONCRETE DOWNSPOUT HEADER



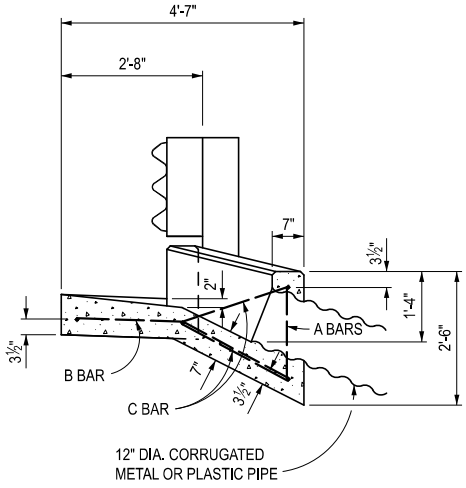
NOTE: ALL BARS ARE EPOXY COATED

DOWNSPOUT STEEL REINFORCEMENT

BAR	DIMENSIONS a	DIMENSIONS b	BAR SIZE	NUMBER REQUIRED	TOTAL LENGTH
A			#4	2	3'-8"
B1	11"	5"	#4	1	2'-9"
B2	1'-7"	8½"	#4	1	3'-5"
B3	2'-3"	1'-0"	#4	1	4'-1"
B4	2'-7"	1'-2"	#4	2	8'-10"
C			#4	2	17'-2"
TOTAL WEIGHT OF STEEL 26.7 LBS					

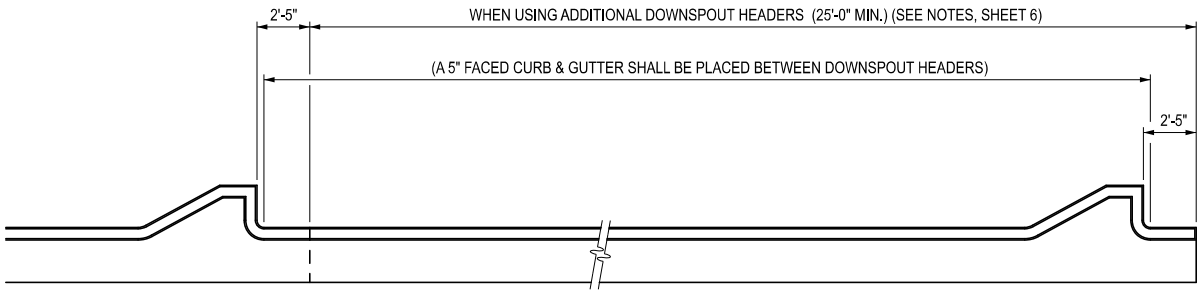


SECTION G - G



SECTION H - H

DETAIL SHOWS RELATIONSHIP OF GUARDRAIL WITH DOWNSPOUT HEADER



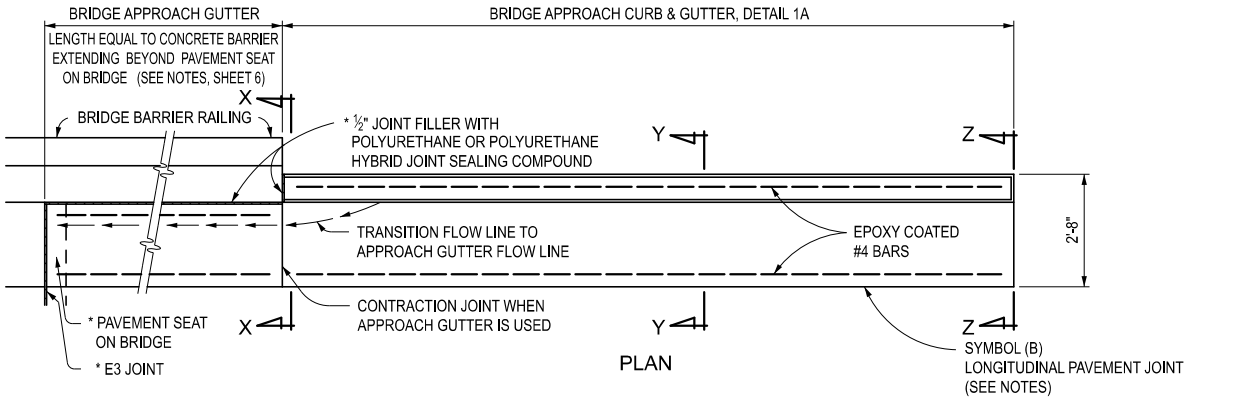
PLAN OF ADDITIONAL CONCRETE DOWNSPOUT HEADERS

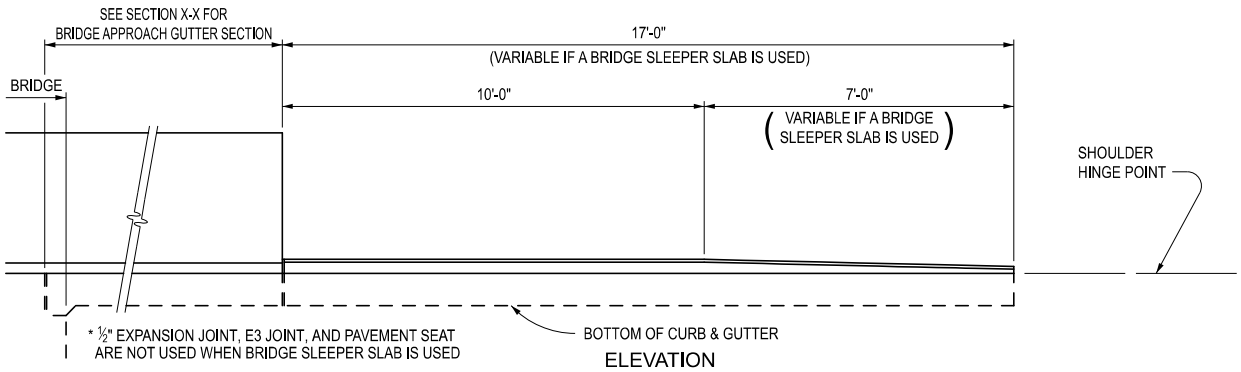
MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

APPROACH CURB & GUTTER DOWNSPOUTS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

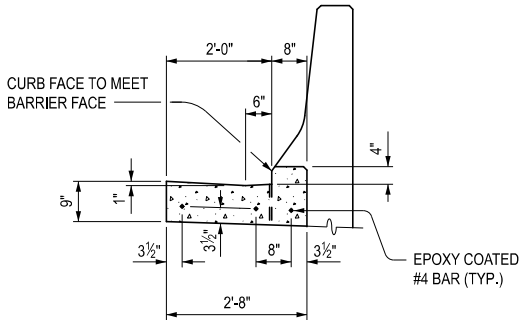
F.H.W.A. APPROVAL	4-24-2023 PLAN DATE	R-32-SD	SHEET 4 OF 6



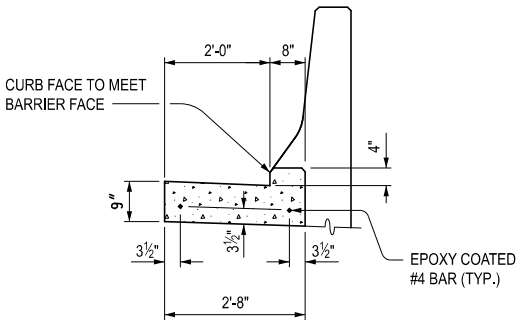


BRIDGE APPROACH CURB & GUTTER, DETAIL 1A

NOTE: FOR USE PRIMARILY WHEN GUARDRAIL IS NOT NEEDED ON DEPARTING ENDS, BUT CAN BE USED WITH GUARDRAIL WHEN DRAINAGE CONDITIONS ALLOW.



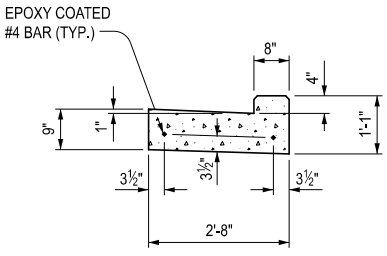
CROSS SECTION WHEN DEPARTING GUTTER IS USED



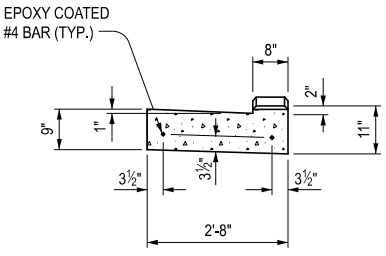
CROSS SECTION WHEN DEPARTING GUTTER IS NOT USED

SECTION X - X

(SEE NOTES, SHEET 6)



SECTION Y - Y



SECTION Z - Z

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

APPROACH CURB & GUTTER DOWNSPOUTS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

F.H.W.A. APPROVAL	4-24-2023 PLAN DATE	R-32-SD	SHEET 5 OF 6

NOTES:

ALL MATERIALS AND WORKMANSHIP SHALL BE ACCORDING TO THE STANDARD SPECIFICATIONS FOR CONSTRUCTION FOR CONCRETE CURB AND GUTTER.

FOR TYPE OF BRIDGE APPROACH CURB AND GUTTER TO USE AT A SPECIFIC LOCATION, SEE BRIDGE APPROACH PLANS.

SEE STANDARD PLAN R-27-SERIES FOR BRIDGE APPROACH CURB AND GUTTER USING EXISTING CATCH BASIN.

THE LENGTH OF BRIDGE APPROACH GUTTER (USED WHEN THE BRIDGE BARRIER RAILING EXTENDS BEYOND PAVEMENT SEAT ON BRIDGE) SHALL BE INCLUDED IN THE PAY ITEM "CURB AND GUTTER, BRIDGE APPROACH, DET __". OMIT BRIDGE APPROACH GUTTER WHEN CONCRETE BARRIER ENDS AT PAVEMENT SEAT ON BRIDGE. (SEE SECTION A-A)

THE CURB AND GUTTER SHALL BE ALIGNED WITH THE BEAM GUARDRAIL AS SPECIFIED ON STANDARD PLAN R-67-SERIES. THE LOCATION OF GUARDRAIL POSTS SHOULD BE DETERMINED PRIOR TO LOCATING THE SPILLWAY OR DOWNSPOUT HEADER.

THE AREA BETWEEN THE EDGE OF THE PAVEMENT AND THE GUTTER SHALL BE SURFACED WITH THE SAME MATERIAL AS THE SHOULDERS, EXCEPT IN THE CASE OF AGGREGATE SHOULDERS, WHERE A BITUMINOUS TREATMENT WILL BE REQUIRED.

ALL EXPANSION JOINTS REQUIRED WILL BE INCLUDED IN THE PAY ITEM FOR BRIDGE APPROACH CURB AND GUTTER.

JOINTS SHALL BE AS SPECIFIED ON STANDARD PLAN R-30-SERIES.

ALL EXPOSED EDGES SHALL BE CHAMFERED ¾".

THE CONCRETE DOWNSPOUT HEADER SHALL BE USED IN CONJUNCTION WITH BRIDGE APPROACH CURB AND GUTTER, DETAILS 3 AND 3A.

CORRUGATED PIPE WILL BE PAID FOR SEPARATELY.

WHEN THE DRAINAGE AREA REQUIRES ADDITIONAL CONCRETE DOWNSPOUT HEADERS, SPACING OF THE SECOND AND/OR ADDITIONAL DOWNSPOUT HEADERS SHOULD BE DETERMINED ACCORDING TO THEIR INDIVIDUAL DRAINAGE AREAS. ADDITIONAL DOWNSPOUT HEADERS ARE TO BE LOCATED BETWEEN GUARDRAIL POSTS AS SPECIFIED ON THE PLAN OF CONCRETE DOWNSPOUT HEADER.

A SYMBOL (B) JOINT SHALL BE PLACED BETWEEN CURB OR CURB AND GUTTER AND ADJACENT CONCRETE PAVEMENT AS SPECIFIED ON STANDARD PLAN R-41-SERIES.

THE 8" ALIGNMENT OFFSET IS REQUIRED FOR GUTTER PAN AND CURB FACE FOR BRIDGE RAILING, TYPE 4 OR TYPE 5 ONLY. OTHERWISE, ALIGN THE APPROACH CURB AND GUTTER WITH THE BARRIER FACE, BRUSH BLOCK, OR SIDEWALK CURB.

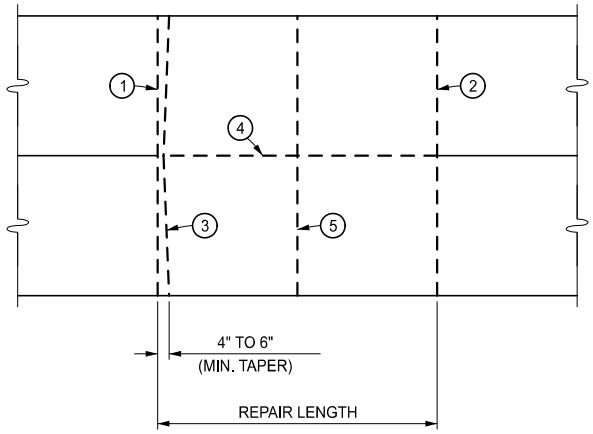
MICHIGAN DEPARTMENT OF TRANSPORTATION

BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

APPROACH CURB & GUTTER DOWNSPOUTS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

F.H.W.A. APPROVAL	4-24-2023 PLAN DATE	R-32-SD	SHEET 6 OF 6



SAWING DIAGRAM FOR
FULL DEPTH CAST IN PLACE REPAIRS

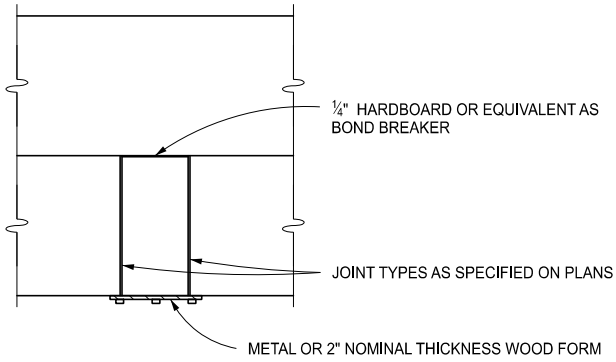
(1) & (2) THESE SAW CUTS SHALL BE FULL DEPTH AND PERPENDICULAR TO THE EDGE OF THE ROADWAY, WITHIN A TOLERANCE OF 1". OVERCUTTING IS ALLOWED INTO ADJACENT SHOULDERS AND WITHIN THE LIMITS OF A SUBSEQUENT REPAIR TO THE ADJACENT LANE. OUTSIDE THESE LIMITS, OVERCUTTING IS NOT ALLOWED INTO ADJACENT NON-REINFORCED CONCRETE PAVEMENTS AND IS RESTRICTED TO 3" INTO ADJACENT REINFORCED CONCRETE PAVEMENTS.

(3) THIS FULL DEPTH SAW CUT IS MADE TO FACILITATE OPENING A TRENCH ACROSS THE SLAB TO RELIEVE COMPRESSION IN THE PAVEMENT PRIOR TO REMOVAL OF THE FAILED AREA. THIS SAW CUT MAY BE OMITTED PROVIDED NO SPALLING OF THE REMAINING CONCRETE OCCURS. IF SPALLING DOES OCCUR, THE CONTRACTOR WILL BE REQUIRED TO MAKE THIS SAW CUT ON SUBSEQUENT REPAIRS. WHEN THIS SAW CUT IS USED AND THE ADJACENT LANE IS NOT REPAIRED, NO OVERCUTTING INTO THAT LANE SHALL BE MADE.

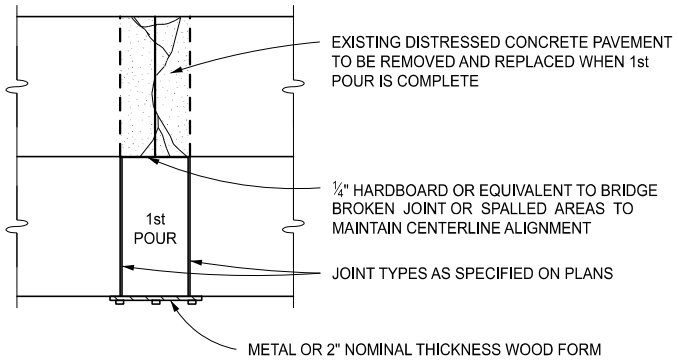
(4) THIS LONGITUDINAL FULL DEPTH SAW CUT IS MADE BETWEEN LANES OR BETWEEN ANY COMBINATION OF THE FOLLOWING: LANE, RAMP, CURB, CONCRETE SHOULDER, OR PARTIAL LANE WIDTH REPAIR.

(5) IF REQUIRED, INTERMEDIATE SAW CUTS MAY BE MADE TO REMOVE A SECTION OF PAVEMENT LANE WHICH IS OVER 5'-0" IN LENGTH, TO PERMIT LOADING INTO THE HAULING UNITS.

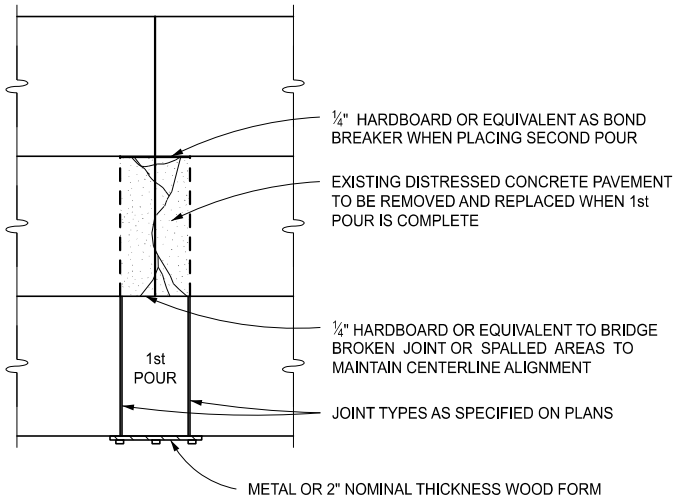
ADDITIONAL SAW CUTS, AT CONTRACTOR'S EXPENSE, MAY BE MADE INSIDE THE REPAIR LIMITS TO REDUCE 5'-0" BY 12'-0" OR LESS SLABS INTO SMALLER PIECES TO FACILITATE REMOVAL.



ONE LANE REPAIRS
(2 - LANE ROADWAY SHOWN)



ALL LANES REPAIRED
(2 - LANE ROADWAY SHOWN)



MORE THAN ONE LANE REPAIRED
BUT REPAIR LESS THAN FULL WIDTH
(3 - LANE ROADWAY SHOWN)

FORMING NOTES:

STAKES USED TO HOLD HMA FILLER OR HARDBOARD IN PLACE DURING CONCRETE PLACEMENT SHALL BE REMOVED BEFORE SCREEDING THE CONCRETE.

ADJACENT LANE REPAIRS MAY BE CAST INTEGRALLY, WHEN APPROVED BY THE ENGINEER.

FORMING REQUIREMENTS FOR
CAST-IN-PLACE REPAIRS 12'-0" OR LESS

MDOT Michigan Department of Transportation

PREPARED BY DESIGN DIVISION

DRAWN BY: B.L.T.

CHECKED BY: W.K.P.

ACTING DEPARTMENT DIRECTOR
Bradley C. Wieferich

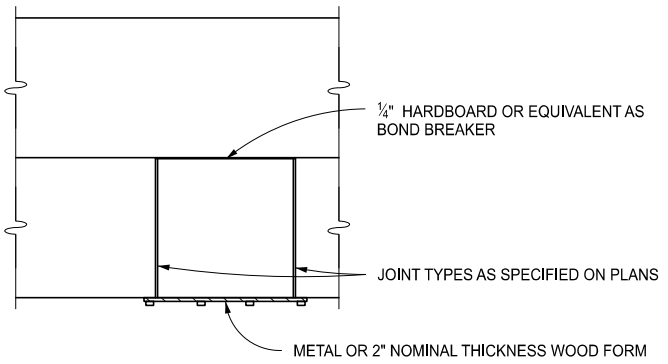
APPROVED BY: _____
DIRECTOR, BUREAU OF FIELD SERVICES

APPROVED BY: _____
DIRECTOR, BUREAU OF DEVELOPMENT

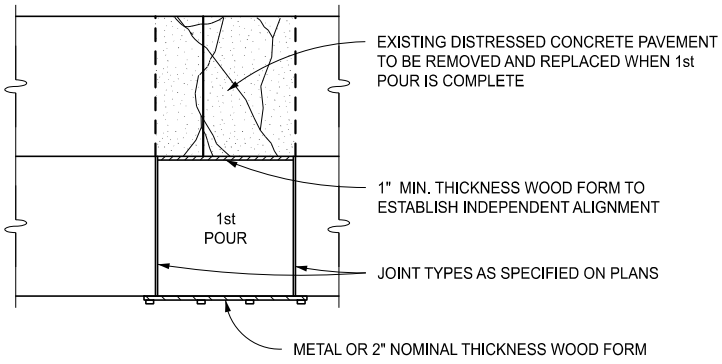
MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

CONCRETE PAVEMENT REPAIR

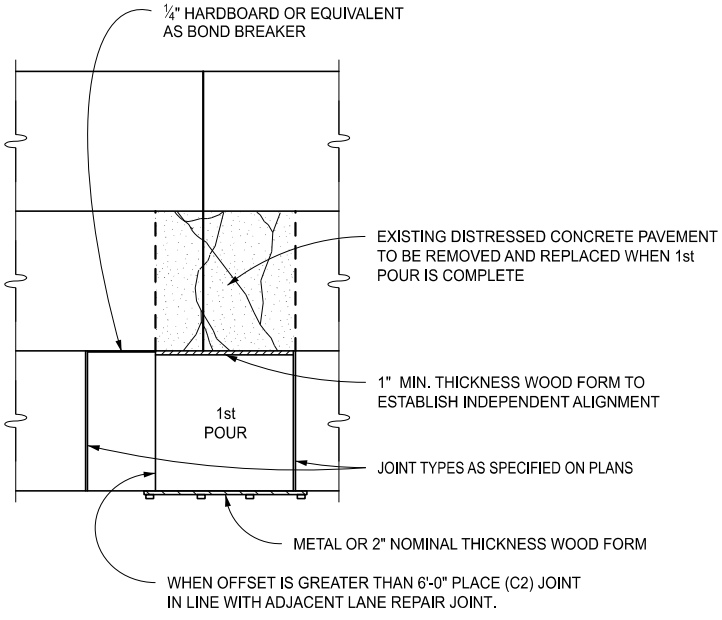
F.H.W.A. APPROVAL	3-14-2023 PLAN DATE	R-44-G	SHEET 1 OF 6



ONE LANE REPAIRS
(2 - LANE ROADWAY SHOWN)



ALL LANES REPAIRED
(2 - LANE ROADWAY SHOWN)



MORE THAN ONE LANE REPAIRED
BUT REPAIRS ARE OFFSET
(3 - LANE ROADWAY SHOWN)

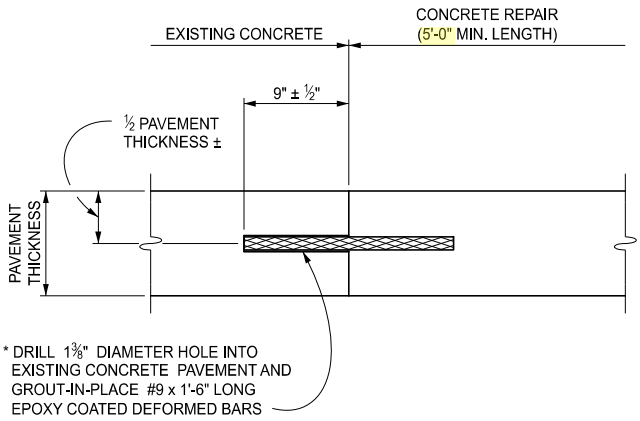
FORMING NOTES:

WHERE REPAIRS LONGER THAN 12'-0" ARE REQUIRED, A NEW GRADE MUST BE ESTABLISHED ALONG THE OLD PAVEMENT INNER JOINT LINE INDEPENDENT OF THE OLD PAVEMENT SURFACE, SO THAT SCREEDING MAY BE DONE PERPENDICULAR TO THE CENTERLINE AND INDEPENDENT OF THE OLD PAVEMENT GRADE.

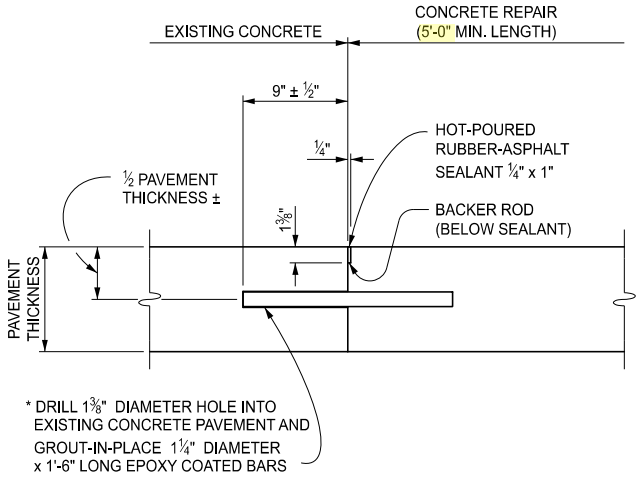
STAKES USED TO HOLD HMA FILLER OR HARDBOARD IN PLACE DURING CONCRETE PLACEMENT SHALL BE REMOVED BEFORE SCREEDING THE CONCRETE.

ADJACENT LANE REPAIRS MAY BE CAST INTEGRALLY, WHEN APPROVED BY THE ENGINEER.

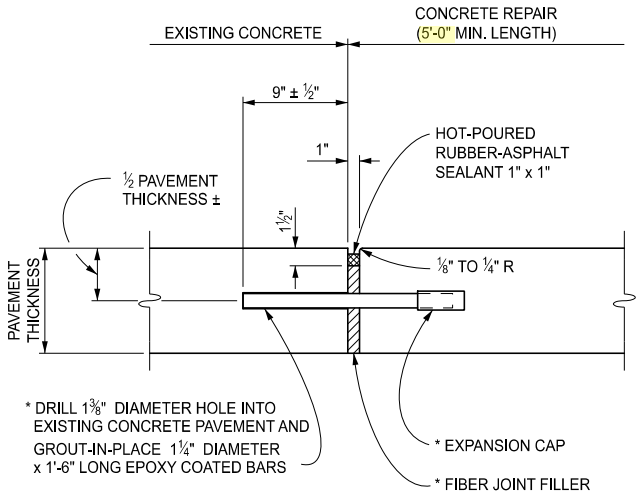
FORMING REQUIREMENTS FOR CAST-IN-PLACE REPAIRS GREATER THAN 12'-0"



TIED JOINT, Trg



CONTRACTION JOINT, Crg



EXPANSION JOINT, Erg

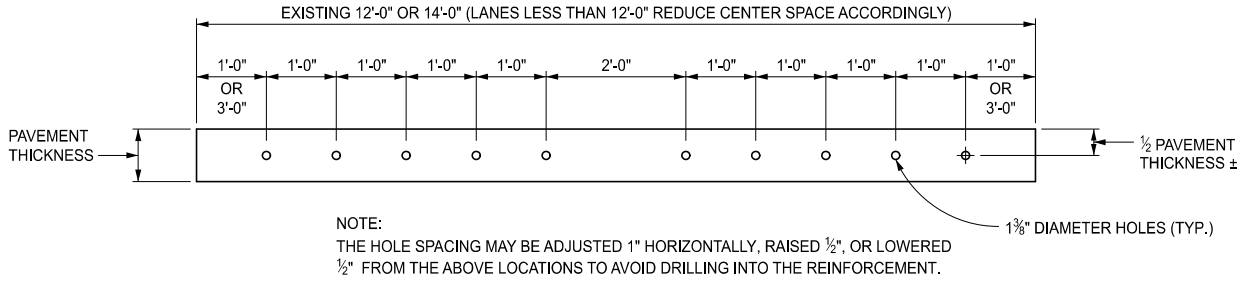
* SEE SHEET 3 OF 6 FOR BAR SPACING AND SHEET 6 OF 6 FOR NOTES.

CAST-IN-PLACE REPAIR JOINTS USING GROUTED DOWEL OR DEFORMED BARS

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

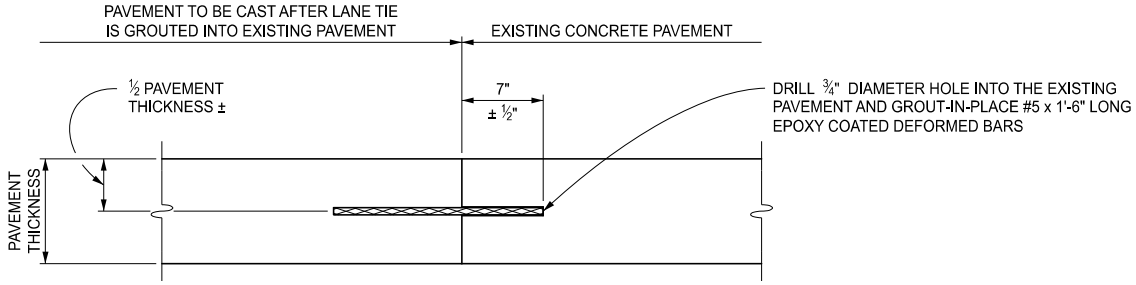
CONCRETE PAVEMENT REPAIR

F.H.W.A. APPROVAL	3-14-2023 PLAN DATE	R-44-G	SHEET 2 OF 6

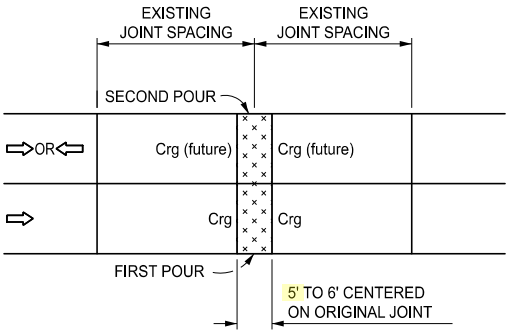


NOTE:
THE HOLE SPACING MAY BE ADJUSTED 1" HORIZONTALLY, RAISED ½", OR LOWERED ½" FROM THE ABOVE LOCATIONS TO AVOID DRILLING INTO THE REINFORCEMENT.

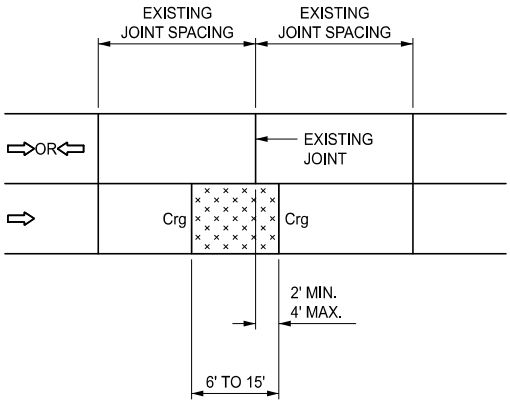
DOWEL OR DEFORMED BAR SPACING FOR CONCRETE REPAIRS



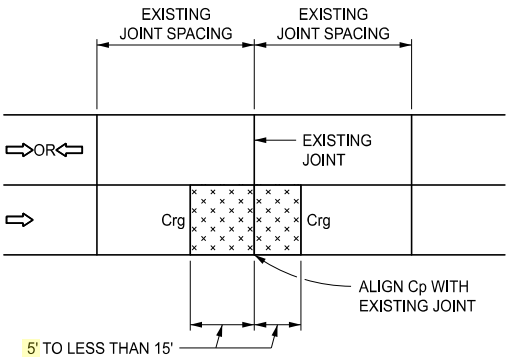
EPOXY ANCHORED LANE TIE



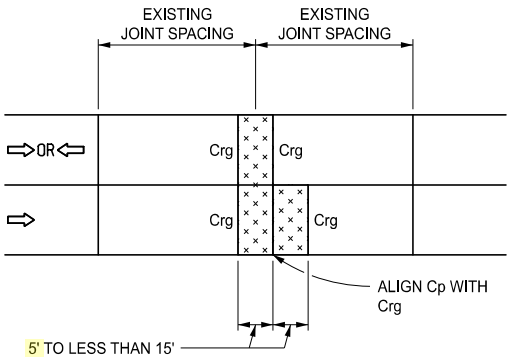
SINGLE LANE OR FULL WIDTH REPAIR



REPAIR LENGTH 6' - 15' WITH ONE JOINT NEAR AN EXISTING JOINT
(SINGLE LANE REPAIR)



REPAIR LENGTHS OVER 15' WITH Cp JOINT
(SINGLE LANE REPAIR)

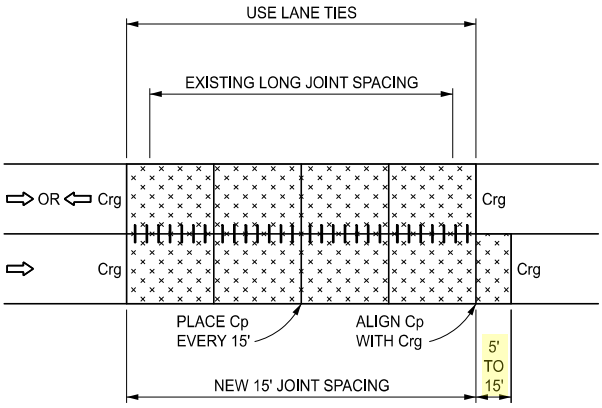


OFFSETTING LANE REPAIRS WITH Cp JOINT

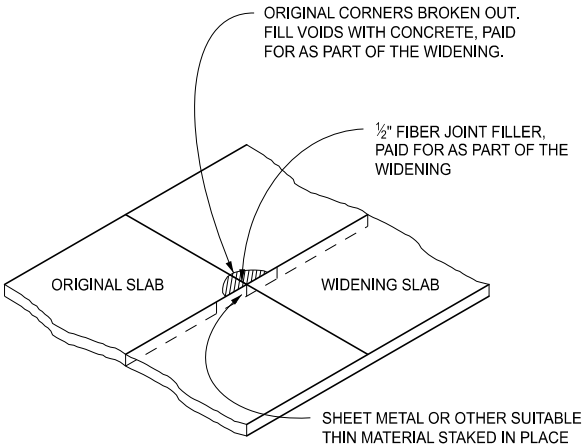
MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

CONCRETE PAVEMENT REPAIR

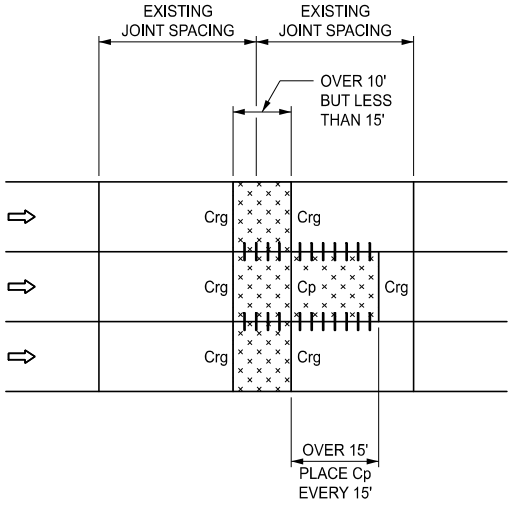
F.H.W.A. APPROVAL	3-14-2023 PLAN DATE	R-44-G	SHEET 3 OF 6



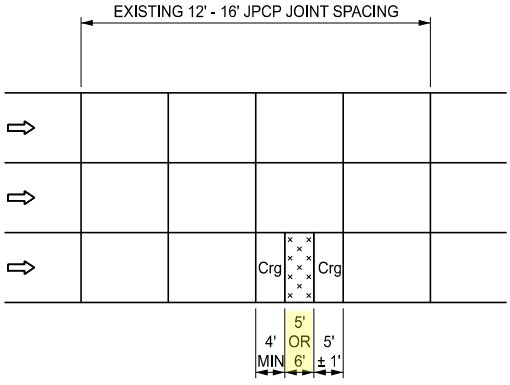
LONG REPAIR SHOWING
Cp JOINT ALIGNMENTS AND LANE TIES



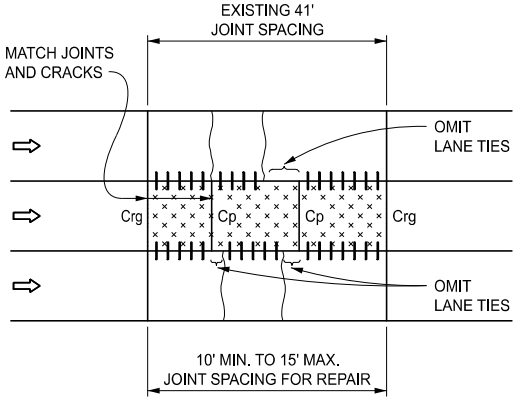
JOINT PATCH ADJACENT TO WIDENING SLAB



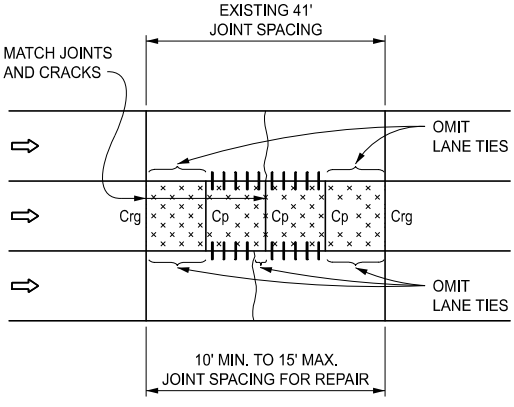
FULL WIDTH MULTI-LANE REPAIRS
WITH OFFSET IN ONE LANE



REPAIR OF 12' - 16' JPCP WITH
ONLY ONE MID-PANEL CRACK
(IF THE PANEL HAS MORE THAN ONE MID-PANEL CRACK
OR IF THE JOINT SPACING IS 12' REPLACE ENTIRE PANEL)
(SINGLE LANE OR FULL WIDTH REPAIR)



TWO CRACK PANEL REPAIR

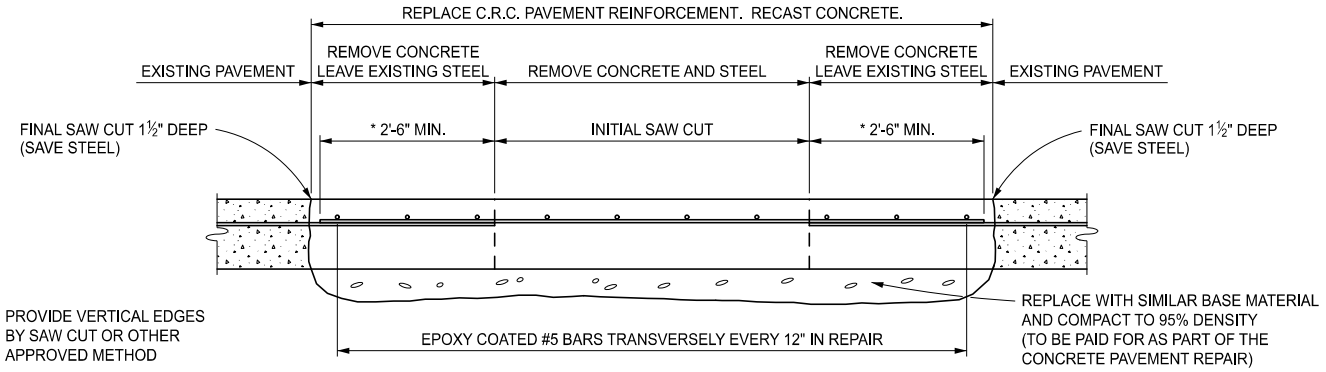


MID PANEL CRACK REPAIR

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

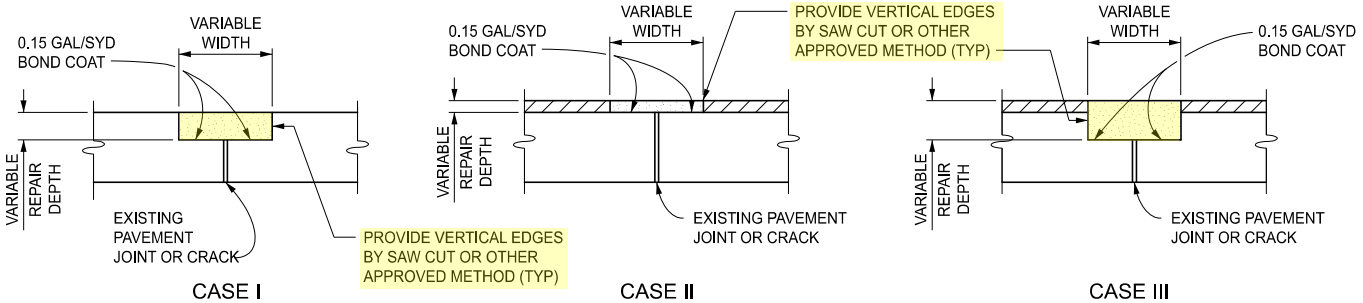
CONCRETE PAVEMENT REPAIR

F.H.W.A. APPROVAL	3-14-2023 PLAN DATE	R-44-G	SHEET 4 OF 6



* NOTE: IF EXISTING REINFORCEMENT LAPS ARE ENCOUNTERED IN THIS AREA, FINAL SAW CUT MUST BE MOVED BACK TO PROVIDE MINIMUM 2'-6" LAP OF PAVEMENT REINFORCEMENT.

REPAIRING CONTINUOUSLY REINFORCED CONCRETE



CASE I

HMA REPAIR OF CONCRETE PAVEMENT

REMOVE LOOSE DETERIORATED CONCRETE. (NOT TO EXCEED PAVEMENT THICKNESS)

CASE II

HMA REPAIR OF CONCRETE PAVEMENT WITH HMA SURFACE

REMOVE HMA OVERLAY TO CONCRETE SURFACE.

CASE III

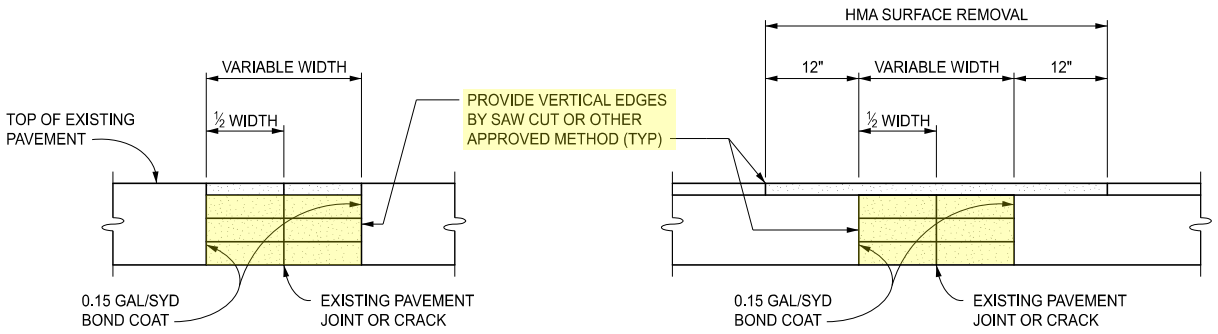
HMA REPAIR OF CONCRETE PAVEMENT WITH HMA SURFACE

REMOVE HMA OVERLAY AND LOOSE DETERIORATED CONCRETE. (NOT TO EXCEED PAVEMENT THICKNESS)

FOR CASES I, II, & III, THE REMOVED MATERIAL SHALL BE REPLACED WITH A HMA TOP COURSE MIXTURE. THE HMA SHALL BE COMPACTED WITH A MACHINE VIBRATOR OR APPROVED ROLLER WITH BASE LIFT THICKNESSES NOT TO EXCEED 3" AND WITH THE TOP LIFT THICKNESS NOT TO EXCEED 2". THE FINAL SURFACE OF THE REPAIR SHALL BE FLUSH WITH THE EXISTING PAVEMENT SURFACE.

SURFACE REPAIR FOR JOINT OR CRACK (TRANSVERSE OR LONGITUDINAL)

DETAIL 7



CASE IV

FULL DEPTH HMA REPAIR OF CONCRETE PAVEMENT

REMOVE THE DETERIORATED CONCRETE FULL DEPTH. COMPACT LOOSE EXISTING BASE. REPLACE AND COMPACT WITH HMA ANY LOST BASE.

CASE V

FULL DEPTH HMA REPAIR OF CONCRETE PAVEMENT WITH HMA SURFACE

REMOVE EXISTING HMA DETERIORATED CONCRETE PAVEMENT FULL DEPTH. COMPACT LOOSE EXISTING BASE. REPLACE AND COMPACT WITH HMA ANY LOST BASE.

FOR CASES IV, & V, THE REMOVED MATERIAL SHALL BE REPLACED WITH A HMA TOP COURSE MIXTURE. THE HMA SHALL BE COMPACTED WITH A MACHINE VIBRATOR OR APPROVED ROLLER WITH BASE LIFT THICKNESSES NOT TO EXCEED 3" AND WITH THE TOP LIFT THICKNESS NOT TO EXCEED 2". THE FINAL SURFACE OF THE REPAIR SHALL BE FLUSH WITH THE EXISTING PAVEMENT SURFACE.

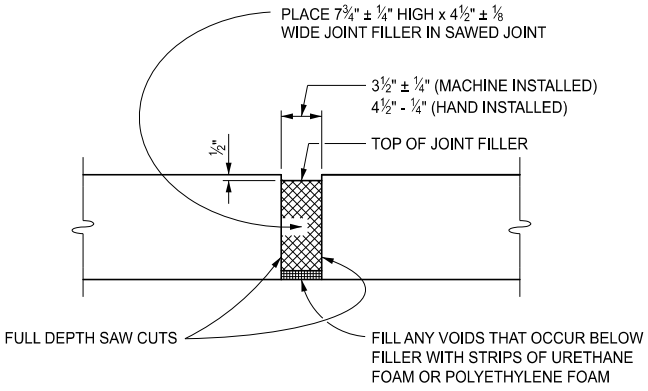
FULL DEPTH REPAIR FOR JOINT OR CRACK (TRANSVERSE OR LONGITUDINAL)

DETAIL 8

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

CONCRETE PAVEMENT REPAIR

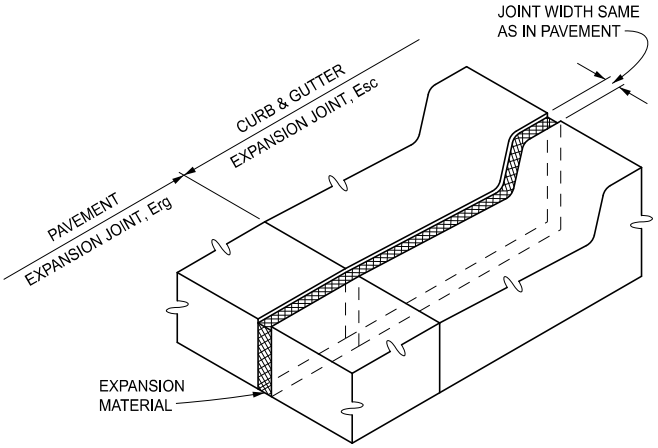
F.H.W.A. APPROVAL	3-14-2023 PLAN DATE	R-44-G	SHEET 5 OF 6



NOTES:
WHEN PRESSURE RELIEF JOINT IS TO BE CONSTRUCTED THROUGH CONCRETE SHOULDER, TRENCHING BELOW CONCRETE MAY BE NECESSARY TO ALLOW ROOM FOR 7¼" FILLER.

PRESSURE RELIEF JOINT

THIS DETAIL ALSO APPLIES TO HMA SURFACED CONCRETE PAVEMENT REQUIRING PRESSURE RELIEF JOINTS



CURB, GUTTER, AND CURB FACE SHALL BE SAWED AS DEEP AS THE EXISTING PAVEMENT THICKNESS. THE REMAINING CONCRETE SHALL BE CHIPPED OUT AND EXPANSION MATERIAL OF SUFFICIENT THICKNESS SHALL BE PLACED IN SAWED JOINT TO FILL THE GAP AS DIRECTED BY THE ENGINEER.

EXPANSION JOINT, Esc

NOTES:

CONCRETE PAVEMENT REPAIRS (INCLUDING JOINT TYPES) OR PRESSURE RELIEF DETAILS SHALL BE AS SPECIFIED ON THE PLANS OR IN THE LOG OF PROJECT.

IF THE EXISTING PAVEMENT HAS A HMA SURFACE, THE SAW CUTS SHALL EXTEND THROUGH THE UNDERLYING PORTLAND CEMENT CONCRETE.

SAW OVERCUTS IN ADJACENT LANE, SHOULDER, RAMP, AND GUTTERS THAT WILL REMAIN IN PLACE, SHALL BE CLEANED AND THEN SEALED WITH HOT-POURED RUBBER-ASPHALT.

WHEN THE CONCRETE PAVEMENT REPAIR IS CONSTRUCTED IN PREPARATION FOR AN OVERLAY, Crg JOINT RESERVOIRS AND SEALANTS SHALL BE OMITTED AND EXPANSION JOINTS (Erg) SHALL HAVE THE FIBER JOINT FILLER KEPT FLUSH TO THE PAVEMENT SURFACE.

EXPANSION CAPS SHALL BE ACCORDING TO STANDARD PLAN R-40-SERIES.

TRANSVERSE CONTRACTION Cp AND EXPANSION E2 JOINTS SHALL BE ACCORDING TO STANDARD PLAN R-39-SERIES.

DOWEL AND DEFORMED BARS USED IN Trg, Crg, AND Erg JOINTS SHALL BE EPOXY COATED ACCORDING TO THE CURRENT STANDARD SPECIFICATIONS.

DOWEL BARS AND DEFORMED BARS FOR TIED JOINTS SHALL BE GROUTED INTO EXISTING PAVEMENT WITH A GROUT SELECTED FROM THE PREQUALIFIED MATERIALS LISTED IN THE DEPARTMENT'S "MATERIALS SOURCE GUIDE" UNDER ADHESIVE SYSTEMS FOR GROUTING DOWEL BARS AND TIE BARS FOR FULL-DEPTH CONCRETE PAVEMENT REPAIRS.

THE BACKER ROD SHALL MEET THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION.

THE SAME TYPE JOINT SHALL EXTEND ACROSS ADJACENT LANE REPAIRS.

AFTER GROUTING IN-PLACE, RC-250 OR AN APPROVED BOND BREAKER SHALL BE APPLIED TO THAT PORTION OF Crg AND Erg DOWEL BARS THAT EXTEND INTO THE CAST CONCRETE.

REPAIRED CONCRETE PAVEMENTS REQUIRE THAT 1" OF Erg EXPANSION JOINTS BE DISTRIBUTED THROUGHOUT A GIVEN 1000' SECTION.

WHERE THERE ARE NO REPAIR LOCATIONS WITHIN A 1000' LENGTH, NO EXPANSION SPACE WILL BE PROVIDED.

EXPANSION JOINT FILLER SHALL EXTEND THE FULL DEPTH OF THE REPAIR AND BE FLUSH WITH THE EXISTING PAVEMENT SURFACE. PRIOR TO SEALING, THE JOINT FIBER FILLER AT THE PAVEMENT SURFACE SHALL BE REMOVED BY CUTTING 1" WIDE AND 1½" DEEP TO PERMIT THE PLACEMENT OF THE HOT-POURED RUBBER ASPHALT SEALANT. HOLES IN EXPANSION JOINT FILLER SHALL BE 1½" MAXIMUM DIAMETER AND SHALL BE ALIGNED TO FIT DRILLED HOLES IN CONCRETE.

Erg JOINTS SHALL BE CONSTRUCTED ONLY WHEN THEY EXTEND ACROSS ALL LANES, RAMPS, OR SHOULDERS.

WHEN Erg JOINTS ARE PLACED ADJACENT TO CONCRETE CURB AND GUTTER THAT IS NOT REQUIRED TO BE REMOVED, AN Esc JOINT SHALL BE CONSTRUCTED IN THE CURB AND GUTTER.

JOINT RESERVOIRS FOR THE HOT-POURED RUBBER-ASPHALT SEALANT SHALL BE ABRASIVE BLAST CLEANED, FOLLOWED BY A FINAL CLEANING OF OIL-FREE COMPRESSED AIR PRIOR TO SEALING.

LANE TIES (TO ADJACENT PAVEMENT LANE, WHEN REQUIRED) SHALL BE SPACED ACCORDING TO STANDARD PLAN R-41-SERIES, EXCEPT THAT THE FIRST LANE TIE ADJACENT TO A TRANSVERSE JOINT SHALL BE INSTALLED AT A DISTANCE OF 1'-8" FROM THE JOINT. WHEN BOTH SIDES OF A LONGITUDINAL JOINT ARE POURED INTEGRALLY, LANE TIES SHALL BE STRAIGHT DEFORMED EPOXY COATED BARS CAST-IN-PLACE AS SPECIFIED ON STANDARD PLAN R-41-SERIES. WHEN ADJACENT LANES ARE CAST SEPARATELY, LANE TIES SHALL BE GROUTED-IN-PLACE AS SPECIFIED ON THIS PLAN. THE GROUT SHALL BE SELECTED FROM THE PREQUALIFIED MATERIALS LISTED IN THE DEPARTMENT'S "MATERIALS SOURCE GUIDE", UNDER LANE TIES.

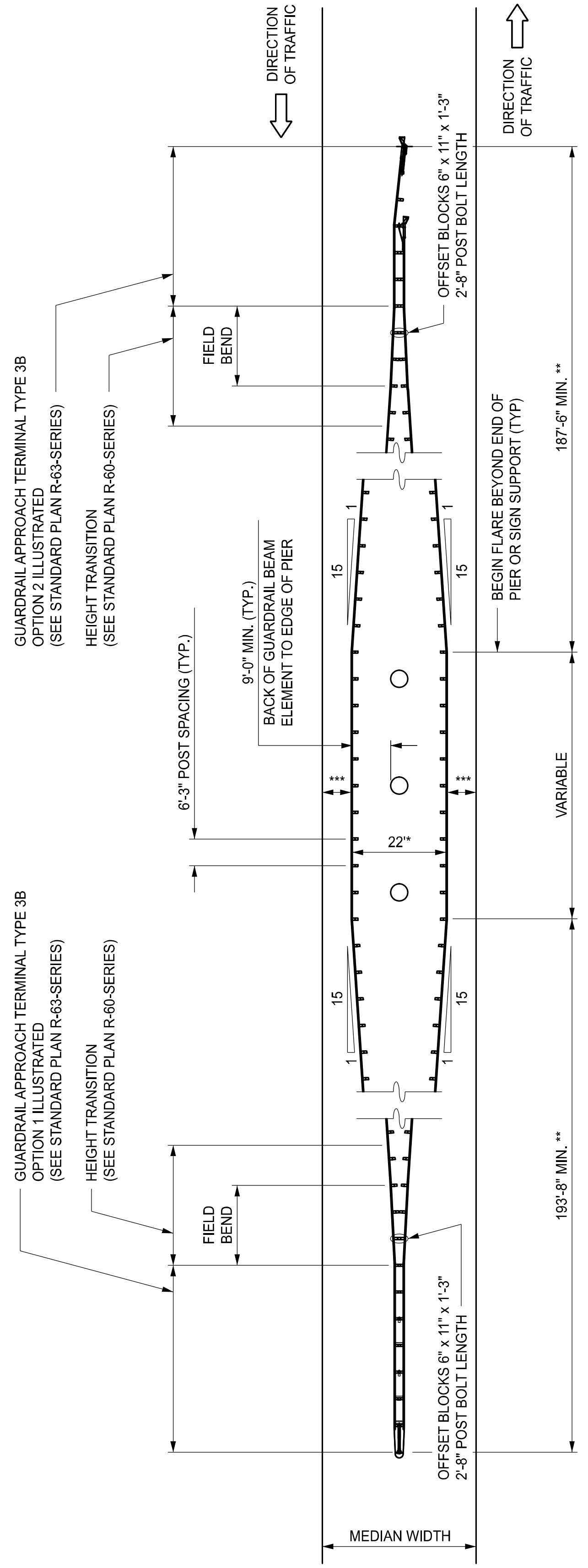
THE MONTH AND YEAR OF CASTING AND STATION NUMBER (IF REMOVED) SHALL BE STENCILED ON EACH CONCRETE REPAIR.

ALL REPAIRS WILL BE JOINTED PLAIN CONCRETE PAVEMENT.

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

CONCRETE PAVEMENT REPAIR

F.H.W.A. APPROVAL	3-14-2023 PLAN DATE	R-44-G	SHEET 6 OF 6



TYPICAL LAYOUT AT PIERS AND SIGN SUPPORTS USING GUARDRAIL TYPE MGS-8

* THE 22' DIMENSION IS CENTERED ON THE PIER OR MEDIAN FROM BACK OF GUARDRAIL TO BACK OF GUARDRAIL. FOR PIERS GREATER THAN 4' IN WIDTH/DIAMETER, INCREASE THE 22' DIMENSION TO PIER WIDTH/DIAMETER + 18'.

** INCREASE LENGTH BY 7.5' FOR EACH FOOT OF PIER WIDTH/DIAMETER ABOVE 4'.

*** ENSURE NO PORTION OF GUARDRAIL ENCROACHES ON SHOULDER.

FOR MEDIANS 36' WIDE TO MEDIANS LESS THAN 70' WIDE USING GUARDRAIL TYPE MGS-8

MDOT
Michigan Department of Transportation

PREPARED BY DESIGN DIVISION

DRAWN BY: B.L.T.

CHECKED BY: W.K.P.

ACTING DEPARTMENT DIRECTOR
Bradley C. Wiieferich

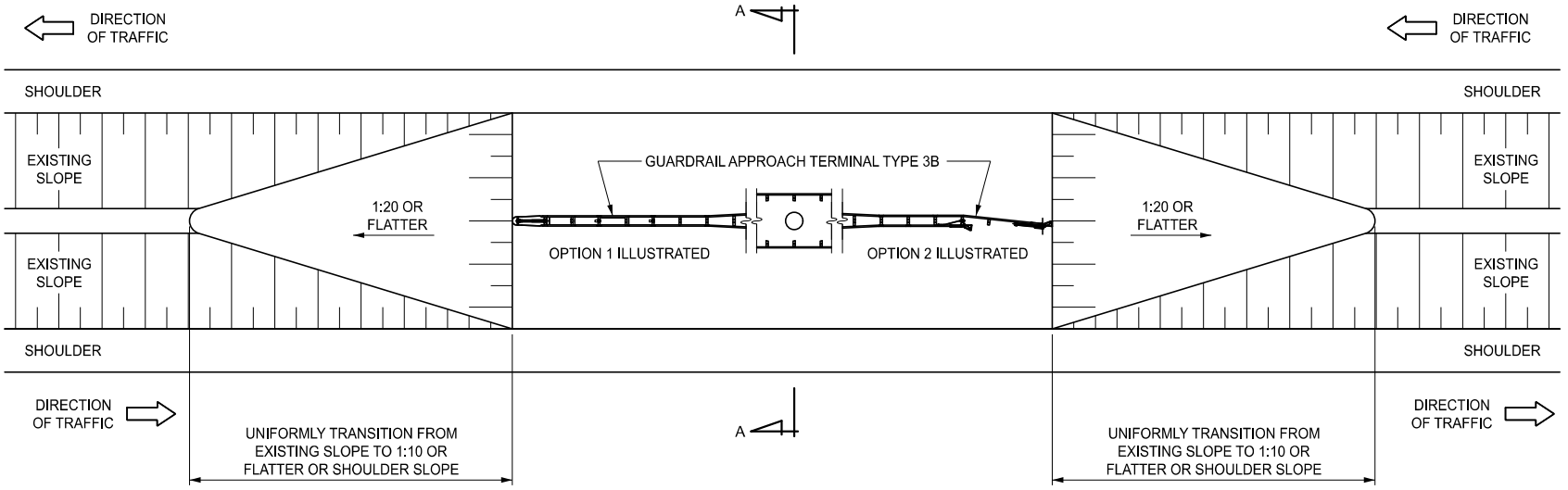
APPROVED BY: ______________________
DIRECTOR, BUREAU OF FIELD SERVICES

APPROVED BY: ______________________
DIRECTOR, BUREAU OF DEVELOPMENT

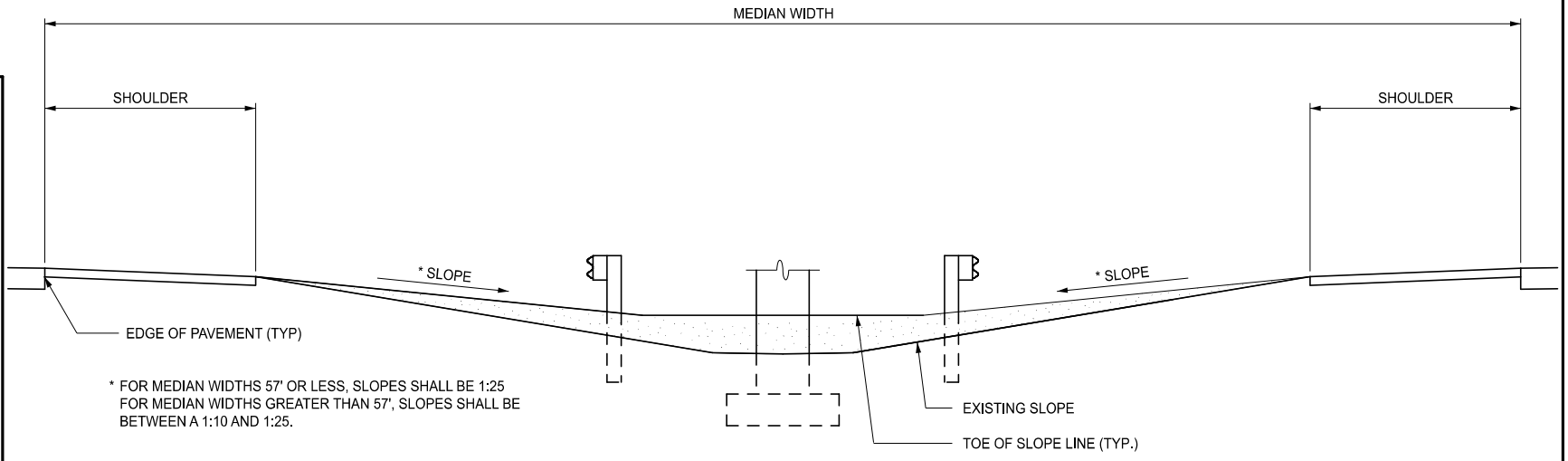
MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

GUARDRAIL MEDIAN OBJECT PROTECTION

F.H.W.A. APPROVAL	4-11-2023 PLAN DATE	R-56-F	SHEET 1 OF 6



GRADING OF SLOPES AT PIERS



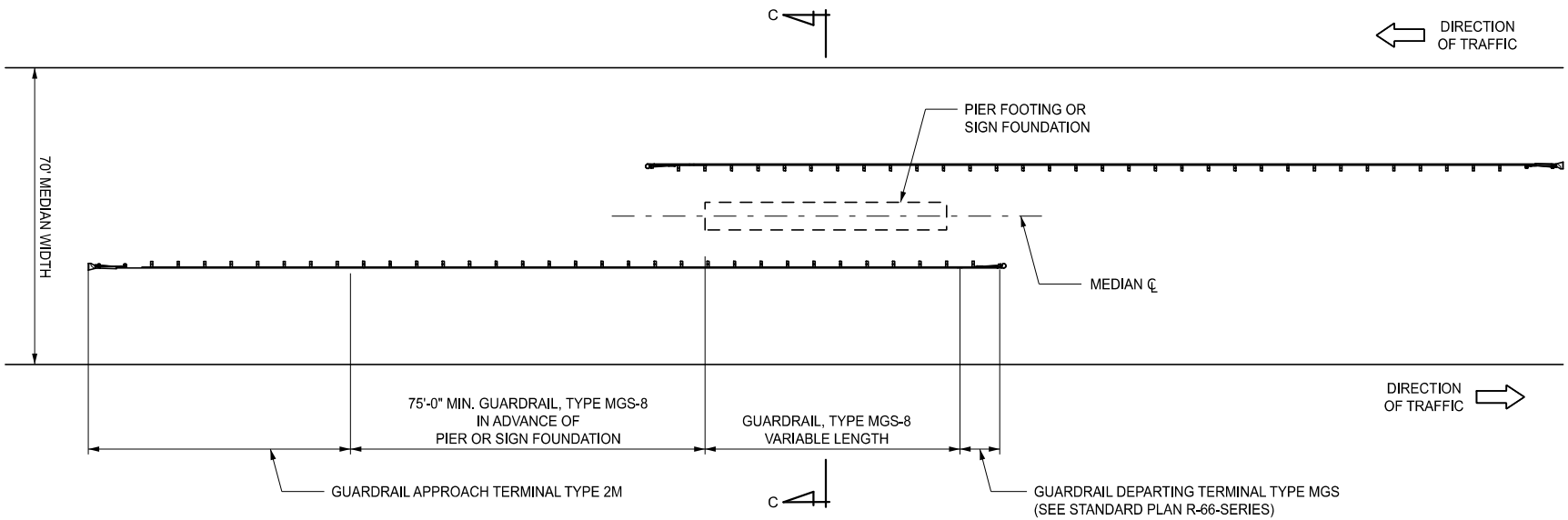
SECTION A-A

GRADING IN MEDIANS FROM 36' TO LESS THAN 70' IN WIDTH USING GUARDRAIL TYPE MGS-8

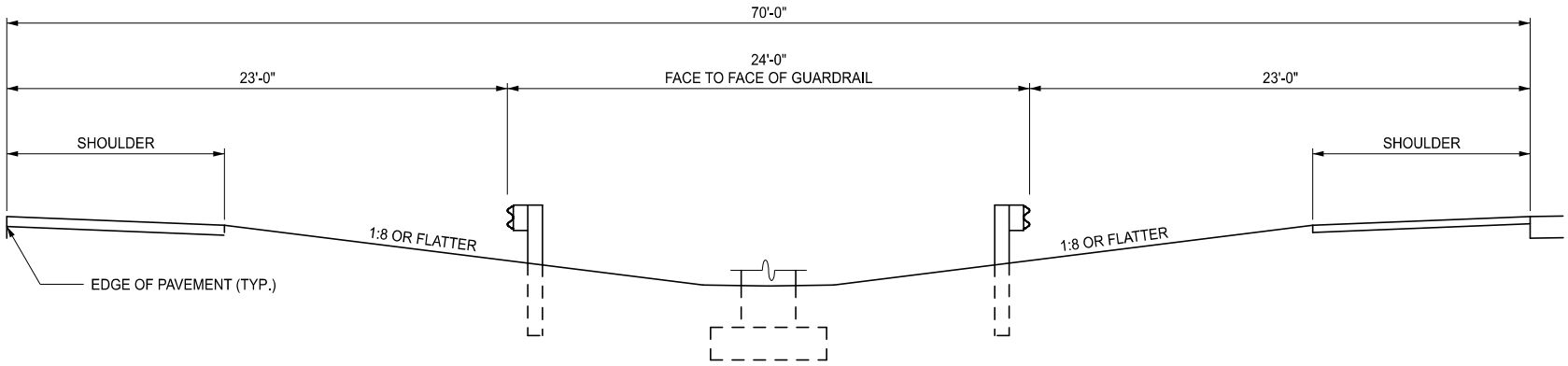
MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

GUARDRAIL
MEDIAN OBJECT PROTECTION

F.H.W.A. APPROVAL	4-11-2023 PLAN DATE	R-56-F	SHEET 2 OF 6



TWIN PARALLEL GUARDRAIL RUNS USING GUARDRAIL TYPE MGS-8



SECTION C-C

MEDIANS 70' IN WIDTH
USING GUARDRAIL TYPE MGS-8

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

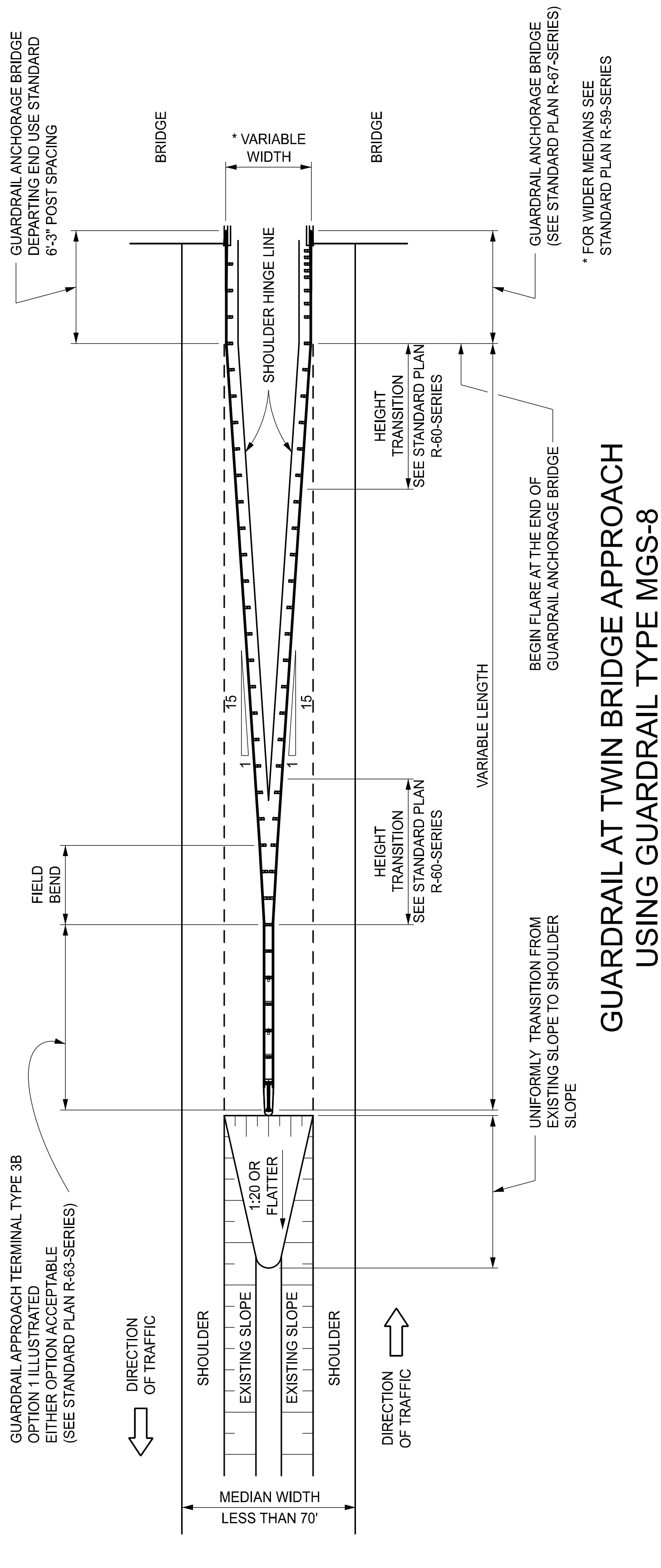
GUARDRAIL
MEDIAN OBJECT PROTECTION

F.H.W.A. APPROVAL

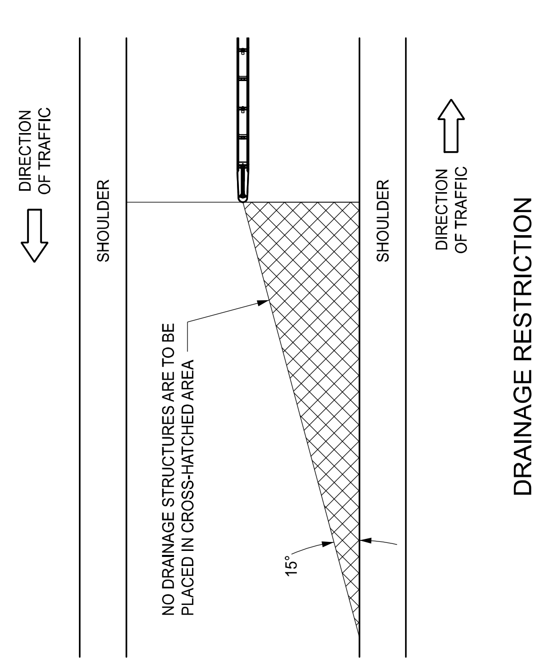
4-11-2023
PLAN DATE

R-56-F

SHEET
3 OF 6



GUARDRAIL AT TWIN BRIDGE APPROACH
USING GUARDRAIL TYPE MGS-8



DRAINAGE RESTRICTION

NOTES:

ALL 1:10 OR FLATTER SLOPES SHALL BE GRADED TO CLASS A SLOPE TOLERANCES.

GUARDRAIL ANCHORAGE, BRIDGE SHALL BE CONSTRUCTED ACCORDING TO STANDARD PLAN R-67-SERIES.

UNLESS INDICATED BY A RADIUS, ALL CURVED GUARDRAIL SHALL BE FIELD BENT.

ANY EXISTING CURB OVER 4" IN HEIGHT SHALL BE REMOVED 150' IN ADVANCE OF THE GUARDRAIL APPROACH TERMINAL OF THE MEDIAN GUARDRAIL INSTALLATION. WHEN IT BECOMES NECESSARY TO USE CURB AND GUTTER IN CONJUNCTION WITH MEDIAN GUARDRAIL INSTALLATIONS, CONTACT THE GEOMETRIC DESIGN UNIT OF THE DESIGN DIVISION.

SLOPES SPECIFIED ON THIS PLAN ARE FOR TYPICAL MEDIAN GUARDRAIL INSTALLATIONS. THE PLACEMENT OF DRAINAGE CULVERTS AND END SECTIONS, WHEN REQUIRED, SHALL BE AS DETAILED ON PLANS OR AS DIRECTED BY THE ENGINEER.

IF THE SPECIFIED MINIMUM OFFSETS FROM THE EDGE OF PIER OR MEDIAN OBJECT TO THE GUARDRAIL CANNOT BE ACHIEVED, EITHER STIFFEN THE GUARDRAIL SYSTEM, AS NEEDED, BY DECREASING THE POST SPACING OR USE CONCRETE BARRIER TO SHIELD THE PIER(S)/MEDIAN OBJECT(S). CONTACT THE GEOMETRIC DESIGN UNIT OF THE DESIGN DIVISION FOR GUIDANCE.

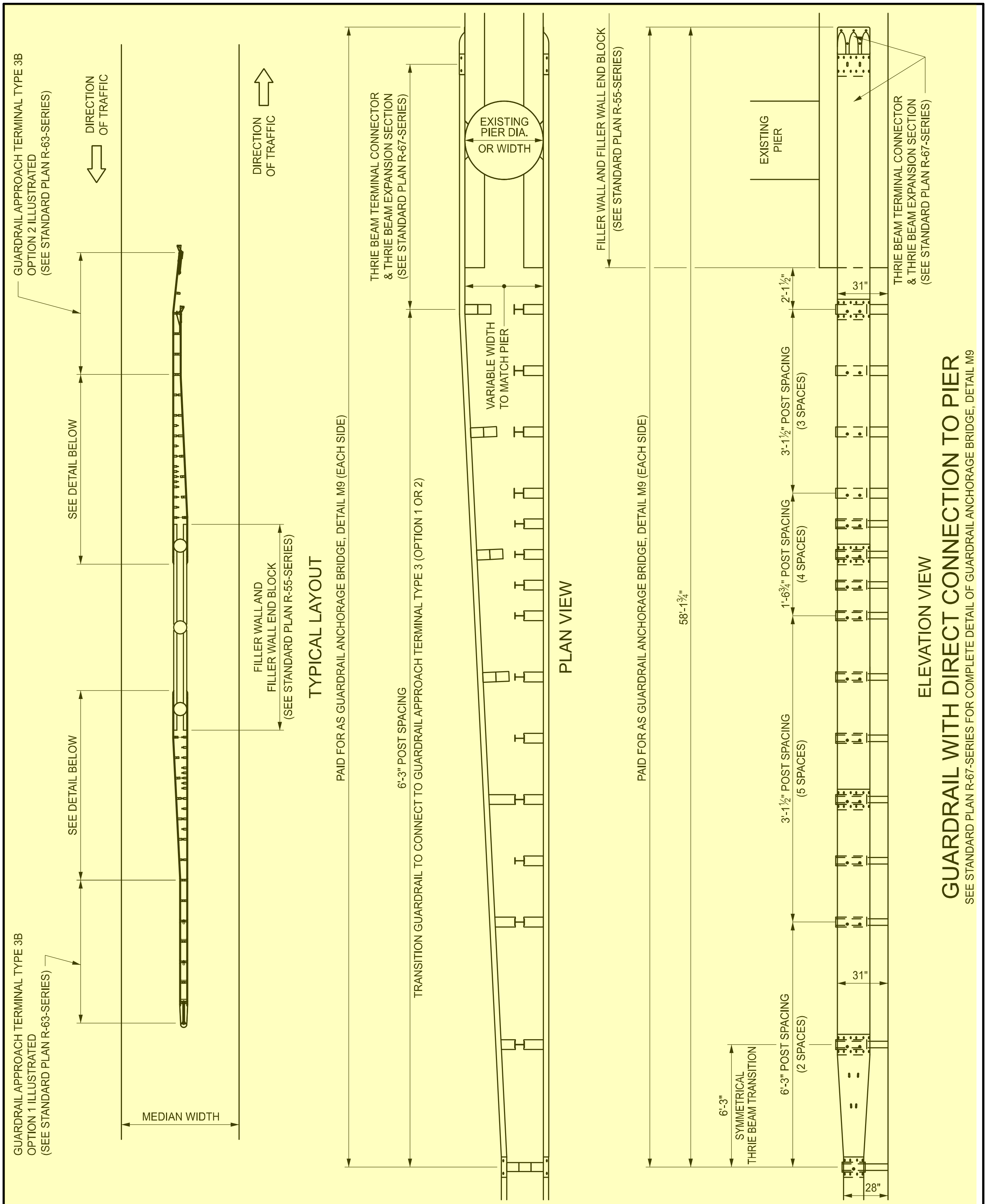
MEDIAN GUARDRAIL INSTALLATIONS ARE NOT REQUIRED IN MEDIANS THAT ARE GREATER THAN 70' IN WIDTH, UNLESS THE OBJECT BEING PROTECTED IS IN THE TARGET PATH OF A CURVE.

WHEN MEDIAN GUARDRAIL INSTALLATIONS ARE TO BE PLACED ON CURVES, CONTACT THE GEOMETRIC DESIGN UNIT OF THE DESIGN DIVISION.

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

GUARDRAIL
MEDIAN OBJECT PROTECTION

F.H.W.A. APPROVAL	4-11-2023 PLAN DATE	R-56-F	SHEET 4 OF 6

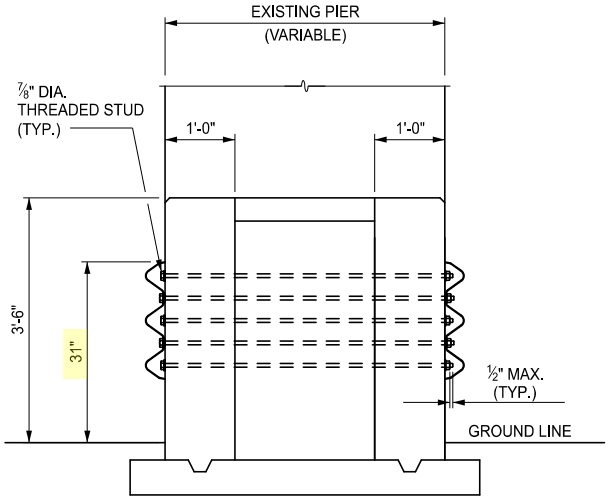


MICHIGAN DEPARTMENT OF TRANSPORTATION

BUREAU OF DEVELOPMENT STANDARD PLAN FOR

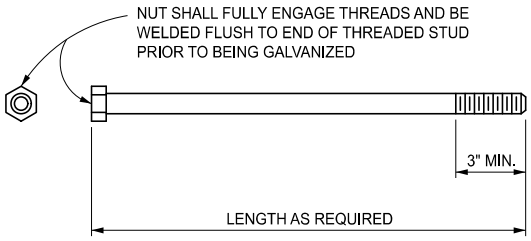
GUARDRAIL
MEDIAN OBJECT PROTECTION

F.H.W.A. APPROVAL	4-11-2023 PLAN DATE	R-56-F	SHEET 5 OF 6

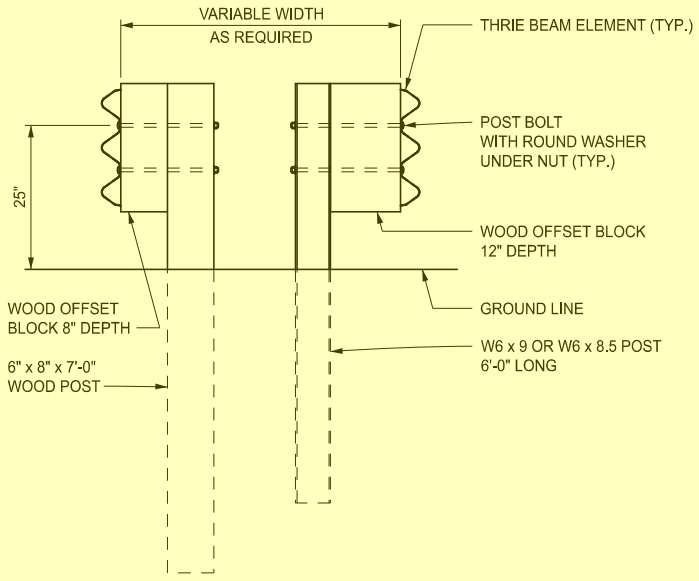


GUARDRAIL CONNECTION
AT FILLER WALL

(FOR FILLER WALL DETAILS SEE STANDARD PLAN R-55-SERIES)

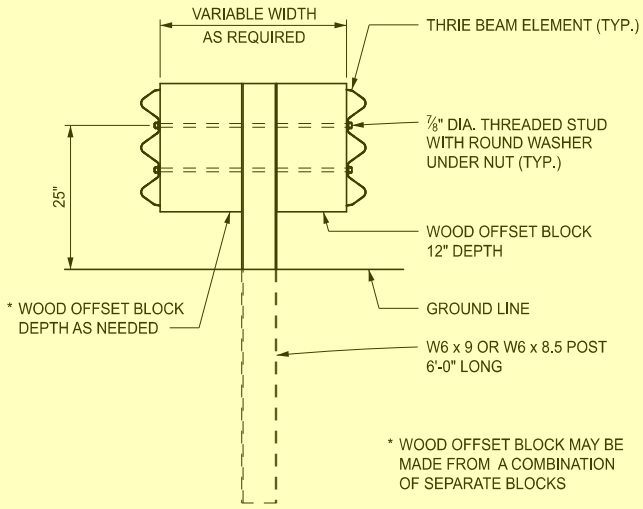


⅞" DIA. THREADED STUD



POST DETAIL

WHEN WIDTH CAN ACCOMMODATE
TWO GUARDRAIL POSTS



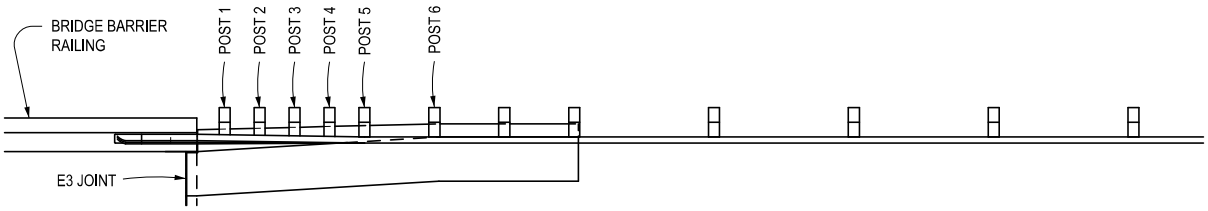
POST DETAIL

WHEN WIDTH CAN ACCOMMODATE
ONLY ONE GUARDRAIL POST

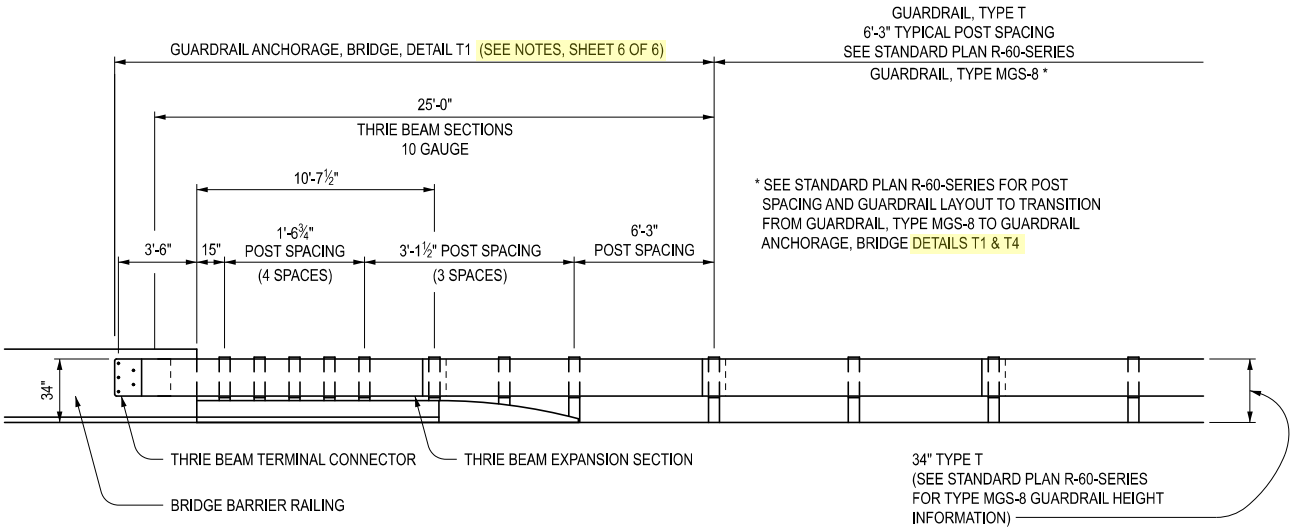
MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT STANDARD PLAN FOR

GUARDRAIL
MEDIAN OBJECT PROTECTION

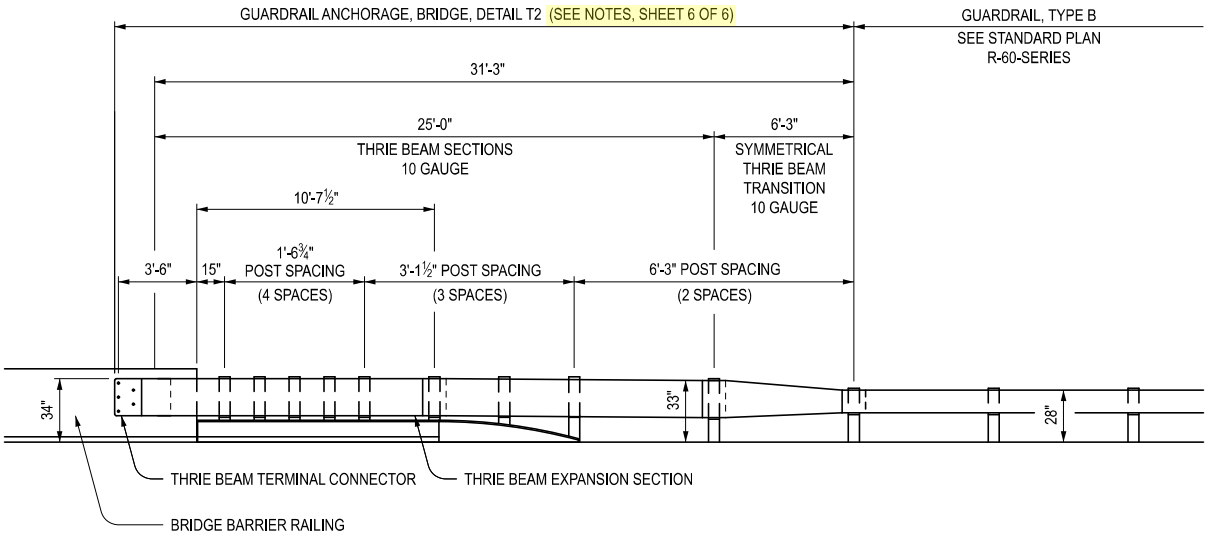
F.H.W.A. APPROVAL	4-11-2023 PLAN DATE	R-56-F	SHEET 6 OF 6



PLAN VIEW



ELEVATION VIEW
(TO BE USED WITH GUARDRAIL, TYPE T & TYPE MGS-8)



ELEVATION VIEW
(TO BE USED WITH GUARDRAIL, TYPE B)

DETAILS FOR CONNECTING GUARDRAIL TO BRIDGE BARRIER RAILINGS, TYPE 4, 2-TUBE, 4-TUBE, AESTHETIC PARAPET TUBE, OR 3 TUBE WITH PICKETS

(WITHOUT EXPANSION AT BACKWALL)

MDOT Michigan Department of Transportation

PREPARED BY DESIGN DIVISION

DRAWN BY: B.L.T.

CHECKED BY: W.K.P.

ACTING DEPARTMENT DIRECTOR
Bradley C. Wiieferich

APPROVED BY: _____
DIRECTOR, BUREAU OF FIELD SERVICES

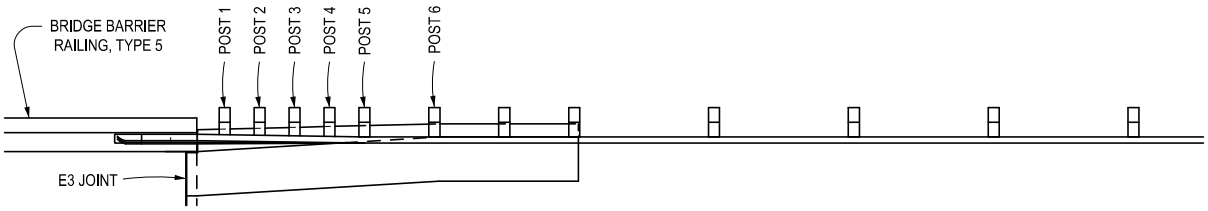
APPROVED BY: _____
DIRECTOR, BUREAU OF DEVELOPMENT

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

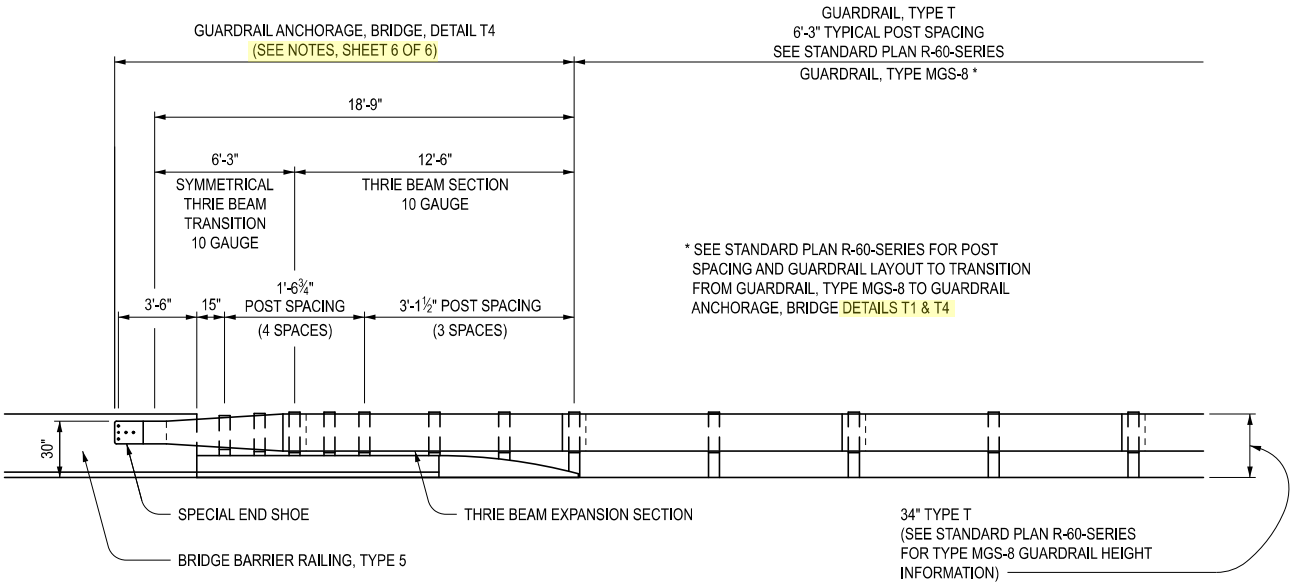
GUARDRAIL ANCHORAGE, BRIDGE, DETAILS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

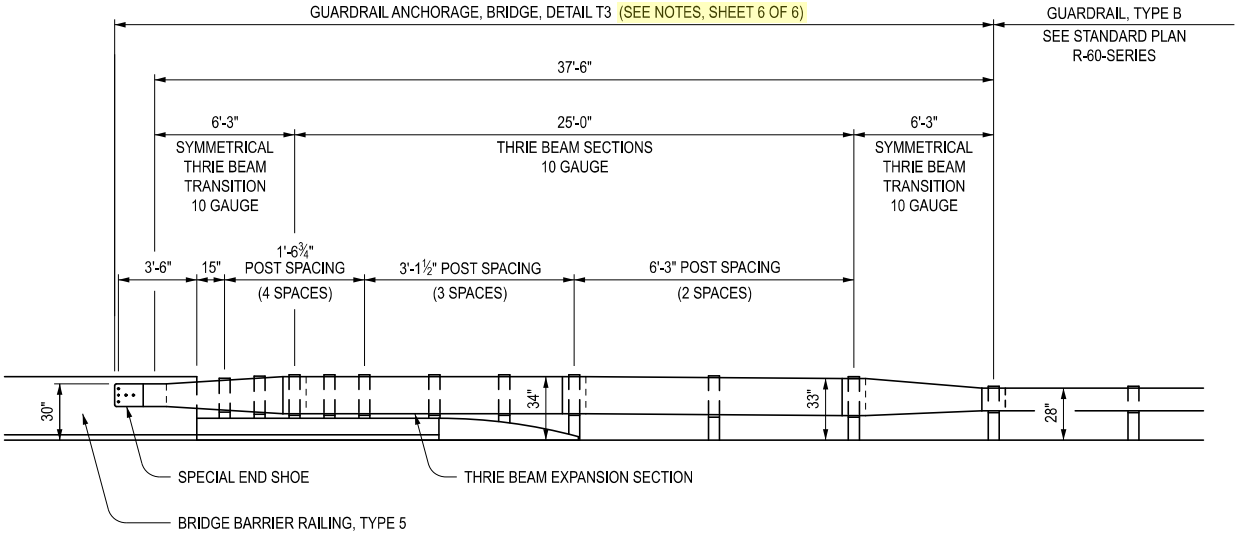
F.H.W.A. APPROVAL	4-4-2023 PLAN DATE	R-67-SD	SHEET 1 OF 6



PLAN VIEW



ELEVATION VIEW
(TO BE USED WITH GUARDRAIL, TYPE T & TYPE MGS-8)



ELEVATION VIEW
(TO BE USED WITH GUARDRAIL, TYPE B)

DETAILS FOR CONNECTING GUARDRAIL TO BRIDGE BARRIER RAILINGS, TYPE 5

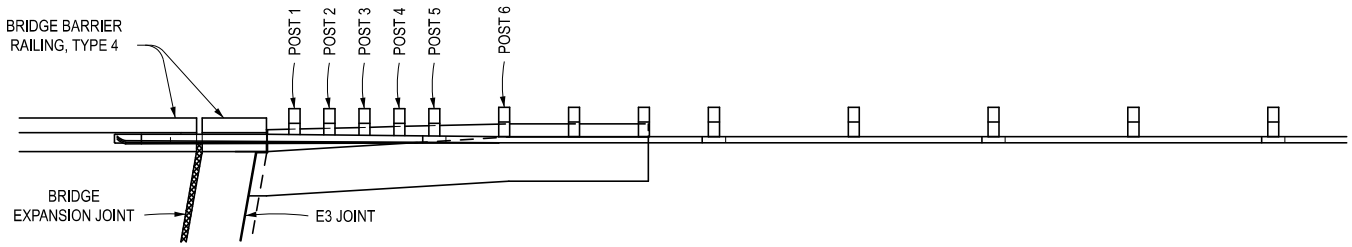
(WITHOUT EXPANSION AT BACKWALL)

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

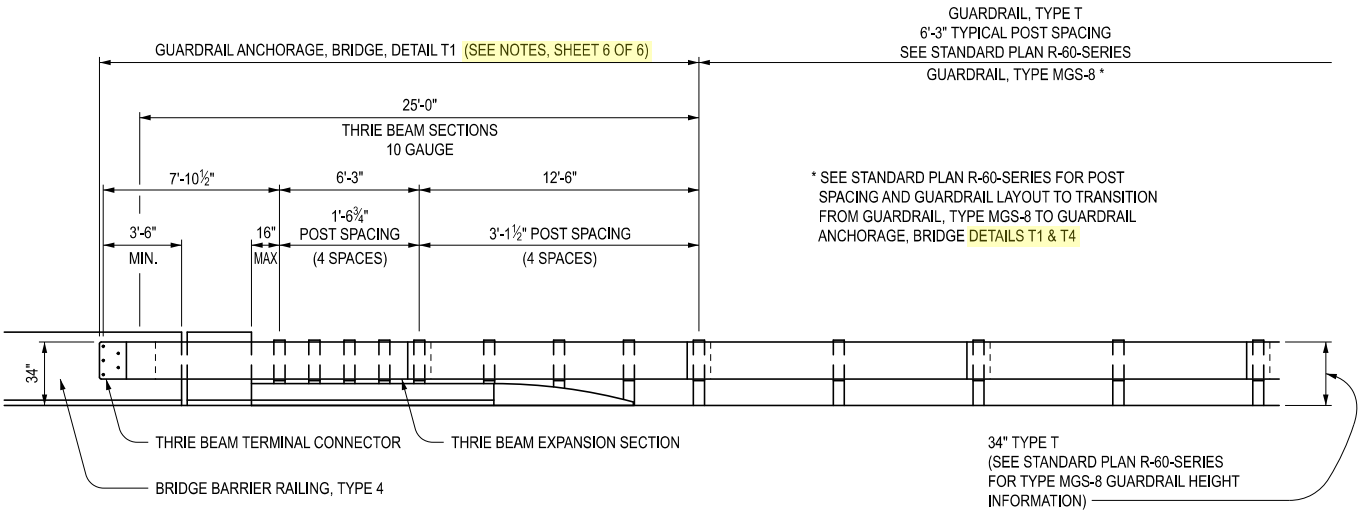
GUARDRAIL ANCHORAGE, BRIDGE, DETAILS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

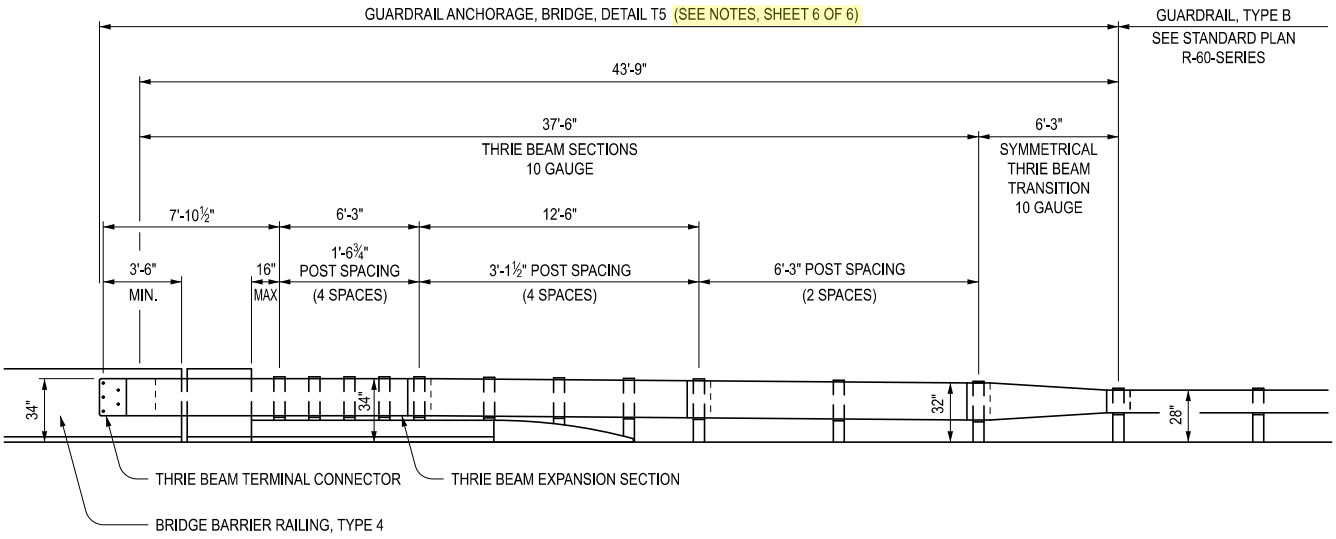
F.H.W.A. APPROVAL	4-4-2023 PLAN DATE	R-67-SD	SHEET 2 OF 6



PLAN VIEW



ELEVATION VIEW
(TO BE USED WITH GUARDRAIL, TYPE T & TYPE MGS-8)



ELEVATION VIEW
(TO BE USED WITH GUARDRAIL, TYPE B)

DETAILS FOR CONNECTING GUARDRAIL TO BRIDGE BARRIER RAILINGS, TYPE 4, 2-TUBE, 4-TUBE, AESTHETIC PARAPET TUBE, OR 3 TUBE WITH PICKETS

(WITH EXPANSION AT BACKWALL/END WALL OR SLEEPER SLAB)

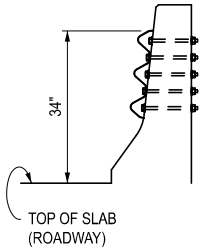
MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

GUARDRAIL ANCHORAGE, BRIDGE, DETAILS

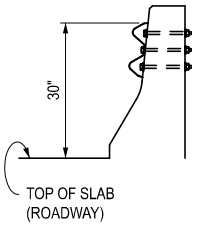
(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

F.H.W.A. APPROVAL	4-4-2023 PLAN DATE	R-67-SD	SHEET 3 OF 6

HIGH STRENGTH $\frac{7}{8}$" DIA. HEX HEAD BOLT AND NUTS SHALL BE USED TO CONNECT GUARDRAIL TO BRIDGE RAILINGS WITH ROUND WASHERS ON FRONT AND SQUARE WASHERS ON BACK. (SEE CHART BELOW FOR LENGTHS AND NUMBER REQUIRED.) WASHER DETAILS ARE SHOWN ON SHEET 5 OF 6.

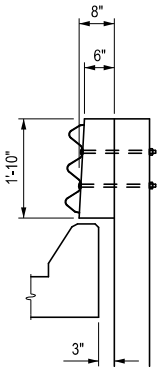


BRIDGE BARRIER
RAILING TYPE 4

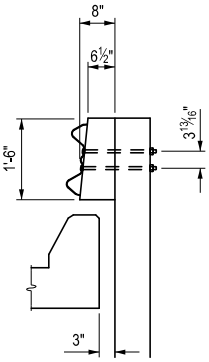


BRIDGE BARRIER
RAILING TYPE 5

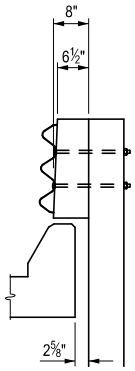
SECTIONS AT BRIDGE RAILINGS



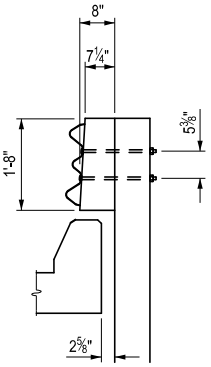
POST 1 FOR
BRIDGE BARRIER
RAILING, TYPE 4



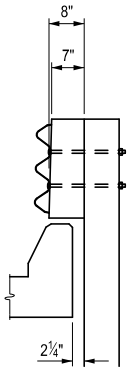
POST 1 FOR
BRIDGE BARRIER
RAILING, TYPE 5



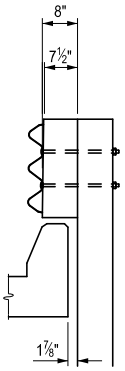
POST 2 FOR
BRIDGE BARRIER
RAILING, TYPE 4



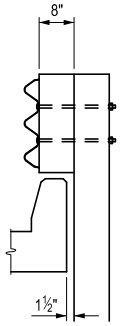
POST 2 FOR
BRIDGE BARRIER
RAILING, TYPE 5



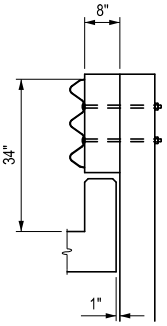
POST 3



POST 4



POST 5



POST 6

BOLT REQUIREMENTS FOR CONNECTING GUARDRAIL TO BRIDGE RAILINGS & FILLER WALLS			
BRIDGE RAILING	BOLT LENGTH	MINIMUM THREAD LENGTH	NUMBER REQUIRED
TYPE 4	12½"	4"	5
TYPE 5	11½"	4"	4
SHORTER BOLT LENGTHS MAY BE USED PROVIDED THE BOLT EXTENDS ¼" BEYOND THE NUT WHEN TIGHTENED.			

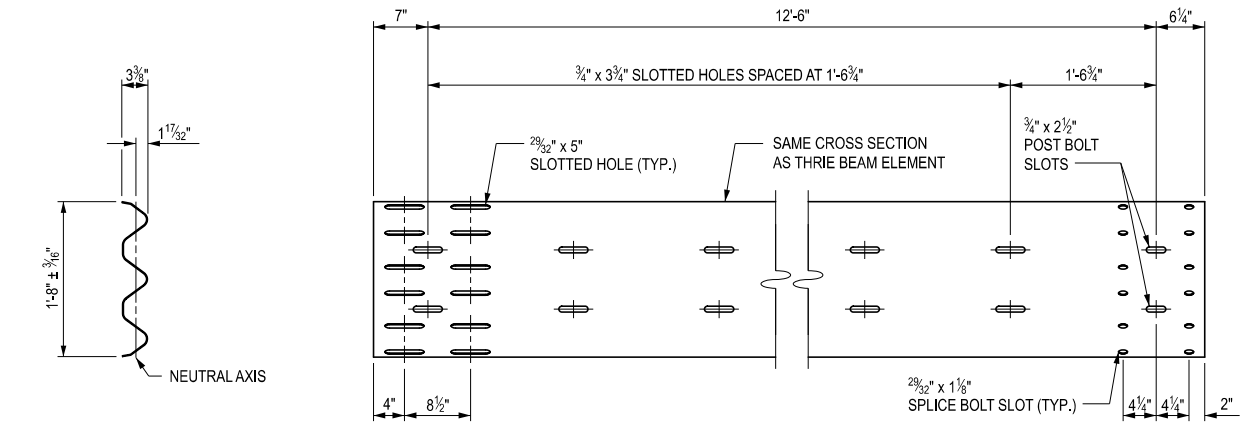
GUARDRAIL POST SECTIONS FOR GUARDRAIL ANCHORAGE, BRIDGE

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

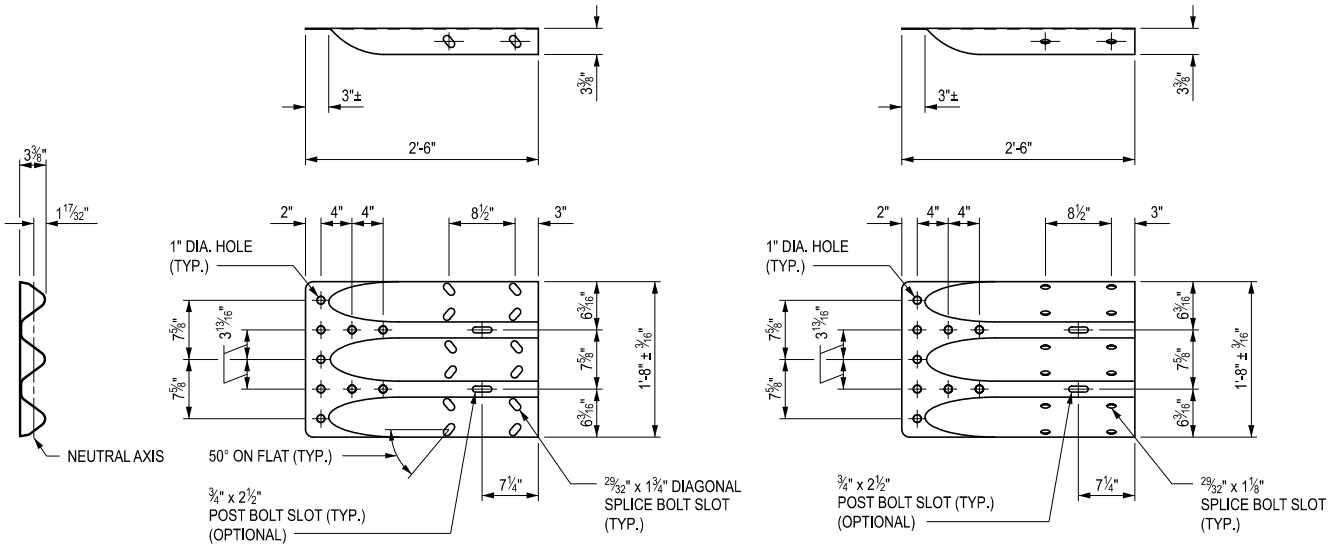
GUARDRAIL ANCHORAGE, BRIDGE, DETAILS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

F.H.W.A. APPROVAL	4-4-2023 PLAN DATE	R-67-SD	SHEET 4 OF 6

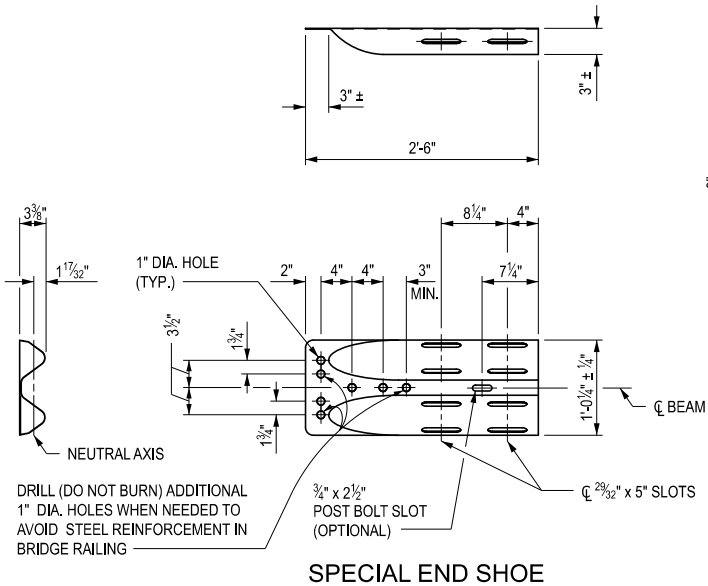


THRIE BEAM EXPANSION SECTION

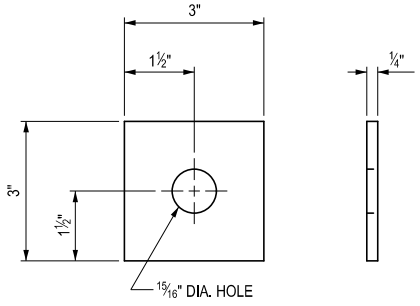


OPTION 1 OPTION 2

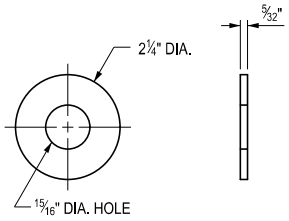
THRIE BEAM TERMINAL CONNECTOR



SPECIAL END SHOE



SQUARE WASHER FOR ⅞" DIA. BOLTS



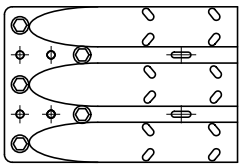
ROUND WASHER FOR ⅞" DIA. BOLTS

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

GUARDRAIL ANCHORAGE, BRIDGE, DETAILS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

F.H.W.A. APPROVAL	4-4-2023 PLAN DATE	R-67-SD	SHEET 5 OF 6



THRIE BEAM TERMINAL CONNECTOR
BOLT LOCATION FOR
GUARDRAIL ANCHORAGE TYPE T1, T2, T5

◎ = REQUIRED BOLT LOCATION TO ANCHOR INTO CONCRETE

NOTES:

ALL POSTS, OFFSET BLOCKS, BEAM ELEMENTS, REFLECTORS, AND HARDWARE, (INCLUDING BOLTS, NUTS, AND WASHERS) SHALL CONFORM TO THE STANDARD SPECIFICATIONS FOR CONSTRUCTION AND TO STANDARD PLAN R-60-SERIES, WHERE APPLICABLE, EXCEPT AS SPECIFIED ON THIS STANDARD.

BEAM ELEMENTS IDENTIFIED AS 12 GAUGE MUST MEET CLASS A REQUIREMENTS PER AASHTO M 180. BEAM ELEMENTS IDENTIFIED AS 10 GAUGE MUST MEET CLASS B REQUIREMENTS PER AASHTO M 180.

ALL POSTS USED TO CONSTRUCT GUARDRAIL ANCHORAGE, BRIDGE, DETAIL T1 THROUGH T5, SHALL BE 7'-0" LONG STEEL POSTS (W6 x 8.5 OR W6 x 9) OR WOOD POSTS (6" x 8").

THE THRIE BEAM TERMINAL CONNECTOR AND SPECIAL END SHOE SHALL BE THE SAME MATERIAL AS ADJACENT RUN OF GUARDRAIL, AND SHALL NOT BE LIGHTER THAN 10 GAUGE (0.138").

SECTIONS OF THE THRIE BEAM ELEMENT REQUIRED TO BE TWISTED FOR USE IN ANCHORAGE SHALL BE FIELD BENT.

GUARDRAIL BEAM ELEMENTS SHALL BE LAPPED IN THE DIRECTION OF TRAFFIC, EXCEPT FOR THE THRIE BEAM TERMINAL CONNECTOR WHICH MAY BE LAPPED IN EITHER DIRECTION.

SPLICE BOLTS SHALL BE USED WHEN SPLICING THE THRIE BEAM TERMINAL CONNECTOR TO THE THRIE BEAM EXPANSION SECTION AND WHEN SPLICING THE SPECIAL END SHOE TO THE TRANSITION SECTION. THE SPLICE BOLT NUT SHALL BE INSTALLED FINGER-TIGHT AND SHALL FULLY ENGAGE THE SPLICE BOLT WITH A MINIMUM OF ONE THREAD EXTENDING BEYOND THE NUT. THIS SHALL BE FOLLOWED UP BY UPSETTING THE FIRST THREAD ON THE OUTSIDE OF THE NUT WITH A CENTER PUNCH OR COLD CHISEL, SO THAT IT WILL NOT LOOSEN.

GUARDRAIL ANCHORAGE, BRIDGE, DETAILS T1, T2, AND T5 REQUIRE THAT THE THRIE BEAM TERMINAL CONNECTOR BE ATTACHED TO THE $^{29}/_{32}$" x 5" LONG SLOTTED HOLES IN THE THRIE BEAM EXPANSION SECTION.

SEE APPROPRIATE PLANS TO DETERMINE WHETHER GUARDRAIL ANCHORAGE, BRIDGE SPANS A BRIDGE EXPANSION JOINT.

SEE STANDARD PLAN R-55-SERIES FOR FILLER WALLS AND FILLER WALL END BLOCK.

SEE STANDARD PLAN R-54-SERIES FOR CONCRETE BARRIER, SINGLE FACE, TYPE __.

CONCRETE BARRIER, SINGLE FACE TRANSITION SECTION SHALL BE INCLUDED IN THE PAY ITEM "CONC BARRIER, SINGLE FACE, TYPE __".

MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF DEVELOPMENT SPECIAL DETAIL FOR

GUARDRAIL ANCHORAGE, BRIDGE, DETAILS

(FOR SAFETY SHAPE BRIDGE BARRIERS & RAILINGS)

F.H.W.A. APPROVAL	4-4-2023 PLAN DATE	R-67-SD	SHEET 6 OF 6

CHAPTER 7 APPURTENANCES INDEX (continued)

CHAPTER 7

APPURTENANCES

7.01

ROADSIDE SAFETY BARRIERS

7.01.01 (revised 4-24-2023)

References

A. ***A Guide to Standardized Highway Barrier Rail Hardware***, AASHTO-AGC-ARTBA Joint Committee, 1995

B. ***Roadside Design Guide,*** AASHTO, 2011, 4th edition

In addition, there are a number of National Cooperative Highway Research Program (NCHRP) research publications and reports of the major research and testing agencies that are available either within the Design Division or in the Transportation Library.

7.01.02 (revised 10-22-99)

Application of Section 7.01

In writing this portion of Chapter 7 it should be noted that the concepts presented will not necessarily be considered as absolutes to be rigidly adhered to, but will be considered as an aid to enhance the engineering judgement of the designer. Even when the word "should" is used, it is recognized that there may be circumstances unique to a situation that will suggest, or even dictate, alteration of a recommended treatment.

It is also intended that the barrier treatments recommended will be applicable to state trunkline projects and not necessarily to local government projects, except as local agencies wish to incorporate them.

7.01.03 (revised 8-21-2017)

History of Guardrail and Barrier in Michigan

The practice of placing an artificial obstruction to prevent an errant vehicle from going down a steep embankment or into an area of water probably originated in the 1920's in the form of a line of posts placed at the edge of the shoulder. At some point in time the system was improved by the addition of connecting planks, which in turn were replaced by a more maintenance-free system of two steel cables. This design is illustrated on the old E-4-A-75 Series of standard plans. Following World War II some metal beam designs were introduced. One that found limited use in Michigan was the Tuthill Highway Guard, a convex smooth steel beam, 12" wide, fastened to spring steel supports, which were mounted on either wood or steel posts. In the early 1950's the concept of a metal beam was further refined with the introduction of the W-beam with the two corrugations that are essentially what we are familiar with today.

7.01.05 (revised 4-24-2023)

Basic Concepts for Roadside Control

The following are basic concepts and design options for the use or non-use of roadside barriers. The primary sources of information for roadside control are found in the AASHTO documents listed in Section 7.01.01, "References".

A. A collision with a roadside barrier is considered a crash, because the barrier itself is a roadside obstacle.

B. A roadside barrier may increase the frequency of crashes, therefore a barrier should only be installed if it will reduce the severity of potential crashes.

C. When considering the design options for roadside treatment and the progression of design options basic concepts for roadside control should be as follows.

1. Remove the obstacle or redesign it so it can be safely traversed.

2. Relocate the obstacle to a point where it is less likely to be struck.

3. Reduce impact severity by using an appropriate breakaway or traversable device.

4. Redirect a vehicle by shielding the obstacle with a longitudinal traffic barrier and/or crash cushion.

5. Delineate the obstacle if the above alternatives are not appropriate.

D. Generally, a roadside barrier should be placed as far from the traveled way as conditions will permit. See Section 7.01.30G.

E. Compared to parallel guardrail installations, flared guardrail installations have the advantage of requiring less guardrail to effectively shield a hazard. However, guardrail installations have minimum grading requirements that must be met, and flared guardrail installations may not be economically feasible if extensive earthwork/slope flattening are required.

7.01.05 (continued)

Therefore, the decision to use a flared or parallel guardrail installation should be made on a case-by-case basis taking site-specific conditions into consideration.

F. To uniformly compute the length of need for roadside barriers, a guardrail worksheet has been developed and should be used on both new and upgrading projects. Computation methods used on this worksheet complies with the guidelines described in the ***Roadside Design Guide***. It still remains important that all designers become familiar with the "Guide" to understand the design process. For determining the length of need when non traversable embankments are the only obstacles of concern, see Section 7.01.30.

The worksheet shall be used by all designers, including consulting firms performing work for the Department, to compute guardrail length of needs.

The designer should fill in all data and compute each individual barrier run. This will assure proper compliance to standards and allow each barrier run calculation to be documented and checked for accuracy.

Construction field offices should be sent the completed worksheets for reference during project construction.

The worksheet does not cover all situations which may occur in the field, although it is expected to cover most installations. Any situation not covered by the worksheet shall be similarly documented, along with a sketch providing the details of the guardrail installation.

7.01.06 (revised 4-24-2023)

Guardrail Worksheet

The guardrail worksheet is shown on the following pages.

GUARDRAIL WORKSHEET

(REV. 04-2023)

FOR APPROACH TERMINALS ON R-61-SERIES AND R-62-SERIES

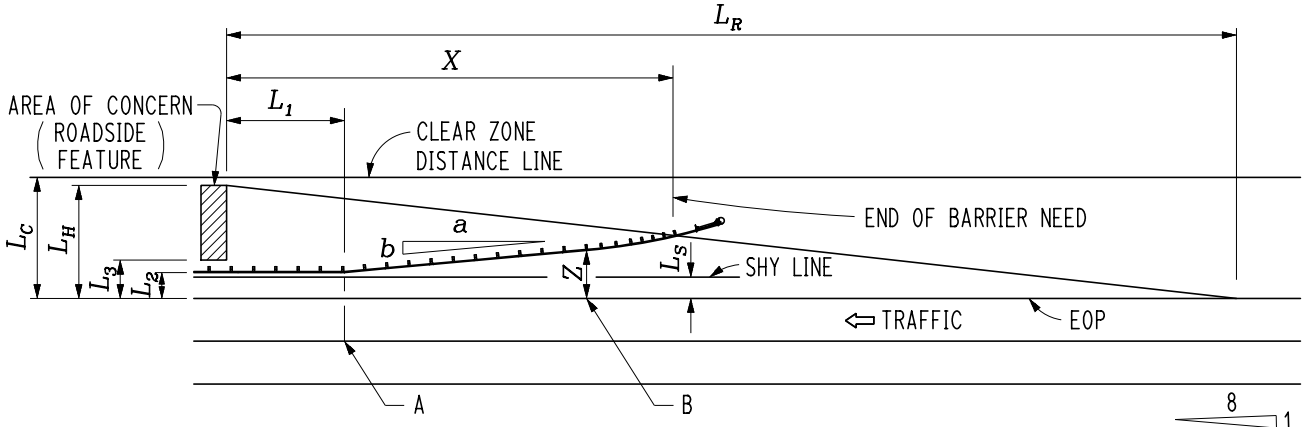
ROUTE _____ CONTROL SECTION _____ JOB # _____

DESIGNED BY _____ DATE _____ CHECKED BY _____ DATE _____

APPROX. STATION OR M.P. _____ DESCRIPTION _____

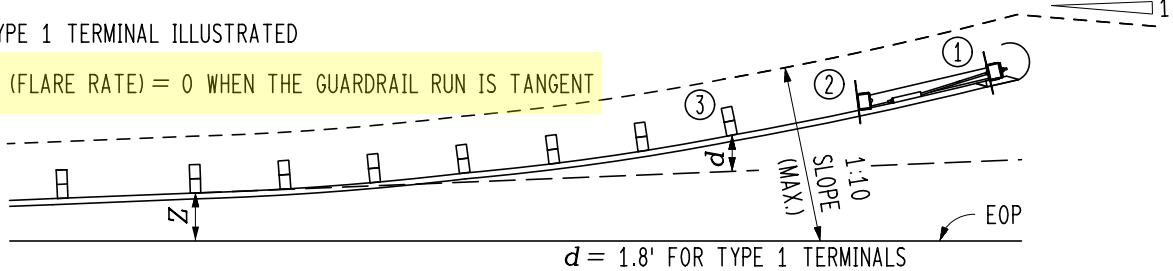
GUARDRAIL RUN # _____

IF STATIONING IS NOT AVAILABLE, LOCATE TO NEAREST FIXED OBJECT



NOTES: TYPE 1 TERMINAL ILLUSTRATED

$\frac{b}{a}$ (FLARE RATE) = 0 WHEN THE GUARDRAIL RUN IS TANGENT



d = 1.8' FOR TYPE 1 TERMINALS
d = 0 FOR TYPE 2 AND 3 TERMINALS

$$X = \frac{L_H + \left(\frac{b}{a}\right)(L_1) - (L_2 + d)}{\frac{b}{a} + \frac{L_H}{L_R}}$$

$$Z = L_2 + \left(|S_B - S_A|\right)\left(\frac{b}{a}\right)$$

LENGTH OF NEED ..... X = _____

RUNOUT LENGTH (7.01.19) ..... L_R = _____

GUARDRAIL TAPER RATE (7.01.29A) ..... $\frac{b}{a}$ = _____

E.O.P. TO FACE OF BARRIER (DESIGNED) ..... L_2 = _____

CLEAR ZONE (7.01.11) ..... L_C = _____

E.O.P. TO ROADSIDE FEATURE (MEASURED) ..... L_3 = _____

EFFECTIVE TURNED OUT DISTANCE OF ANCHORAGE ... d = _____

LATERAL EXTENT OF ROADSIDE FEATURE (MEASURED) .. L_H = _____

LATERAL OFFSET AT END OF FLARE ..... Z = _____

NOTE: DISTANCE OF OBJECT FROM BACK OF BARRIER MUST BE GREATER THAN THE MAXIMUM DEFLECTION (7.01.20)

$L_H \leq L_C$

REFER TO STANDARD PLAN R-59-SERIES AND DESIGN MANUAL SECTION 7.01.30 FOR GUARDRAIL AT EMBANKMENTS

DESIGN ADT _____

DESIGN SPEED _____

APPROACH SLOPE _____

L_1 = _____ (RECOMMENDED MINIMUM DISTANCE: 25' OR LENGTH OF GUARDRAIL BRIDGE ANCHORAGE MEASURED FROM BRIDGE RAIL ENDING, WHICHEVER IS GREATER)

L_S = _____ SHY LINE (7.01.18)

STATION AT A (S_A) _____

STATION AT B (S_B) _____

(REV. 04-2023)

PROPOSED TREATMENT

CALCULATIONS OR NOTES

PAY ITEMS

_____	Ft	* Guardrail, Type _____ , _____ inch Post
_____	Ea	Guardrail Anch, Bridge, Det _____
_____	Ft	Bridge Railing, Thrie Beam Retrofit
_____	Ea	Guardrail Approach Terminal, Type _____
_____	Ea	Guardrail Departing Terminal, Type _____
_____	Ea	Guardrail Reflector
_____	Cyd	Embankment, LM

* FOR THIS PAY ITEM, THE GUARDRAIL APPROACH TERMINAL, TYPE ____ PORTION OF LENGTH OF NEED (X) MUST BE DEDUCTED

DEDUCTION TABLE						
GUARDRAIL APPROACH TERMINAL TYPE						
1B	1T	2B	2T	2M	3B	3T
25'	31.25'	37.5'	43.75'	34.3'	12.5'	31.25'

PAY LENGTHS MUST BE DIVISIBLE BY 12.5'. ROUND TO NEXT HIGHEST RAIL LENGTH, EXCEPT WHEN TYPE MGS-8 OR TYPE MGS-8D GUARDRAIL IS ATTACHED TO A GUARDRAIL FEATURE REQUIRING A HEIGHT TRANSITION (e.g., GUARDRAIL APPROACH TERMINAL TYPES 1B, 2B, OR 3B; A T-SERIES GUARDRAIL BRIDGE ANCHORAGE; etc.)

7.01.10 (revised 10-21-2013)

Clear Zone – History

For a number of years road designers and safety authorities considered 30' a desirable requirement for a safe roadside free of obstacles. This was based upon a study by General Motors in the early 1960's which revealed that of 211 cases at the proving grounds involving vehicles leaving the road, 80% did not travel more than 29' from the edge of pavement. The 1967 “Yellow Book” (***Highway Design and Operational Practices Related to Highway Safety***, AASHTO), page 20, rounded this distance off to 30'. The 2nd edition of the “Yellow Book”, published in 1974, reiterated the 30' distance, but called for an application of engineering judgement by emphasizing that the "30' distance is not a “magic number" (page 38). The 1977 Barrier Guide defined clear zone, in the glossary on page iv, as "That roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. Establishment of a minimum width clear zone implies that rigid objects and certain other features with clearances less than the minimum width should be removed, relocated to an inaccessible position outside the minimum clear zone, or remodeled to make safely traversable, breakaway, or shielded."

The 1977 Barrier Guide introduced the concept that rate of sideslope, speed of traffic, horizontal curvature, and ADT would affect the width of clear zone. The 30' width was retained for 60 mph speed in combination with flat side slopes, tangent roadway alignment, and ADT exceeding 6,000. However, a graph on page 16 adjusts this basic 30' for traffic speed and rate of sideslope. These adjustments are both up or down (wider or narrower) for either descending or ascending slope. A formula on page 17 further adjusts the clear zone for horizontal curvature. Finally, a procedure shown on pages 60-65 adjusts the clear zone downward (narrower) for ADT's below 6,000. The Supplement to the 1977 Barrier Guide expanded on the clear

7.01.10 (continued)

zone criteria that begins on page 15 of the Barrier Guide by including a series of tables prepared by the state of Illinois that show clear zone requirements for various degrees of curve. These criteria have been criticized by a number of states because of the extreme clear zone widths, particularly for the combination of sharp curve, higher speed, high traffic volume and steep slope.

In anticipation of a proposed revision of the 1977 Barrier Guide, FHWA in April 1986 afforded the states a measure of relief with respect to clear zone requirements. It provided a formula for a curve correction factor that is based upon increasing the value for clear zone for a tangent section, obtained from the Barrier Guide. This new formula is more reasonable than the formula on page 17 of the Barrier Guide. It was adopted by the Department in July 1986. In 1989 the ***Roadside Design Guide*** was issued by AASHTO and adopted by MDOT as a guide. Updates to the ***Roadside Design Guide*** were published in 1996, 2002, 2006 and 2011.

7.01.11 (revised 4-24-2023)

Current Clear Zone Criteria

Virtually everyone agrees that a flat, smooth, unobstructed area adjacent to the driving lanes is highly desirable and significantly improves roadside safety. The only point of contention is how wide to make this area. The designer needs to understand that the clear zone distance is not an absolute number. Some designers have erroneously believed, that in all cases, the need for protecting motorists ends at the selected clear zone distance.

7.01.11 (continued)

Current Clear Zone Criteria

The Department measures the clear zone from the outer edge of the through lane. When determining clear zones in auxiliary lane areas, use the volume of the through lanes and the freeway design speed to obtain the clear zone distance. The resulting clear zone distance should be measured from the outer edge of the through lane and is not to be less than 23 ft out from the outer edge of the auxiliary lane.

The ***Roadside Design Guide*** defines the clear zone as a variable distance from the traveled way, depending on design speed, ADT, and embankment slope rate and direction.

The Clear Zone Distances Table presents a range of values that can be used for specific conditions. These numbers are based on limited data that was gathered under non-typical conditions and extrapolated to account for sloped roadsides. Also the values obtained from the Clear Zone Distances Table are based on an assumption of constant side slope throughout the clear zone. They must not be perceived as absolute. In situations where the side slope changes within the calculated clear zone, the clear zone may be recalculated based upon a weighted average calculation. An example of this procedure is shown in Section 13.02.08 of this manual.

However, there is no single method for establishing the clear zone, since site conditions must be considered when determining the clear zone at each location. Engineering judgment may need to be exercised when determining the clear zone. Contact the Geometric Design Unit - Design Division if there are any questions pertaining to determining clear zone values.

Application of the values in the Clear Zone Distances Table is dependent on the extent of work and the roadway classification. The higher values should be used on new construction, reconstruction and on all freeways.

7.01.11 (continued)

When evaluating existing conditions and when designing rehabilitation projects, we should attempt to use the higher values; however, economics, existing field conditions, and other restraints may justify using the lower values.

Clear zone for 3R-nonfreeway projects must be selective and generally "fit" conditions within the existing right-of-way and character of the road. Some roadside improvements that should be considered may include removal, relocation, or shielding of such obstacles as culvert headwalls, utility poles, and bridge supports that are within the selective clear zone.

The designer should also be aware that current clear zone distances and 3R guidelines serve as general guidance for Heritage Routes (See Section 3.09). Narrow pavement, narrow shoulders, winding and/or rolling alinement, steep side slopes, roadside obstacles and narrow right-of-way are common characteristics of Heritage Routes that sometimes prevent the use of even the lower range of the Clear Zone table. Where economic or environmental concerns are great, and there is no history of crash concentration, shorter clear zone distances may be considered to preserve the characteristics of the Heritage Route. Some areas of concern may be addressed with appropriate traffic signing. When distances below the ranges offered in the Clear Zone Distances Table are used, the rationale for the alternative treatment should be noted in the project file.

Tree removal should be considered as stated in Section 3.09.03C. Some alternatives are also offered in the next two sections (7.01.11A and 7.01.11B).

7.01.11 (continued)

Current Clear Zone Criteria

D. Curve Correction Factors Table

The Curve Correction Factors Table shown below shall be applied to horizontal curves with radii less than or equal to 2950 ft. The curve correction factor (Kcz) shall be applied to the outside of curve only. The inside portion of the curve will be treated as a tangent section.

CURVE CORRECTION FACTORS (Kcz) CZ corr = Kcz *x* CZ

Radius (ft)	DESIGN SPEED (mph)						
	40	45	50	55	60	65	70
2950	1.1	1.1	1.1	1.2	1.2	1.2	1.2
2300	1.1	1.1	1.2	1.2	1.2	1.2	1.3
1970	1.1	1.2	1.2	1.2	1.3	1.3	1.4
1640	1.1	1.2	1.2	1.3	1.3	1.3	1.4
1475	1.2	1.2	1.3	1.3	1.4	1.4	1.5
1315	1.2	1.2	1.3	1.3	1.4	1.4	
1150	1.2	1.2	1.3	1.4	1.5	1.5	
985	1.2	1.3	1.4	1.5	1.5	1.5	
820	1.3	1.3	1.4	1.5			
660	1.3	1.4	1.5				
495	1.4	1.5					
330	1.5						

7.01.11 (continued)

E. Other Controlling Factors

For free access highways, the clear zone should ideally be the same as for controlled access highways, but often this is impossible as it would require complete reconstruction of the highway, and destruction of the existing roadside features. Clear zone may often be restricted by drives, intersections, ditches, narrow R.O.W., and other features. While it may be argued that the dynamics of a vehicle running off the road are no different on a free access road than they are on a limited access facility, it remains as a fact of life that there will always be obstacles of some description on free access roads - mailboxes, driveway embankments, trees, buildings, etc. Enormous numbers of these obstacles occur on the trunkline system.

7.01.11 (continued)

Continued efforts should be made to reduce these obstacles as finances permit, even though some cannot be removed without great difficulty, because of socio-environmental considerations, e.g., mature shade trees in a west-facing front yard. However safety considerations should overrule, and if need be, even these mature shade trees may have to be removed.

The designer should note that the presence of an up-slope significantly reduces the clear zone width required. It is therefore seldom necessary to remove a tree or to shield an obstacle that is located at the top of a cut-slope if the elevation of the top of slope is approximately 5'-0" to 6'-0" higher than the edge of pavement. These situations should always be checked, however.

7.01.12 (continued)

Types of Guardrail used in Michigan

G. Type MGS-8D
(Standard Plan R-60-Series)

Description: Type MGS-8 with W-beam guardrail and 8" offset blocks on both sides of the post.

Current Use:

1. In all roadway medians, freeway and free access, when median guardrail is recommended and a MASH-compliant guardrail system is desired. On projects let after December 31, 2017, Type MGS guardrail systems will be required for new guardrail installations on all freeways (including ramps) and free access roadways.

H. Cable Barrier (See Section 7.01.55C)

Description: Three or four steel cables mounted on steel posts, anchored and tensioned.

Current Use:

1. Medians where crash history indicates cross median crashes and rigid barrier is not warranted.

2. Special situations where up to 90 degree impacts can be expected and larger deflections can be tolerated.

7.01.13 (revised 4-24-2023)

Curved Beam Elements

Curved steel beam elements having a radius of 150' or less must be shop bent. W-beam and thrie-beam guardrail can be shop bent. However, thrie-beam transition panels, both symmetrical and asymmetrical, cannot be shop bent. Shop bent guardrail beam elements can be curved concave (inward) or convex (outward) as required. The radius for curved guardrail beam elements should be reported in increments of 5 feet. The smallest radius for curved guardrail is 5 feet, although guardrail with very small radii should only be used when necessary. Designers should try to be as accurate as possible when specifying a radius for curved rail, as it is time consuming and expensive returning elements to the shop for re-bending. When shop bent rail will be required, the following note should be included on the plans: "Shop bent curved guardrail elements shall not be ordered until the radius has been field verified by the Engineer."

7.01.16 (revised 4-24-2023)

Guardrail Attachment to Bridges and Walls

The following guardrail anchorage details are in current use for new construction and where specified for upgrading and are detailed on Standard Plans R-67-Series, B-22-Series, B-23-Series:

A. Guardrail Anchorage, Bridge, Details M1 & M4 (See Standard Plan R-67-Series)

Current Use:
When connecting Guardrail, Type MGS-8 to Bridge Railing, 2-Tube, 4-Tube, Aesthetic Parapet Tube, 3 Tube with Pickets, Concrete Block Retrofit, Type 6, Type 7, or Single Face Concrete Barrier without expansion at backwall (M1) or with expansion at backwall (M4).

B. Guardrail Anchorage, Bridge, Details M2 & M5 (See Standard Plan R-67-Series)

Current Use:
When connecting Guardrail, Type T to Bridge Railing, 2-Tube, 4-Tube, Aesthetic Parapet Tube, 3 Tube with Pickets, Concrete Block Retrofit, Type 6, Type 7, or Single Face Concrete Barrier without expansion at backwall (M2) or with expansion at backwall (M5).

C. Guardrail Anchorage, Bridge, Details M3 & M6 (See Standard Plan R-67-Series)

Current Use:
When connecting Guardrail, Type B to Bridge Railing, 2-Tube, 4-Tube, Aesthetic Parapet Tube, 3 Tube with Pickets, Concrete Block Retrofit, Type 6, Type 7, or Single Face Concrete Barrier without expansion at backwall (M3) or with expansion at backwall (M6).

7.01.16 (continued)

D. Guardrail Anchorage, Bridge, Details M7, M8 & M9 (See Standard Plan R-67-Series)

Current Use:
When connecting Guardrail, Type MGS-8 (M7), Type T (M8) or Type B (M9) to Filler Wall.

E. Guardrail Anchorage, Bridge, Detail A3 (See Standard Plans B-22-Series and B-23-Series)

Current Use:
When connecting Guardrail, Type MGS-8 to Bridge Railing, Thrie Beam Retrofit.

F. Guardrail Anchorage, Bridge, Detail A4 (See Standard Plans B-22-Series and B-23-Series)

Current Use:
When connecting Guardrail, Type T to Bridge Railing, Thrie Beam Retrofit.

G. Guardrail Anchorage, Bridge, Detail A5 (See Standard Plans B-22-Series and B-23-Series)

Current Use:
When connecting Guardrail, Type B to Bridge Railing, Thrie Beam Retrofit.

H. Need for Additional Expansion

The Guardrail Anchorage, Bridge details on Standard Plan R-67-Series will accommodate thermal deck movement up to about 4". If the expected thermal deck movement will exceed 4", the Road designer should consult with the Bridge designer to decide the method for providing the additional expansion required in the guardrail.

7.01.16 (continued)

Guardrail Attachment to Bridges and Walls

I. Curved Guardrail Bridge Anchorages

While not desirable, in some cases it may be necessary to curve a guardrail bridge anchorage. This is commonly the case when there is an intersecting driveway or street located near a bridge, and the intersecting driveway or street cannot be closed or relocated. It is acceptable to curve only a portion of the guardrail anchorage.

If guardrail panels must be curved to a radius of 150' or less, use the Guardrail Anch Bridge, Det __, Curved pay item. Also, note that thrie-beam transition panels, both symmetrical and asymmetrical, cannot be shop bent. So designers need to select guardrail anchorage details that do not have thrie-beam transition panels within the curved section when dealing with radii of 150 feet or less.

7.01.17 (revised 4-24-2023)

Strength Requirements of Steel Beam Guardrail

The Standard Specifications reference material requirements for steel beam guardrail and associated hardware to AASHTO Specification M 180, which requires 70,000 psi tensile strength in the base metal.

Crash testing of roadside safety devices, such as guardrail and other barriers, is standardized according to procedures outlined in *National Cooperative Highway Research Program Report 350* (NCHRP 350) and the *Manual for Assessing Safety Hardware* (MASH), respectively.

MASH contains the current guidelines for testing and evaluating roadside safety devices, thereby superseding NCHRP 350. As of January 1, 2011, newly tested or modified roadside safety devices must be evaluated using MASH criteria.

7.01.17 (continued)

There are up to six test levels in NCHRP 350 and MASH, respectively, depending on the feature being evaluated. All six test levels apply to longitudinal barriers. Test levels 2 and 3 apply to breakaway features and test levels 1, 2, and 3 apply to crash cushions and end treatments.

Fundamentally, guardrail is intended to redirect the impacting vehicle, not stop it. Energy absorption and vehicle deceleration are the functions of an impact attenuator (or a Type 2 terminal, under certain conditions). For this reason, 25 degrees is the maximum angle used in testing for guardrail strength.

The designer will occasionally encounter situations where a broad area must be shielded. These may be areas wide enough to allow a vehicle to exceed 25 degrees in approach angle and too wide to make an impact attenuator feasible. These situations must be studied. The solution will usually involve guardrail placed in a curving configuration or the use of cable barrier if there is room for the deflection that is characteristic of a cable barrier.

NCHRP 350 Test Level	Vehicle	Impact Conditions	
		Nominal Speed (km/h)	Nominal Angle (deg)
1	2000P (2000 kg pick up truck)	50	25
2	2000P (2000 kg pick up truck)	70	25
3	2000P (2000 kg pick up truck)	100	25
4	8000S (8000 kg single unit truck)	80	15
5	3600V (3600 kg tractor van trailer)	80	15
6	3600T (3600 kg tractor tanker-type trailer)	80	15

7.01.19 (revised 6-28-2021)

Suggested Runout Lengths for Barrier Design

Runout length is the distance from the object being shielded to the point the vehicle is assumed to depart from the roadway. Interpolation between runout length values is recommended when dealing with intermediate design speeds.

	Traffic Volume (ADT) veh/day			
	Over 10,000	**Over 5,000-10,000**	**1000-5000**	**Under 1000**
Design Speed (mph)	**Runout Length L_R (ft)**	**Runout Length L_R (ft)**	**Runout Length L_R (ft)**	**Runout Length L_R (ft)**
80	470	430	380	330
70	360	330	290	250
60	300	250	210	200
50	230	190	160	150
40	160	130	110	100
30	110	90	80	70

7.01.20 (revised 4-24-2023)

Guardrail Deflection

Both steel beam guardrail and cable barriers are expected to deflect under impact. This deflection is a result of deformation of the beam element or stretching of the steel cable, fracturing of the post (if wood) or bending of the post (if steel), and lateral displacement of the post in the soil. It is therefore necessary that room for deflection be provided between the back of the rail system (e.g. back of posts) and the object or area being shielded. For design purposes, use the chart at the end of this section for the recommended minimum design offset distances of the various guardrail systems. Refer to Section 7.01.55C, "Cable Barrier", for expected deflections and offset recommends of cable barrier systems.

7.01.20 (continued)

It should be noted that the recommended offset distances should not be treated as absolute values, since guardrail deflection may vary for different impact conditions, soil types and moisture contents, thawed or frozen ground, different types of posts, different types of anchorages, and differing lengths of installation. Therefore, the recommended offset distances should be treated as minimums, and larger offset distances between the back of the rail system (e.g., back of posts) and the object or area being shielded should be provided where feasible. In general and, where feasible, the offset should be increased by 12 inches or more beyond the recommended minimum value. If specific site conditions are such that it is predictable that greater deflection values may occur, and space for deflection is restricted, then shorter post spacing should be considered. Shorter post spacing is only effective, however, if the full effect of proper post embedment is realized. See Section 7.01.41D, "Guardrail Posts at or near the Shoulder Hinge Line". See also Section 5.5.2, 2011 AASHTO Roadside Design Guide.

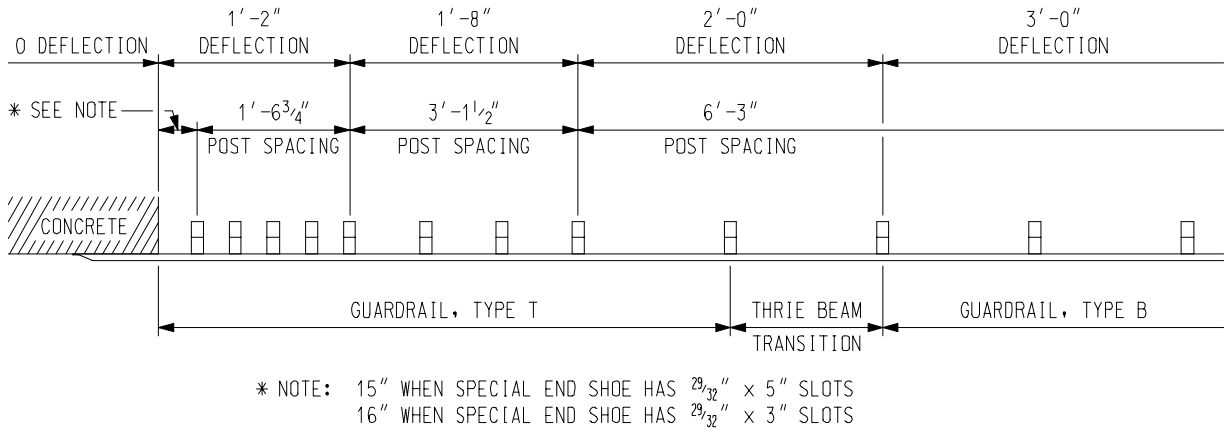
7.01.21 (revised 10-21-2013)

Guardrail Strength Transitions

Sudden and significant changes in lateral stiffness of a barrier system may cause an impacting vehicle to pocket, if it proceeds from a weaker system to a stronger system. A gradual modification of the deflection characteristics of the barrier is therefore needed. This may be achieved by closer post spacing, heavier barrier elements, larger posts or a combination of these. Illustrated below is

7.01.21 (continued)

a typical transition from Guardrail, Type B to a concrete barrier, filler wall, or barrier railing. The 2011 AASHTO, ***Roadside Design Guide*** (page 7-15) advocates that the transition length between joining barrier types should be approximately 10 to 12 times the difference in dynamic deflection. For a difference in deflection of 12", the transition stiffening length should occur in one effective beam element length or 12'-6". See Section 7.01.20 for dynamic deflections.



7.01.22 (10-22-99)

Minimum Guardrail Lengths and Gaps

A free-standing section of guardrail (one not attached to a bridge or other structure) should be at least 100' in length. Greater lengths are recommended; lesser lengths maybe acceptable under low speed conditions. A gap of less than approximately 200' between barrier installations should be avoided. Usually this will require filling in the gap with connecting barrier. An exception would be the unique situation where an approach and trailing ending, separated by a gap, can be buried in a cut slope, and the consequences of a vehicle encroaching on the cut slope would be less than hitting the guardrail filling the gap.

7.01.23 (revised 4-24-2023)

Function of Guardrail Components

It is essential that the designer understand the function of the various components of a guardrail system and some of the principles underlying barrier design details.

Beam height – The top of rail height is essential for proper barrier performance (28" for Type B, 31" for Type MGS-8, and 34" for Type T).

7.01.23 (continued)

Function of Guardrail Components

Offset block - Serves two principal purposes, 1) locates beam farther from the post to minimize the possibility of wheel snagging on the post and pocketing in the guardrail, and 2) maintains top of rail height momentarily longer as the post rotates backward under impact, reducing the probability of the vehicle vaulting over the rail. (See page 5-16, 2011 AASHTO, ***Roadside Design Guide***)

Round washer - Provides an even bearing surface around holes that are often field-drilled and rough.

Post bolt washer - Used in earlier guardrail systems to prevent the head of the post bolt from pulling through the beam element. However, it was later determined that allowing the post bolt head to pull through the beam element during a crash was better from a guardrail performance standpoint. Therefore, all current guardrail types used by MDOT do not call for the use of post bolt washers. Washers are now recommended only on the end post of the SRT, or on the end post in a Departing End Terminal.

Rail splice - Splices, of course, are unavoidable. They should be at least as strong as the rail itself; all eight connection bolts (twelve in thrie beam) are needed to distribute the load throughout the rail section. Lapped splices are usually such that the outer rail overlaps in the downstream direction, to reduce the potential of vehicle snagging.

7.01.24

Accommodation of Expansion

Provision must be made for the movement of guardrail beam elements caused by thermal expansion and contraction. The movement in rail elements is accomplished by means of oblong slots at the splices. Additional expansion at structures is obtained by means of longer slots in the Special End Shoes and Thrie Beam Expansion Section illustrated on Standard Plan R-67-Series (see Section 7.01.16I).

7.01.25 (revised 4-24-2023)

Guardrail Approach Terminals

Crashworthy end treatments are critical to guardrail installations. An approach terminal is designed to redirect an impacting vehicle and to reduce the occurrences of a vehicle being penetrated, rolled, or vaulted in an end on hit. The following section describes the characteristics and uses of approved standard treatments.

A. Type 1 Terminals

Type 1 guardrail approach terminals are flared gating terminals used only in special cases at locations where a Type 2M guardrail approach is not feasible, and a Type 1 guardrail approach terminal is necessary. This is the design formerly preferred when grading limits allow for the appropriate 4'-0" offset of the terminal end from the tangent extension of the standard line of guardrail run. When the Type 1 terminal is called for on the plans by special detail, the contractor may use one of the approved terminal options. The special detail is available by request from the Design Standards Unit.

Consult with the Geometrics Design Unit, Design Division, when considering use of a Type 1 guardrail approach terminal.

7.01.25 (continued)

B. Type 2 Terminals

Type 2 terminals are tangent, energy absorbing terminals which require less grading than the Type 1 terminals. There is currently only one subcategory under the Type 2 terminal category; Type 2M.

1. Type 2M Terminals

Type 2M terminals are MASH-compliant tangent guardrail approach terminals. They are specified in Standard Plan R-62-Series and by special provision. Type 2M terminals are required for new installations and when updating guardrail approach terminals, except in special cases. These terminals are intended to be attached directly to Type MGS-8 guardrail. Therefore, designers will need to include an appropriate transition section for connecting a Type 2M guardrail terminal to either Type B or Type T guardrail (refer to Standard Plan R-60-Series). Current Type 2M terminals available for use are the MSKT, the Soft-Stop, and the MAX-Tension. Refer to Standard Plan R-62-Series for the overall length, recommended offset, and grading requirements of each terminal.

Contact the Geometrics Design Unit, Design Division, for additional information regarding MASH-compliant guardrail terminals.

2. Minimum Offset

The original intent of the Type 2 terminals was to provide endings that required no offset. This was the orientation used in the crash tested system. However, all three approved Type 2M approach terminals (MSKT, Soft-Stop, and Max-Tension) may be installed with an offset between 0 and 2 feet. A 1’-0” offset was adopted in Standard Plan R-62-Series in order to minimize the number of nuisance accidents that may occur when the impact head was located close to or encroaching on the shoulder.

7.01.25 (continued)

Guardrail Approach Terminals

C. Function of the Various Guardrail Terminal Components

It is important that designers, as well as construction and maintenance personnel, understand the function of the components that make up guardrail terminals.

Please note that guardrail terminals are comprised of a wide variety of different components, and each guardrail terminal has its own set of unique parts and assembly requirements. Therefore, the following is not intended to be a comprehensive list of all guardrail terminal components. Contact the Geometric Design Unit - Design Division if there are any questions related to guardrail terminal components and their function.

Bearing plate - Distributes the forces in the cable to the post.

Terminal End Shoe - This feature absorbs some of the impact forces, spreading them over a wider area, to reduce the potential for the end of the beam element to penetrate the vehicle passenger compartment. This feature is found on guardrail departing terminals and certain guardrail approach terminals, such as the SRT and BCT.

Impact head - The impact head, like a terminal end shoe, helps spread the forces over a wider area. Some impact heads are designed to extrude or compress the guardrail as the head gets pushed along the guardrail by an impacting vehicle, thereby absorbing energy from the impact. With some terminals, the rail element passes through the impact head and is extruded away from the impacting vehicle.

The physics and overall function of each terminal, including the function of the impact head, varies by terminal brand.

7.01.25 (continued)

Cable Assembly - For downstream impacts, transfers tensile forces from the beam to the base of the end post, allowing the full redirective strength of the rail system to be developed at the third post. For ending impacts the cable is released and serves no purpose. However, not all terminals utilize cable assemblies. For example, the Soft-Stop does not require a cable assembly, since the guardrail end is bolted to a post in a manner allowing all tensile forces in the guardrail to be transferred to the post.

Channel or Angle Strut - This strut and yoke distributes the load from the tensioned cable between the first and second post. The strut also contributes to the collapse of the second post during an end on impact. Please note, not all terminals utilize a channel or angle strut.

Controlled release terminal (CRT) post - CRT posts are 6" x 8" wood posts with two 3½" diameter holes drilled through the post. One hole is placed at the ground line and the other 1'-4" below the ground, to facilitate fracture of the post during end-on impacts.

Holes in the two end posts - These holes are used to weaken the end posts and to allow them to break off close to the ground, when the guardrail ending is struck by an end impacting vehicle. The guardrail ending will likely collapse, thereby reducing spearing and vaulting. The holes have no function for downstream impacts.

Pipe Insert - No function for ending impacts. For downstream impacts, distributes vertical component of forces in the cable to the post.

7.01.25 (continued)

Guardrail Approach Terminals

***Slotted Rail Element (SRT)* -** The first two panels of rail in the SRT are slotted to provide controlled dynamic buckling. Rail buckling in the SRT is controlled by the length and location of the slots. The controlled buckling of the rail element reduces the potential for the rail to directly impact or penetrate the vehicle occupant compartment.

***Slot guard (SRT)* -** Slot guards are installed on the SRT at the downstream end of each set of rail slots. It prevents the bumper or other parts of the impacting vehicle from intruding into and extending the slots.

***Soil plate* -** Inhibits movement of the post in the soil; aids in keeping the post from pulling out of the ground.

***Steel sleeves* -** For ending impacts, reduces tendency for the post to rotate in the soil; aids in resisting movement so the post will break off at the weakening hole. For downstream impacts, distributes loads from the post to the soil.

D. Guardrail Full Strength Point

When a standard guardrail terminal is used, the length of need is calculated to a point where the guardrail run develops the full strength of the system. This is typically known as the beginning length of need (BLON) point. It should be stressed that most guardrail approach terminals are gating terminals, meaning the BLON point is located beyond the nose of the terminal. Designers need to take this into consideration when performing length of need calculations. The deduction values in the MDOT guardrail worksheet have taken the BLON points into consideration.

7.01.25 (continued)

E. Clear Area Behind Guardrail Terminals

When determining the length of need of a guardrail run, the designer should verify that there will be no obstacle behind or to the behind side of a guardrail terminal that would prevent gating.

The area behind should be traversable for the vehicle after it passes through the terminal. The minimum recovery area behind and beyond a terminal should be an obstacle free area approximately 75' long and 20' wide. If it appears that the area behind will not be traversable, then the guardrail run will probably have to be extended to a point where the area behind the terminal is clear.

F. Burying Ending in a Backslope

Occasionally high cut slopes adjacent to the traveled roadway do not provide sufficient clear area behind the terminal to allow gating, or adequate site conditions may exist making a buried-in-backslope terminal desirable.

In these cases, the designer should consider terminating the guardrail inside the backslope. The designer or project manager can obtain a special detail for this treatment from the Design Standards Unit.

G. Slope Under Guardrail Terminals

The area under the terminal should be graded to a 1:10 slope or flatter from the edge of the traveled lane and extend at least 2'-0" behind the back of posts. In addition, the terminal details include required grading in advance of the terminal approach. The designer should consider these required limits when estimating grading and earthwork quantities. See the appropriate guardrail approach terminal Standard Plans for grading details.

7.01.29 (revised 4-24-2023)

Guardrail Flare

When designing guardrail, the designer should take advantage of opportunities to flare the installation. This reduces the required length of need. It also places the guardrail terminal farther from the traveled lane, thus reducing the potential for nuisance hits.

A. Flare Rate

The maximum recommended flare rate is dependent on barrier type and design speed. Maximum flare rates are provided to minimize impact severity, since a barrier flared toward traffic in the downstream direction will result in a larger impact angle between the impacting vehicle and the barrier, and this will increase the impact severity. Consequently, the maximum flare rates for rigid barriers, such as concrete barriers, are typically less than those for semi-rigid barriers, such as guardrail.

The specified flare rates are maximums, and shallower (flatter) flare rates may be used.

Larger flare rates may be considered in certain cases, such as barrier sections flared away from traffic in the downstream direction, where the resulting angle between an impact vehicle and the barrier would be less than expected compared to a non-flared barrier installation.

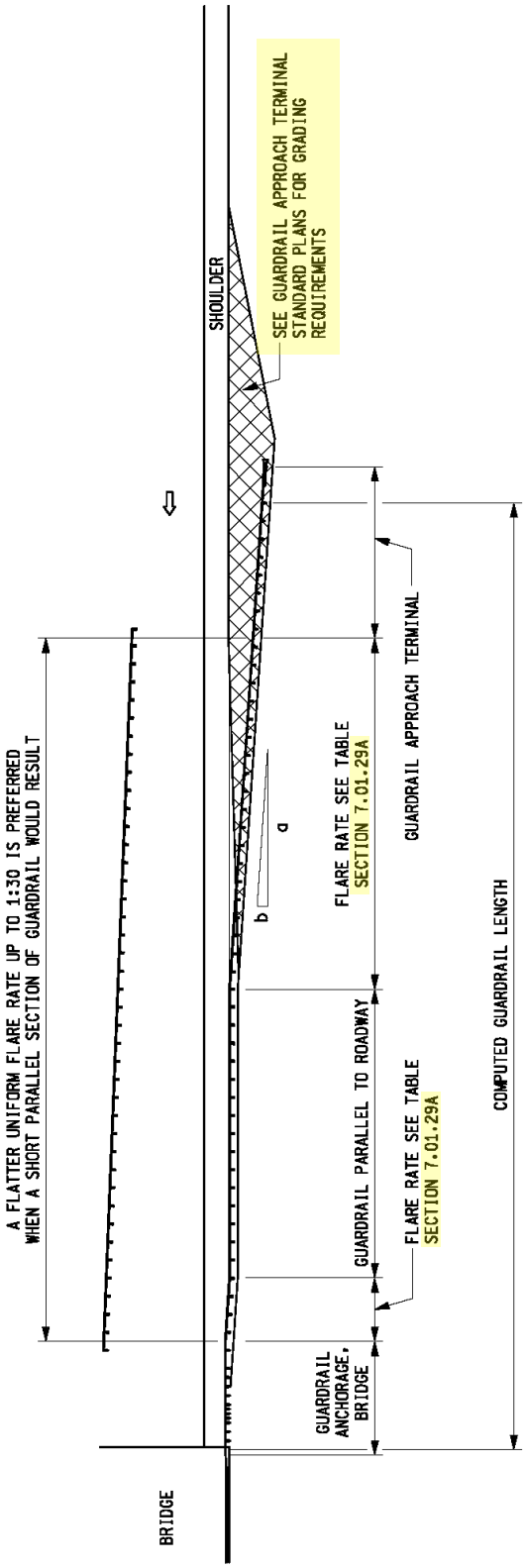
Design Speed (mph)	Flare Rate (b/a) for	
	Concrete Barriers	Guardrail
70	1:20	1:15
60	1:18	1:14
55	1:16	1:12
50	1:14	1:11
45	1:12	1:10
40	1:10	1:8
30	1:8	1:7

7.01.29 (continued)

Guardrail Flare

B. Uniform Flare from Structures

Guardrail may need to be flared inward to meet the bridge barrier railing of bridges with narrow shoulders. When the guardrail length at a structure is increased, such as for an embankment, a uniform guardrail flare rate (not flatter than 1:30) may be substituted for the combined short parallel section and the two flared sections. The Illustration at right shows this situation on a left approach rail. When the shielded area in advance of the bridge rail is a steep embankment, the length of need is determined as outlined in Section 7.01.30E. A uniform flare can then be constructed between the guardrail anchorage and the guardrail approach terminal.



7.01.30 (revised 4-24-2023)

Guardrail at Embankments

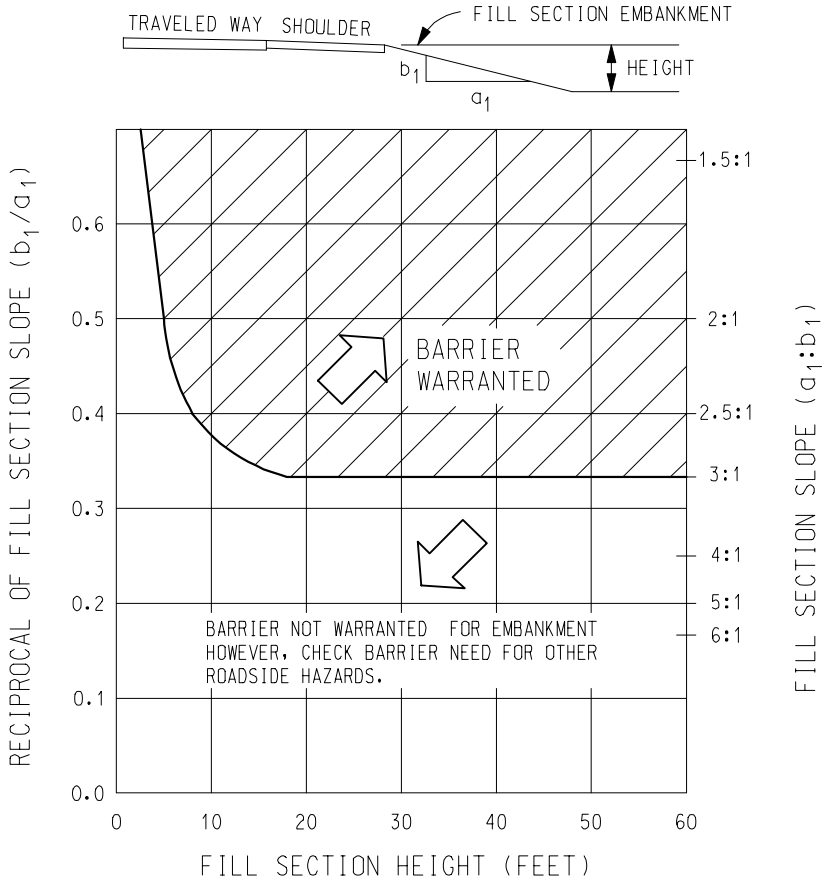
As a general rule, a barrier should be placed to protect a vehicle from going down an embankment only if the barrier itself is the least severe of the two features. Such a comparison must of necessity be very subjective because of the many variables involved. The Department generally follows the criterion that, if the fill slope is 1:3 or flatter, no barrier is required. For slopes of 1:3 or flatter, the height of fill does not increase severity.

7.01.30 (continued)

The economics of earthwork obviously dictate that all slopes cannot be 1:6, regardless of fill height. As the fill becomes higher, more consideration must be given to steepening the slopes, which in turn may call for a decision relative to placing a barrier.

Slopes intended to be traversable, i.e., one flat enough that a barrier can be omitted but still perhaps 1:3, should be relatively free of discontinuities that might "trip up" a vehicle. Plans should note that half-buried boulders and large rocks should be removed as part of the final trimming operation. Also, a clear runout area with a 10' minimum width should be provided at the bottom of traversable, non-recoverable slopes.

A. Height-Slope Guidelines



7.01.30 (continued)

Guardrail at Embankments

G. Placing Beam Guardrail on a Downslope

Usually the greater the distance from the roadway that a barrier can be placed, the less chance there is of it being struck and less barrier length will be needed to shield the object. However, placing a barrier on a downslope close to the shoulder hinge point (approximately 12'-0" or less) introduces the potential for the barrier to be less effective because of the tendency for a vehicle, leaving the shoulder, to vault over it. The following guidelines therefore apply:

1. Beam guardrail may be placed on a slope, beyond the shoulder point, if the slope is 1:10 or flatter.

2. Generally, a 1:10 or flatter slope should not be constructed specifically to locate the barrier farther out.

3. The placement of Type MGS-8 guardrail on 1:8 slopes should be confined to the applications specified in Section 7.01.32.F.

4. Usually, the installation of guardrail on a 1:6 slope is not recommended for new installations.

7.01.30 (continued)

H. Guardrail Placed near Intersecting Streets and Driveways

An intersecting street or driveway located near a roadside object or feature may prevent installation of the full length of barrier required along the main road. An example of this would be a bridge on a main road with an intersecting driveway located near the bridge.

The preferred solution is to close or relocate the intersecting street or driveway in order to install the full length of barrier required along the main road. A crash cushion or other impact attenuating devices may be used to shield a fixed object such as a bridge railing end, however, this may not provide the length of need required to shield other roadside objects or features in the vicinity.

When closing or relocating the intersecting driveway or street is not feasible, two possible solutions are given in the accompanying sketches. A second guardrail run in advance of the intersecting street or driveway should be considered when the vehicle's runout path does not intersect guardrail, or when the runout path intersects the departing terminal or the first 16.5 feet of the approach terminal attached to the curved run of guardrail. See Special Detail 21 for installing a curved guardrail run near an intersecting street or driveway. Also, graphical design methods are suggested when utilizing the proposed solutions depicted in the accompanying sketches.

Site-specific constraints must be taken into consideration when designing guardrail near intersecting streets and driveways. Examples of these constraints include limited intersection sight distance, right-of-way limitations, and the presence of multiple intersecting driveways in close proximity to each other. In addition, the use of excessively short advanced guardrail runs should be avoided. Questions regarding guardrail installations near intersecting streets and driveways should be directed to the Geometric Design Unit of the Design Division.

7.01.31 (revised 4-24-2023)

Shielding Bodies of Water

Warrants for shielding streams or permanent bodies of water are judgement decisions based on location and depth of water and likelihood of encroachment (page 5-9, 2011 AASHTO, ***Roadside Design Guide***). Streams or permanent bodies of water more than 2'-0" in depth will usually require shielding by a barrier if within the clear zone. Barrier may also be required for bodies of water beyond the clear zone if, in the judgement of the designer, there is greater than usual potential for an errant vehicle to enter the water. An exception may be water close to the road for a considerable distance (a causeway is a case in point). In this case, speeds may have been correspondingly reduced because the roadside might be heavily used for recreational access to the water and for fishing. An intermittent barrier leaves many exposed endings to treat and space may not be available for proper flaring of the ends. After all factors are taken into consideration, it may be decided that the disadvantages of a barrier outweigh the advantages.

7.01.32 (revised 4-24-2023)

Barrier at Bridge Approaches (Over and Under)

Besides shielding embankments, the other most common use of a roadside barrier is shielding massive structural components. These fall into two general categories, the overpassing structure (approaches and railings) and the under passing structure (piers, drainage structures, and abutments).

A. Attachment to Barriers and Closer Post Spacings

Guardrail beam elements fastened to concrete structures should overlap the concrete sufficiently to place the end bolts as shown in Standard Plan R-67 Series. This is necessary to ensure proper guardrail anchorage to the concrete structure.

All of the guardrail anchorage, bridge attachments specified on Standard Plans R-67-Series, B-22-Series and B-23-Series increase in lateral stiffness. This is done to keep an impacting vehicle from displacing the guardrail and pocketing against the rigid bridge structure. The transition for lateral stiffness of guardrail is described in Section 7.01.21. Additionally, heavier 10 gage (0.135") thrie-beam elements and nested 12 gage (0.105") beam elements, consisting of two stacked beam elements, are used to increase barrier strength to reduce the possibility of rail rupture.

7.01.32 (continued)

Barrier at Bridge Approaches (Over and Under)

B. Relationships Between Bridge Sidewalk and Approach Guardrail

Any guardrail run leading up to a bridge must be properly anchored to a bridge railing. Refer to Standard Plans R-67-Series, B-22-Series and B-23-Series. If curbs are present, the guardrail in conjunction with curb guidelines described in Section 7.01.34 should be followed when site conditions allow. Contact the Geometric Design Unit, Design Division if there are any questions regarding specific situations.

7.01.32 (continued)

C. Barrier at the Trailing End of Overpassing Structures

The departing end of a bridge railing on a bridge carrying one-way traffic is generally not considered a hazard. However, there could be other hazards beyond the bridge, such as a slope steeper than 1:3, that may justify guardrail installation on the departing end of a bridge railing carrying one-way traffic.

Where a roadway carries two-way traffic, guardrail may be needed on the trailing end of the bridge railing because the trailing end for one direction of traffic is the approach end of the other. The designer should determine if the opposite side railing and any roadside hazards are within the clear zone, measured from the centerline in the case of a two-way, two-lane roadway.

If one or more downspout headers are required on the departing end of a one-way bridge, it will be necessary to shield it with guardrail. This guardrail should extend a minimum length of the Guardrail Departing Terminal beyond the last downspout header.

When a major railing or bridge reconstruction project is programmed, existing 12" high approach curbs on the departing ends of one-way bridges should be removed and replaced with a reduced height curb, unless shielding with a T-Series guardrail bridge anchorage. See current Standard Plans R-32-Series and R-67-Series for bridge approach curb and gutter requirements.

7.01.32 (continued)

Barrier at Bridge Approaches (Over and Under)

D. Shielding Requirements at Bridge Underpasses

The clear zone criteria presented in Section 7.01.11 is the primary source of information used in determining whether bridge columns or abutments require shielding. Because a clear zone distance cannot always be determined precisely, it may happen that a fixed object thought to be outside the clear zone may need shielding. When this occurs, the designer must determine a method to shield them. Accepted methods for shielding are specified on the standard plans. If the only requirement is to shield the bridge pier or abutment, the barrier length should be calculated using the information found in Section 7.01.05F.

Current bridges are usually designed with longer spans, so that bridge columns and abutments can be placed outside the clear zone. Even when spans are increased, not all bridge columns and abutments can be located outside clear zones. An example might be where a widened clear zone results from a bridge being located over a curved roadway.

Currently, the approach bridge fill, behind the abutment, is designed to have a 1:6 slope facing oncoming traffic on the road below. However, when the approach slope is not 1:6 or flatter, additional barrier may be required to obtain the required runout length used in the above formula.

7.01.32 (continued)

E. Guardrail Median Object Protection

Standard Plan R-56-Series illustrates an enclosed guardrail system for shielding objects such as bridge piers and sign supports in medians 36’ to less than 70’ in width. The system encloses the median objects between two parallel runs of guardrail converged and terminated at each end with a Type 3 approach terminal (Standard Plan R-63-Series). Details are provided for both Type T and Type MGS-8 guardrail (see Standard Plan R-60-Series). Therefore, it is necessary to specify the guardrail type to be used at each location. This design replaces the past versions of Standard Plan R-56-Series featuring the Minnesota Bullnose design. The current standard also provides details for a direct connection to filler walls. This connection detail requires construction of concrete end walls and reduces the overall guardrail length required.

Standard Plan R-56-Series also details a treatment for shielding the opening between twin-bridge approaches. For wider medians at twin bridge approaches, the barrier length should be calculated using the information found in Section 7.01.05F.

It is necessary to ensure the minimum offset is provided from the edge of pier or median objects to the back of guardrail posts, while ensuring there is adequate space from the face of guardrail to the edge of shoulder. In cases where the minimum offset from the edge of pier or median objects to the back of guardrail posts cannot be satisfied, it may be possible to stiffen the guardrail system by decreasing the post spacing (see Section 7.01.20, “Guardrail Deflection”). However, in cases where it is impossible to meet the minimum offset from the edge of pier or median objects and/or provide adequate space between the guardrail and the shoulder, concrete barrier should be considered for shielding the bridge piers or median objects. Consult with the Geometric Design Unit, Design Division for guidance.

7.01.32 (continued)

Barrier at Bridge Approaches (Over and Under)

F. Bridge Columns and Foundations in 70’ Medians

Bridge columns and sign support foundations located in the center of 70’ medians were once considered outside the clear zone. Shielding is now required and should be included in any programmed project upgrading.

The treatment for shielding columns and foundations for new construction and reconstruction projects should be according to the enclosed system designs shown on Standard Plan R-56-Series, Guardrail Median Object Protection.

In addition to the enclosed systems discussed in the previous section, an open system is detailed in Standard Plan R-56-Series for other than new construction and reconstruction projects with 70’ medians and existing fill slope rates of 1:8 or flatter. This detail features twin parallel guardrail runs that shield the median objects independently for each direction of traffic. This option offers the advantage of better accessibility for maintenance equipment to service the median or sign foundations. It is intended only for the conditions stated above.

7.01.33 (revised 4-24-2023)

Maintaining Guardrail Strength When One or More Posts Must Be Omitted

A. Downspout Headers

Standard Plan R-32-Series, under "Notes", advises field personnel to determine the location of proposed guardrail posts prior to locating the spillway or downspout header(s). If this is done, there will be no conflict. There are occasions however, when miscalculation in construction layout or when upgrading guardrail, that an existing downspout header will prevent a post from being placed at the proper spacing. Downspout headers that were constructed prior to 1970 and according to Standard Plan E-4-A-144 series, are an example. These downspouts had deeper throats and were designed to fit 12'-6" post spacing. When a post cannot be properly placed, Standard Plan R-72-Series, "Guardrail Long Span Installations" should be considered.

B. Wide Culverts

Maintaining the continuity of the barrier strength is also necessary when a run of guardrail spans a wide culvert and the proper embedment of a guardrail post(s) cannot be obtained. When the spanning of a wide culvert requires the omission of one or two posts, Standard Plan R-72-Series, "Guardrail Long Span Installations" should be used. Where no barrier wall exists and the span is over 25’-0” Standard Plan R-73-Series, "Guardrail over Box or Slab Culverts" may be considered.

7.01.40

Guard Posts for Roadside Control

Barrier systems should not be used merely for roadside control. Where it is impractical to use curb for this purpose, wooden posts without connecting beam elements will suffice. These posts should be weakened by adding two 3½" diameter holes, through the 8" face and 6" apart, with the bottom one about 1" above the ground. The holes should be perpendicular to traffic. Posts may be about 5'-0" apart or as necessary to control traffic in the specific situation. See Standard Plan R-74-Series.

7.01.41 (revised 4-24-2023)

Upgrading and Replacement of Guardrail

The upgrading and replacement of existing guardrail runs is a leading construction item in Michigan. Two principle reasons for updating are an obsolete design or because of changed conditions, e.g., a guardrail made too low by resurfacing the shoulder.

A. Guidelines for Upgrading or Replacing Guardrail

1. If entire runs of guardrail must be replaced because the guardrail is out of specifications or cannot be adjusted to meet specifications, then the guardrail should be replaced following the current MDOT recommendations as called for in Section 7.01.12.

2. Height adjustment may be made on existing guardrail posts that pass a thorough inspection for soundness. Existing beam elements should be evaluated for expected life and may be used if they meet current design standards. If the existing guardrail cannot be made to meet these conditions, then the entire run should be replaced with new guardrail using the recommended type from Section 7.01.12.

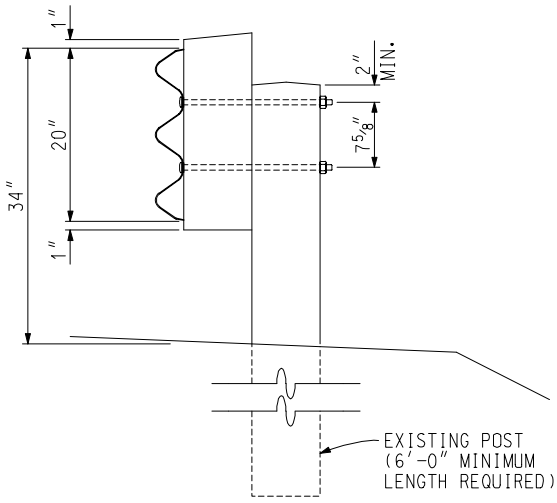
7.01.41A (continued)

Upgrading and Replacement of Guardrail

3. When replacement of the existing guardrail on freeway ramps is necessary, use Type MGS-8. If a continuous guardrail run is needed up to and along the crossroad, with Type B guardrail along the crossroad, transition Type MGS-8 to Type B at a point 50'-0" minimum from the edge of the crossroad for a "T" intersection ramp terminal. For a continuous run through a free-flow ramp, with Type B guardrail along the free-flow ramp, transition to Type B opposite the 2'-0" point in the gore. This should be done at both on and off ramp terminals.

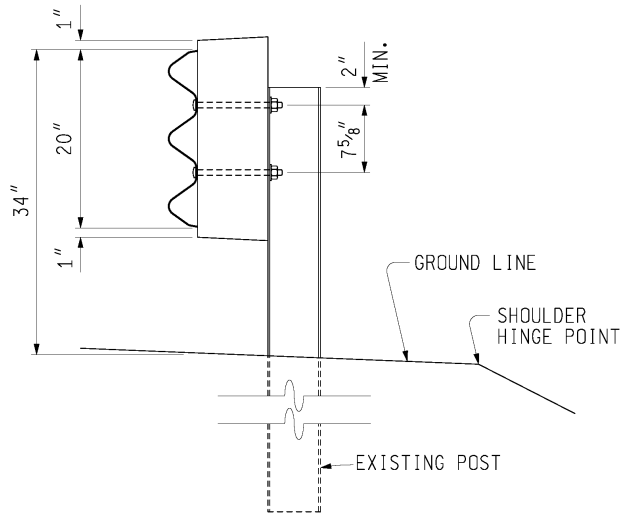
4. Height adjustments may be made to guardrail meeting the conditions stated in 2 of this section. If the existing posts are too low to allow the thrie beam rail to be placed at the proper height, then new guardrail should be installed.

   The placing of the upper bolt shall not be closer than 2" from top of wood or steel posts. See the following illustrations.



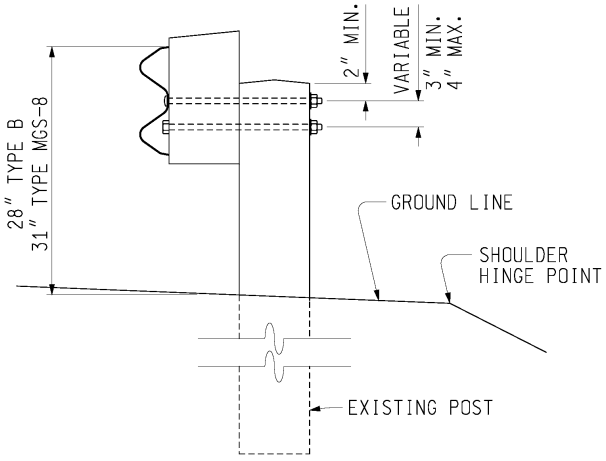
ADJUSTING THRIE BEAM GUARDRAIL
HEIGHT ON EXISTING WOOD POSTS

7.01.41A (continued)



NOTE: HOLES IN STEEL POST SHALL BE DRILLED NOT BURNED.

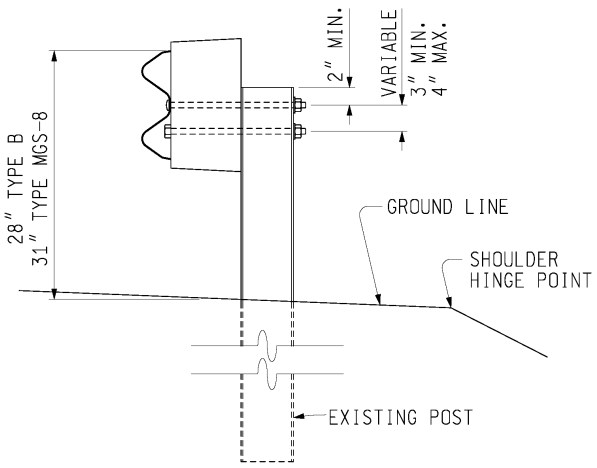
ADJUSTING THRIE BEAM GUARDRAIL
HEIGHT ON EXISTING STEEL POSTS



ADJUSTING TYPE B OR TYPE MGS-8
GUARDRAIL HEIGHT ON
EXISTING WOOD POSTS

7.01.41A (continued)

Upgrading and Replacement of Guardrail



ADJUSTING TYPE B OR TYPE MGS-8
GUARDRAIL HEIGHT ON
EXISTING STEEL POSTS

7.01.41 (continued)

B. Upgrading Guardrail Terminals

MDOT policy is to replace any Breakaway Cable Terminals (BCT) encountered on all trunkline projects, including both 3R and 4R projects, NHS and non-NHS routes, all guardrail runs within the projects limits (both flared and non-flared), and regardless of whether guardrail work is included as part of the project. See Standard Plan R-62-Series for details of approved terminals.

These guidelines do not apply to Capital Preventive Maintenance (CPM) projects. Safety Criteria for CPM projects are covered under a separate agreement with the FHWA.

Maintenance forces are to replace a damaged BCT with an approved terminal from Standard R-62-Series.

7.01.41 (continued)

Upgrading and Replacement of Guardrail

C. Intermixing Wood and Steel Posts

At the present time, the Standard Specifications permit the use of either wood or steel guardrail posts. Both types of posts may be randomly intermixed in making repairs on Types A, B, T, and MGS-8 guardrail, but, for appearance, complete runs being reconstructed should utilize only one type of post.

Posts in terminals shall be the same as those specified on Standard Plans R-62-Series, R-63-Series, R-66-Series and the special provision which specifies the Type 2M endings. When the repair of an existing bullnose installation is necessary, wood posts shall be used.

D. Guardrail Posts at or near the Shoulder Hinge Line

Guardrail upgrading on local roads and trunklines sometimes requires setting the posts at or near the shoulder hinge line rather than 2'-0" (shoulder hinge point to front face of post) for Guardrail Types B and T, or 2'-8" (shoulder hinge point to front face of post) for Guardrail Type MGS-8, as specified on Standard Plan R-60-Series. Most of the time this condition occurs on a fill, which means that the soil support behind the post will be reduced because of the close proximity of the slope. In these cases, 8'-0" long posts should be specified for Guardrail Types B and T, and 9'-0" long posts should be specified for Guardrail Type MGS-8. If the ground does not fall away behind the guardrail, then conventional length posts are sufficient. These requirements also apply to double sided guardrail (Guardrail Types BD, TD, and MGS-8D).

7.01.41 (continued)

E. Allowable Variation from Standard Height

When evaluating existing guardrail to determine upgrading needs, variation from standard barrier height is a consideration. A variation of 3" from the standard height is allowable. This is considered a functional variation. Closer tolerances are expected for construction purposes. If an existing guardrail is of the proper type, and after all phases of the proposed project are complete, e.g., shoulder resurfacing, etc., the guardrail height should be within this limit. If any work must be done on it at all, however, then the run should be brought up to standard. Before allowing such a run of guardrail to remain untouched, it should pass a thorough inspection for the soundness of posts and the expected remaining life of the beam elements. The timing of future road improvements should also be a consideration.

F. Unpainted Corrosion Resistant Beam Elements

See Section 7.01.14B. The Engineering Operations Committee meeting on January 20, 1989 decided that all existing corrosion resistant, or "rusty steel", guardrail encountered on proposed Interstate resurfacing or reconstruction projects should be removed and replaced as part of the project.

On projects involving bridges only, the nominal provisions of approach guardrail (guardrail anchorage to bridge and approach terminal) shall be replaced if the rail elements are rusty steel. Where guardrail at the bridge approaches is part of a more extensive installation, the decision to replace will be made on the merits of the specific project.

7.01.41 (continued)

Upgrading and Replacement of Guardrail

G. Thick Shoulder Lifts

Rehabilitation of rural freeways often entails placing a new concrete pavement on top of the old, or placing a thick HMA overlay. This procedure also raises the shoulder elevation, thus causing the existing guardrail to be too low. When this occurs, the designer is reminded that provisions should be made to either reconstruct or upgrade the guardrail.

If reconstruction of the guardrail must precede the pavement lift by a year or so; the designer may be tempted to call for longer than normal posts, leaving them with tops protruding so that they will be long enough to fit the ultimate installation. This should not be done; crash test films frequently show the impacting vehicle laying over on the rail and sliding along it. Protruding post tops would thus have a detrimental effect on smooth redirection of the vehicle.

H. Type A Guardrail Parallel to Continuous Abutment, Twin Overpassing Structures

It was practice for a number of years to place Type A guardrail in front of the opening between twin overpassing structures, parallel to the continuous abutment and about 4'-0" in back of it. Current standards provide either a length or a configuration of guardrail that eliminates the need for this transverse section of barrier. On an updating project, if this transverse barrier is still in place and in good condition, it may be left as a determent to persons or animals who could accidentally fall over the backwall. If the condition of the barrier warrants removal, replacement is not necessary. However, replacement may be considered if deemed essential to provide positive protection for mowing operations and/or other maintenance purposes.

7.01.41 (continued)

I. Replacing with Thrie Beam Guardrail

Even though guardrail Type T and Type MGS-8 are the current standards for use on freeways, other guardrail types do not need to be replaced unless physical deficiencies exist.

7.01.43

Guidelines for Bridge Railing Replacement and Attached Approach and Trailing Guardrails

See Chapter 12 of the Bridge Design Manual.

7.01.44 (revised 10-22-99)

Guardrail Upgrading on Local Roads

A. Guardrail Upgrading Guidelines on Local Roads (In Conjunction with Freeway Work)

In conjunction with work programmed on a freeway, the Department may have occasion to upgrade guardrail on roads that are under local jurisdiction. Generally, the guardrail will be constructed to "trunkline standards" with respect to the type of guardrail and the type of ending. Depending on site conditions, the location and configuration of the guardrail used on local roads may not necessarily be to "trunkline standards".

The Department attempts to prevent errant local road traffic from encroaching on the freeway and its appurtenances. The following guidelines have been established for upgrading guardrail on local roads over and under freeways.

7.01.44 (continued)

Guardrail Upgrading on Local Roads

D. Cable on Chain Link Fence

Cable on chain link fence consists of attaching 2 steel cables to a chain link fence. This treatment may be useful in urban freeway areas where a local street ends at a service road and where a chain link fence is located parallel between the freeway and service road. Its possible use might be at locations where there is greater than usual potential for an errant vehicle to go down onto the freeway. Details are available from the Standards Unit.

7.01.45 (revised 4-24-2023)

Alternative Barrier End Treatments

All the terminals discussed in this section have been crash tested as recommended by NCHRP Report 350 and approved by FHWA. As with all terminals where penetration behind and beyond the barrier can be expected, a traversable area, free of fixed objects, is recommended to aid post-crash vehicle stability. Alternative endings should be considered where restrictive site conditions exist, such as bi-directional traffic or two-sided directional traffic, and where the designer is unable to obtain the required offset, length, etc.

Note that this is not a comprehensive list of all alternative barrier end treatments, and future developments in the roadside safety industry will likely result in the availability of additional barrier end treatments. Consult with the Geometric Design Unit, Design Division, for additional information regarding alternative barrier end treatments.

7.01.45 (continued)

A. X-TENuator

The X-TENuator is an NCHRP 350, Test Level 3 compliant crash cushion manufactured by Barrier Systems (a Lindsay Corporation company), Vacaville, California. The X-TENuator may be used for both permanent and temporary applications, and may be used to terminate single-sided guardrail, double-sided guardrail, and concrete barriers. The X-TENuator is approximately 24'-9" long, and requires a concrete or asphalt base pad for installation. While the X-TENuator has a relatively low installation cost compared to other crash cushions, this device is considered to be a sacrificial unit that generally requires complete removal and replacement after a vehicular impact.

The X-TENuator may be desirable for restrictive site conditions, such as shielding concrete barrier or bridge railing endings at locations that prevent the installation of a traditional guardrail bridge anchorage and guardrail approach terminal. Designers should note that the X-TENuator requires 12'-6" of longitudinal clear space behind the unit on both sides of the object being shielded in order for the side panels of the X-TENuator to slide back and telescope when the unit is impacted.

Detailed information on design and installation is available from the Geometric Design Unit, Design Division.

7.01.45 (continued)

Alternative Barrier End Treatments

B. QuadTrend™

The QuadTrend system is a proprietary terminal manufactured by Energy Absorption Systems Inc. This device is for one-sided directional traffic and is intended for shielding concrete barrier endings, bridge railing endings, abutments, etc. This device can be attached directly to a rigid ending without a guardrail strength transition. Detailed design, construction and maintenance information is available from the Geometric Unit, Design Division.

7.01.45 (continued)

C. BEAT-SSCC

The BEAT-SSCC (Box Beam Bursting Energy Absorbing Terminal Single-Sided Crash Cushion) is an NCHRP 350, Test Level 3 compliant terminal manufactured by Road Systems Inc., Big Springs, Texas.

The BEAT-SSCC may be used for both permanent and temporary applications, and is intended for use as a single-sided terminal for shielding concrete barrier, bridge abutments/piers, and certain types of bridge railings. The BEAT-SSCC is available in the following lengths: 28', 32', 36', 40', and 44'. The BEAT-SSCC is available with driven (ground-mounted) posts or with surface-mounted posts for installation on a concrete surface. While the BEAT-SSCC has a relatively low installation cost compared to other crash cushions, this device is considered to be a sacrificial unit that generally requires complete removal and replacement after a vehicular impact.

The BEAT-SSCC may be desirable for restrictive site conditions, such as shielding concrete barrier or bridge railing endings at locations that prevent the installation of a traditional guardrail bridge anchorage and guardrail approach terminal.

Detailed information on design and installation is available from the Geometric Design Unit, Design Division.

7.01.55 (revised 4-24-2023)

Median Barrier Types

Median barriers, when used, are employed almost exclusively on controlled access highways. If the road is free access, openings would have to be provided at intersections and crossovers. This means that the barrier must be terminated at these points with a crash worthy end treatment. The lengths of the end treatments must be added to the length of the opening thus increasing the length of unprotected median, as the end treatments provide only marginal median crossover protection.

Generally, the initial installation cost of concrete median barrier is about 10-15% more than a double-sided metal guardrail. (However, this comparison does not include the possible additional cost of drainage alterations, etc., that might be required in conjunction with concrete barrier.) Advantages and disadvantages for the three barrier systems are as follows:

A. Concrete Median Barrier

Advantages

1. Very low maintenance.
2. Relatively good visibility.
3. Less vehicle damage at low angles of impact.
4. Easier on which to affix glare screen (glare screen can be integrally cast)

Disadvantages:

1. Greater "snow fence" effect (wind cannot pass through)
2. Traps blowing paper and trash
3. Usually requires some form of internal drainage
4. May require extensive grading. In most cases, adjacent slopes should be 1:10 or flatter.

7.01.55 (continued)

B. Double Steel Beam Guardrail

Advantages

1. May be used in the wider medians (median width not a factor)
2. Less "snow fence" effect than concrete barrier
3. Lateral drainage can flow under
4. Performs better than concrete barrier for high angle impacts
5. When placed along the top of a V-ditch, guardrail may be installed adjacent to a 1:6 or flatter backslope (Type TD) or 1:8 or flatter backslope (Type MGS-8D).

Disadvantages:

1. Maintenance repair usually required after a hit
2. Harder to install in rock
3. No durable glare screen available for mounting on top

C. Cable Barrier

General Guidelines

- Cable median barrier is recommended on divided roadways where:
  1. Median crossover crashes have been reported, and
  2. Median barrier is not warranted based on Section 7.01.54 of the Michigan Road Design Manual.
- Median width should be a minimum of 30 feet.
- Median slopes shall be 1:4 or flatter.
- The cable barrier shall be placed at a location that permits the system to deflect unimpeded during a vehicular impact. The cable barrier shall not interfere with opposing traffic or other roadside objects during a vehicular impact. If a single run of cable barrier cannot satisfy the offset requirements, dual runs should be used.
- At locations where both NCHRP 350, TL-3 and TL-4 cable systems may be installed, NCHRP 350, TL-4 cable systems are preferred.

7.01.55C (continued)

Median Barrier Types

- The length of need (LON) for cable median barrier is based on engineering judgment. Consult with the Geometric Design Unit of the Design Division for additional information.
- Due to the advantages high-tension cable systems possess, high-tension cable systems are preferred over low-tension cable systems.

Approved Cable Median Barrier Systems

The following cable barrier systems are approved for use as median barrier. Questions regarding cable median barriers should be directed to the Geometric Design Unit of the Design Division.

A. Low-Tension Three-Cable Median Barrier (Type M Cable Barrier per Standard Plan R-70-Series)

This is a non-proprietary cable system that is described in the 2011 AASHTO ***Roadside Design Guide*** and MDOT Standard Plan R-70-Series. This design has been adopted by various agencies throughout the nation. The cable system and the end terminals have been successfully tested to NCHRP 350, TL-3.

Advantages:

1. Non-proprietary, usually less expensive than proprietary items
2. May be used on curved roadways with radii as low as 110 feet

Disadvantages:

1. Generally requires more maintenance than high-tension cable systems
2. System is usually inoperative after an impact (i.e., requires immediate inspection and maintenance after an impact)
3. Larger impact deflection compared to high-tension cable systems
4. Maximum length between terminals is considerably smaller than high-tension cable systems

7.01.55C (continued)

Table 1:

DESIGN CRITERIA FOR LOW-TENSION THREE-CABLE MEDIAN BARRIER		
Maximum Flare Rate	4:1	
Minimum Design Deflection Distance	16 feet	
Minimum Offset Between Median Ditch Line and Cable Barrier (Single Runs Only)	8 feet	
Maximum Length Between Terminals	2,000 feet	
Post Spacing and Roadway Curvature Requirements	**RADIUS**	**POST SPACING**
	Less than 110 feet	**CABLE BARRIER NOT RECOMMENDED**
	110 feet to 219 feet	6’-0”
	220 feet to 699 feet	12’-0”
	700 feet or more and Tangent Sections	16’-0”

7.01.55C (continued)

Median Barrier Types

B. High-Tension Cable Median Barrier

CASS Cable System
The CASS cable system is a proprietary, high-tension cable barrier manufactured by Trinity Industries, Inc. The system is available with I-shaped steel posts installed in concrete post foundations with a sleeve of steel, or a driven steel socket with a soil plate welded to the socket.

There are two versions of the CASS system in use on MDOT roadways.

The CASS 4:1 Slope cable barrier system is an NCHRP 350, TL-4 system when placed on 1:6 or flatter slopes. This system may also be placed on slopes steeper than 1:6, up to 1:4, and is NCHRP 350, TL-3 compliant under such conditions. This cable system consists of three 3/4" diameter pre-stretched cables, with the top and middle cables located in a slot in the middle of the post. The top and middle cables are separated by recycled plastic spaces. The bottom cable is placed on the side of the post and secured with J-hook fasteners. This is the most common version of the CASS system used on MDOT roadways.

The CASS TL-4 cable barrier system is an NCHRP 350, TL-4 compliant cable barrier system. This cable system consists of three 3/4" diameter pre-stretched cables, with all three cables located in a slot in the middle of the post and separated by recycled plastic spacers. This cable system can only be installed on 1:6 or flatter slopes. As a result of this limitation, it is used less often than the CASS 4:1 Slope cable barrier system.

In addition, the CASS cable terminal (CCT) is an NCHRP 350, TL-3 compliant end terminal for use with both CASS systems.

7.01.55C (continued)

Gibraltar Cable System
The Gibraltar cable system is a proprietary, high-tension cable barrier manufactured by Gibraltar Global, LLC. The system consists of steel posts installed in concrete post foundations with a sleeve of steel or a driven steel socket with a soil plate welded to the socket. Even though Gibraltar manufactures several cable barrier systems, the three-cable, Gibraltar TL-4 cable barrier system is the system commonly used on MDOT roadways. It meets NCHRP 350, TL-4 when placed on 1:6 or flatter slopes, but also meets NCHRP 350, TL-3 on slopes steeper than 1:6, up to 1:4. Furthermore, the Gibraltar cable terminal is an NCHRP 350, TL-3 compliant end terminal for use with the Gibraltar cable system. ¾" diameter prestretched cables are attached to the posts and kept at the appropriate height by devices called "hairpins," which are unique to Gibraltar. The cables are tensioned according to cable temperature.

7.01.55C (continued)

Brifen Cable System

The Brifen cable system is a proprietary, high-tension cable barrier manufactured by Brifen USA, Inc. The system consists of steel posts installed in concrete post foundations with a sleeve of steel, or a driven steel socket with a soil plate welded to the socket, and four ¾" pre-stretched cables. Three of the four cables are woven on alternating sides of sequential posts over the entire segment length. The cables are tensioned according to cable temperature.

The Brifen cable system used on MDOT roadways meets NCHRP 350, TL-4 when placed on 1:6 or flatter slopes, and also meets NCHRP 350, TL-3 when placed on slopes steeper than 1:6, up to 1:4. In addition, the Brifen WRGT end terminal is an NCHRP 350, TL-3 compliant end terminal for use with the Brifen cable system.

7.01.55C (continued)

Median Barrier Types

Advantages:

1. Typically impact deflection is 10 feet or less
2. Generally requires less maintenance than low-tension cable systems
3. Compared to low-tension cable barrier, high-tension cable barrier has a much higher probability of remaining operative after an impact

Disadvantages:

1. Systems are proprietary; more expensive than low-tension cable systems
2. System may be inoperative after an impact (i.e., usually requires immediate inspection and maintenance after an impact)
3. System is limited to curved roadways with radii of 650 feet and greater

7.01.55C (continued)

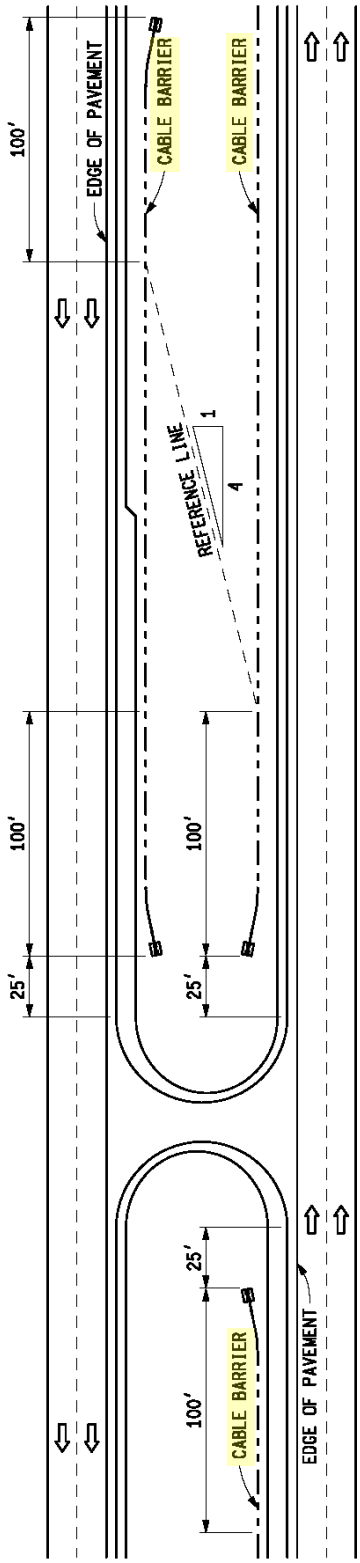
Table 2:

DESIGN CRITERIA FOR HIGH-TENSION CABLE MEDIAN BARRIER		
Maximum Flare Rate	30:1	
Minimum Design Deflection Distance	12 feet	
Minimum Offset Between Median Ditch Line and Cable Barrier (Single Runs Only)	10 feet	
Maximum Length Between Terminals	10,560 feet (2 miles) *	
Post Spacing and Roadway Curvature Requirements	**RADIUS**	**POST SPACING**
	Less than 650 feet	**CABLE BARRIER NOT RECOMMENDED**
	650 feet and greater	See Manufacturer's Specifications

* 2 miles is a suggested operational value, but longer runs are possible if the local TSC deems it acceptable.

7.01.55C (continued)

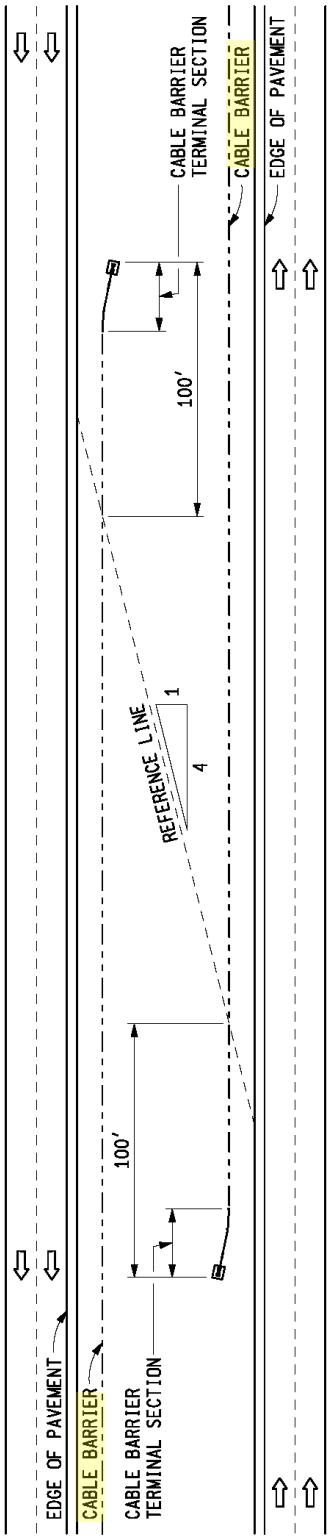
Median Barrier Types



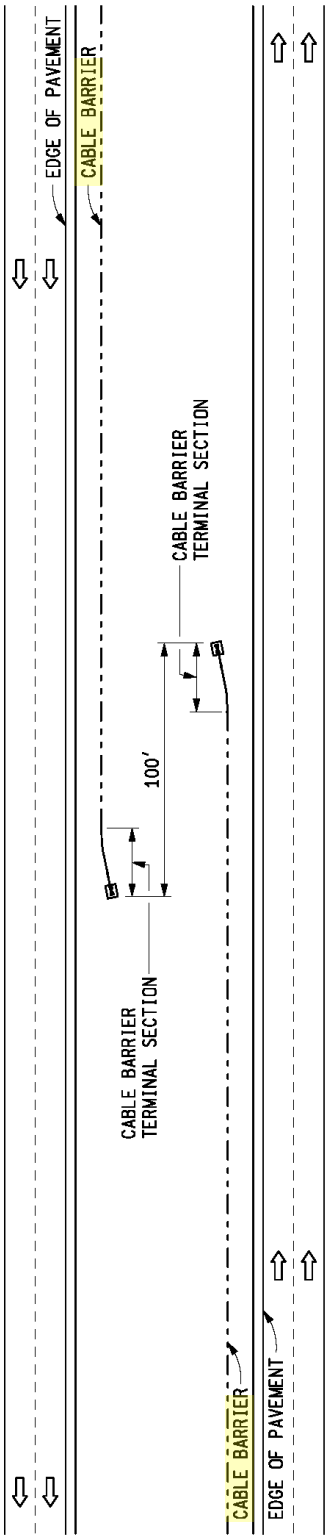
MAINTENANCE CROSSOVER LAYOUT

7.01.55C (continued)

Median Barrier Types



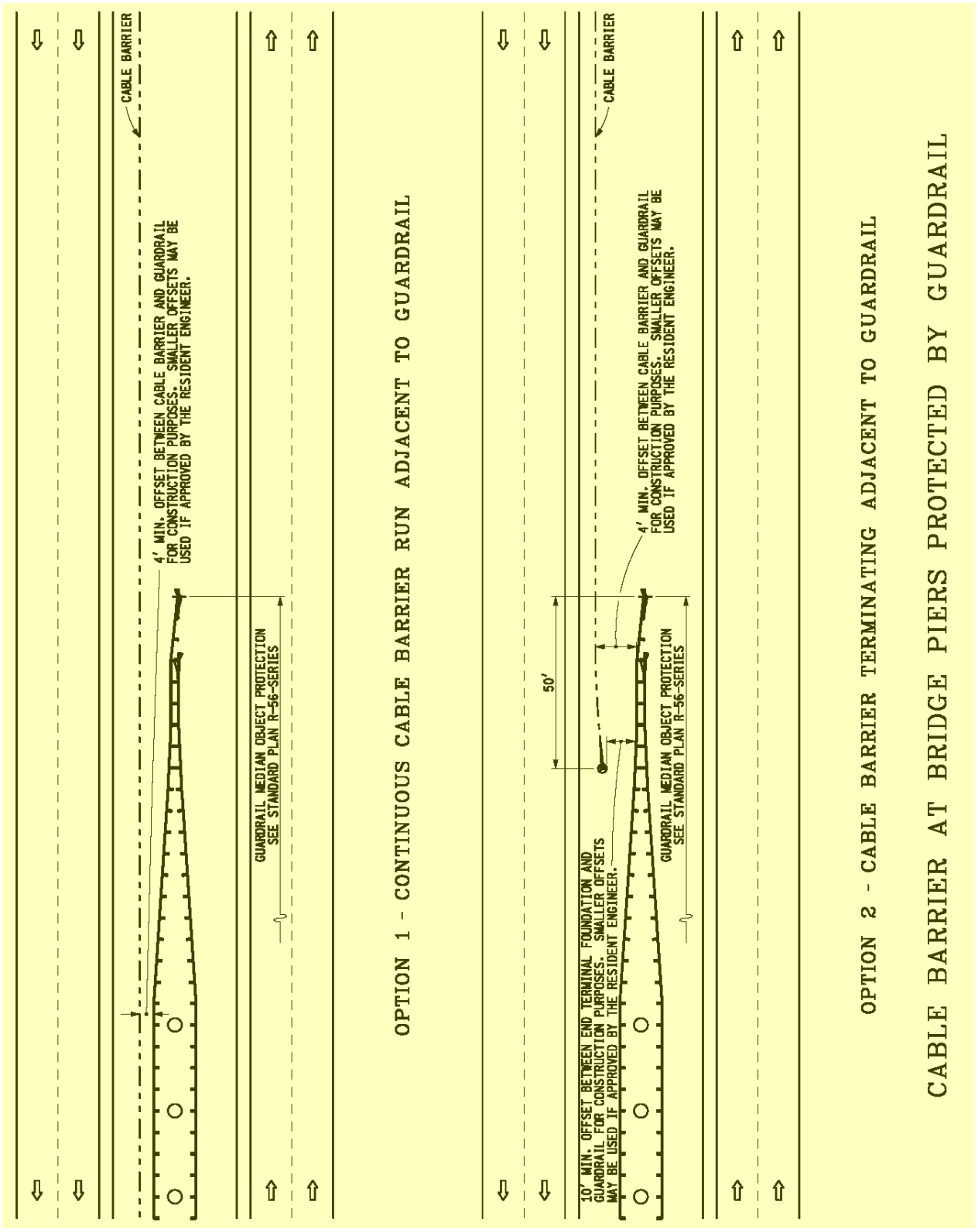
CABLE BARRIER SHIFT - APPROACH END



CABLE BARRIER SHIFT - DEPARTING END

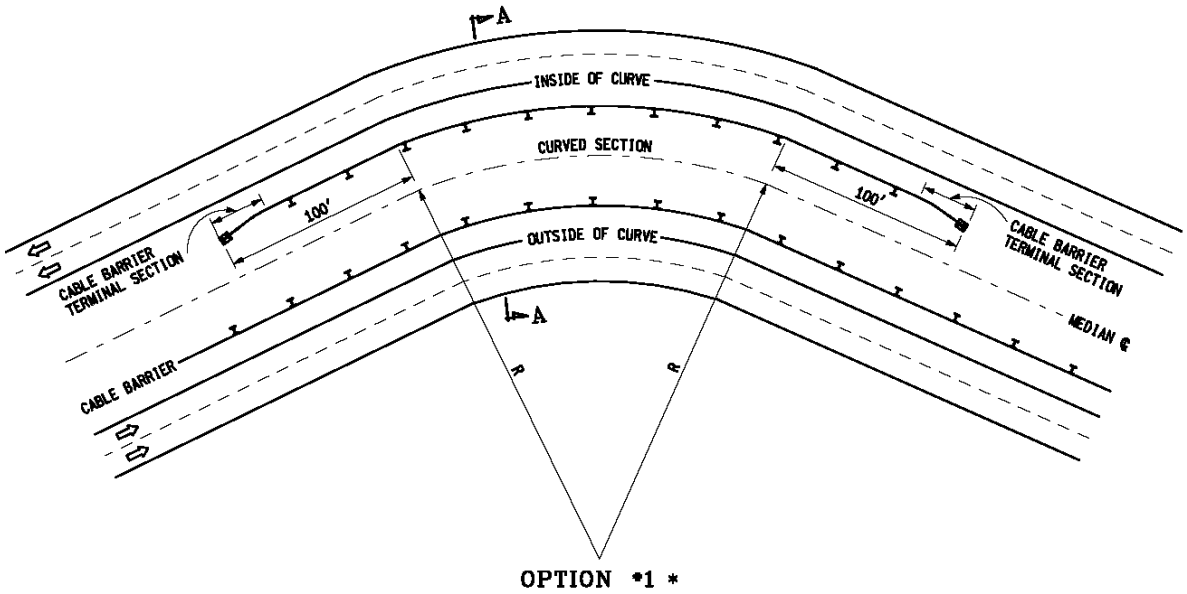
7.01.55C (continued)

Median Barrier Types

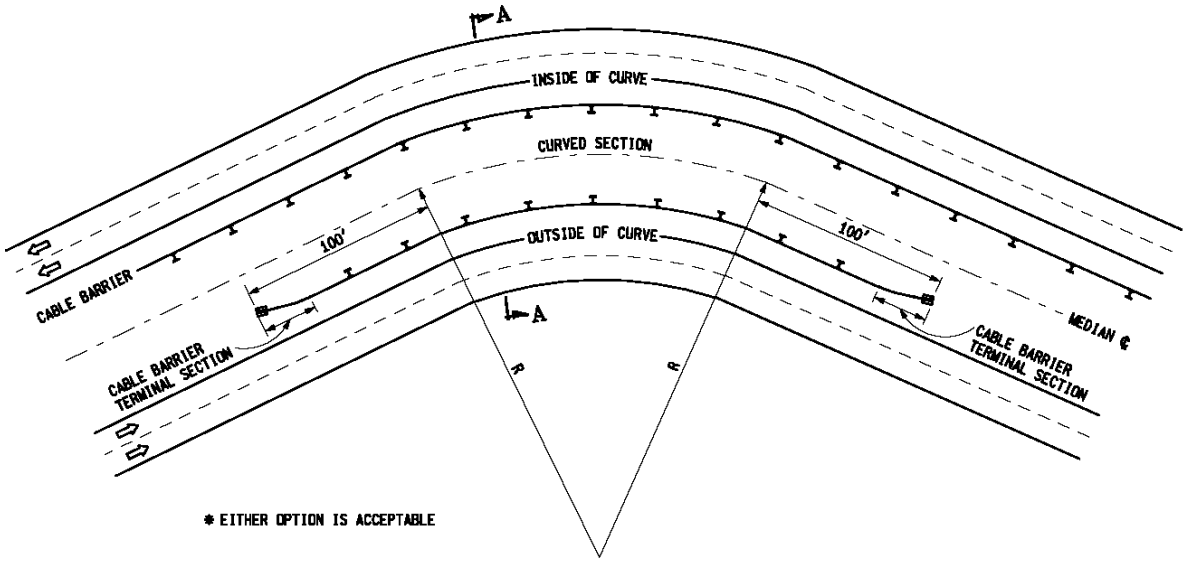


7.01.55C (continued)

Median Barrier Types

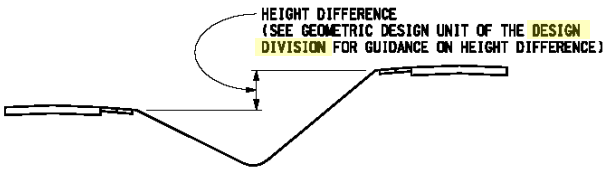


OPTION *1 *



* EITHER OPTION IS ACCEPTABLE

OPTION *2 *



SECTION A-A

RECOMMENDED CABLE BARRIER PLACEMENT ON CURVED ROADWAYS

R < 5,730' WITH UNEQUAL EMBANKMENT HEIGHT OR MEDIAN SLOPES STEEPER THAN 1:4

7.01.56 (revised 4-24-2023)

Concrete Median Barriers

A. GM Shape

The first concrete barrier shape used in Michigan was developed by General Motors. Sections of the GM barrier shape still remain in use, but is no longer being built on new construction projects. It was replaced by the New Jersey shape on Standard Plan II-49D in 1976.

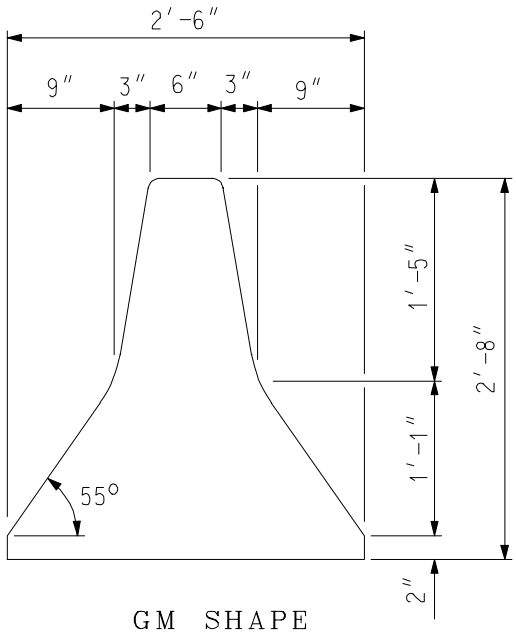
The key design parameter for a safety shape barrier is the distance from the ground to the slope break point because this determines how much the vehicle suspension will be compressed. The higher slope break (1'-1") of the GM shape causes less sheet metal damage, but it has more potential for an impacting vehicle to ride up on the barrier. There would be nothing wrong with a vertical-faced barrier except that the slightest vehicle contact will result in sheet metal damage. A vertical wall, of course, is more difficult to construct if slip-form methods are used.

At it's June 2, 2000 meeting, the Engineering Operations Committee approved a Department policy that calls for replacement of existing GM barrier as warranted by the condition of the existing barrier and crash history.

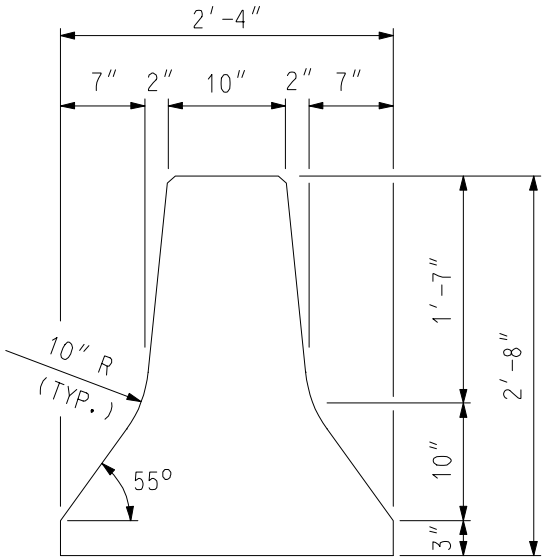
B. New Jersey Shape

The New Jersey shape was the second barrier shape used in Michigan. It has a 3" high vertical face at the toe. This is an allowance for future resurfacing. The 10" radius at the change in vertical slope has no safety purpose; it is for aesthetic purposes only. The standard 10" top width was determined as necessary to provide the same overturning moment as the previously used G.M. barrier, and to reduce the probability of fracture under heavy impact. It should be emphasized that the New Jersey shaped barrier should not be built with a 6" top width and, in fact, has never been standard in Michigan.

7.01.56 (continued)



GM SHAPE



NEW JERSEY SHAPE

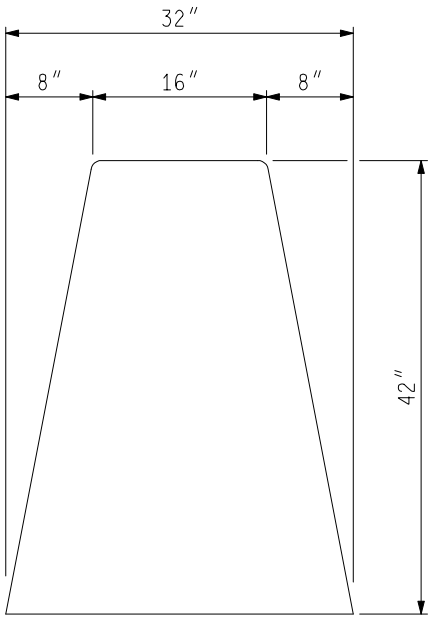
7.01.56 (continued)

Concrete Median Barriers

C. Single Slope

The single slope is Michigan's current standard shape. It has a 32" base and a 16" top which are connected by single 21:4 slopes on each side of the barrier. This single slope design provides the potential for several future overlays, since the single slope shape will not be impacted by future overlays. However, designers must ensure that the barrier is at least 36” tall after an overlay in order to meet the minimum barrier height requirement for MASH, TL-4 conditions.

The single slope is also common to a majority of the states in the country and is easier to slip form than the New Jersey shape.



SINGLE SLOPE

7.01.57 (revised 4-24-2023)

Ending Concrete Barrier

Concrete barrier normally can be ended by attaching a combination of a bridge guardrail anchorage (Standard Plan R-67-Series), conventional guardrail, and a guardrail approach terminal (see Standard Plans R-61 & R-62-Series). The same criteria for calculating the length of need should be used with the concrete barrier included in the length of need. The minimum length of anchorage and ending guardrail are specified on Standard Plan R-54-Series.

In the case of ending a concrete median barrier, the approach side can be ended with guardrail as long as the barrier is ended with all portions of the barrier system being located outside the clear zone area for the opposing traffic.

Where the minimum length and lateral clearance cannot be obtained, a more expensive alternative for ending the concrete barrier would be to use an impact attenuator. (See Section 7.02.)

7.01.58 (revised 4-24-2023)

Two Types of Concrete Median Barrier Footings

Designers should note that the standard plan for concrete median barrier (R-49-Series) specifies a Type A and a Type B. Type A has an integrally cast footing whereas Type B is doweled to a separately cast footing or concrete shoulder. When Type A barrier is called for on the plans the contractor has the option of casting the base integrally with footing or constructing the barrier in the same manner as Type B without any extra payment. Type B is payment for the upper portion of the barrier and is doweled onto an existing separately cast footing or concrete shoulder. If the designer wants to designate that the barrier be cast on a separate footing, they should note this on the plans or in a special provision.

7.01.59 (revised 10-22-99)

Concrete Glare Screen

Concrete glare screen, as opposed to glare screen made of other materials, is now used exclusively in Michigan when a glare screen is needed in conjunction with a concrete median barrier. Glare screen is called for routinely whenever the concrete median barrier is on a curve and whenever the concrete median barrier is used on new urban type construction. See Section 7.03.

7.01.60 (revised 4-24-2023)

Retrofitting Concrete Median Barrier

It is usually difficult and costly constructing a concrete median barrier where no median barrier had existed previously and especially where the median is drained by open ditch. Factors which the designer must consider are:

1. Where will the median barrier be placed? If located at the center of the median, the clear recovery area remaining is equal for both roadways; if constructed adjacent to one shoulder, recovery area is unequal for the two directions.

7.01.60 (continued)

2. Is the median ditch shallow enough and the slopes gentle enough to permit safe traversal? Typically slopes leading to the face of concrete barriers should be 1:10 or flatter. If the open ditch must be filled in and enclosed drainage provided, then the median must be completely reconstructed.

3. If enclosed drainage is decided upon, are roadway grades sufficient to drain surface water?

When flat (0 - 0.1%) grades are encountered, it may be necessary to use metal slotted drain adjacent to concrete median barrier. When slotted drain is used, only about 50% of the length of flat grade actually needs the slotted drain (placed intermittently).

7.01.65 (revised 5-22-2017)

Concrete Median Barrier Between Roadways of Different Elevations

Superelevation on divided highways may cause the median shoulders to be at different elevations. When this occurs, one side will be higher than normal resulting in the median barrier being asymmetrical. The barrier must be specially detailed on the plans. The single slope shape should be used, and the high side should be created by extending the upper slope as high as necessary to match the other, normal, side. The plans should not refer to the single slope shape as such, except in the context that it is modified.

A 2'-0" difference in elevation is the maximum the barrier can accommodate without the use of steel reinforcement. Elevation differences exceeding 2'-0" will require structural steel reinforcement in the barrier, and slip-forming should not be permitted when constructing reinforced barrier sections. Contact the Geometric Design Unit, Design Division for assistance with designing barriers with a grade separation exceeding 2'-0".

7.01.66 (revised 4-24-2023)

Concrete Barrier, Single Face

Single face concrete barrier was developed to shield roadside objects or features from one side only. One such situation is found on depressed expressways, where the right-side approaches to bridge piers need shielding from only one side. The Metro Region favors the use of a concrete barrier over the use of steel beam guardrail in these locations. The major justification for its use is minimal maintenance. The results are less exposure to risk for maintenance personnel and the reduced potential of a damaged system being exposed to the motoring public between an impact and the completed repair.

If the normal width shoulder can be maintained and a concrete barrier is needed, it should be placed in front of the underpass bridge piers. Otherwise, the concrete barrier should be transitioned to the vertical face of the pier column as specified on Standard Plan R-54-Series. Because single face concrete barrier is most commonly used on urban depressed expressways, the approach ending is usually buried in the adjacent cut slope. See Standard Plan R-54-Series. If the approach end cannot be buried in a backslope, it should be shielded with a minimum of a Guardrail Anchorage, Bridge and a guardrail approach terminal, or an impact attenuator.

The use of single face concrete barrier will usually be requested at the plan review meeting and will usually be restricted to the depressed urban freeway situation. Its use in rural areas is generally discouraged because of the cost factor, the "snow fence" effect, and drainage problems created by concentrating runoff at one or few locations on high fills. However, the single face concrete barriers might be considered between two consecutive bridges having concrete railings that are approximately 200' apart or less.

7.01.67 (revised 4-24-2023)

Temporary Barrier

Temporary barrier was introduced in Michigan around 1972, with temporary concrete barrier being the first type of temporary barrier available. Since that time, the use of temporary barrier in construction work zones has steadily increased. Temporary barrier serves a dual purpose: it shields hazards originating from construction practices and protects construction and maintenance personnel from the inherent hazard of closely adjacent moving traffic.

Presently, three crashworthy temporary barrier types are available for use; temporary concrete barrier, temporary steel barrier, and portable water-filled barrier. Each temporary barrier type has unique features and limitations. Therefore, it is important to determine which barrier types are acceptable for use on each project based on site-specific conditions.

A. Temporary Concrete Barrier (TCB)

TCB sections were initially precast. Then, a cast-in-place or slip-formed barrier similar to permanent barrier was allowed. Current designs meeting or exceeding NCHRP 350, TL-3 or MASH, TL-3 criteria are now required. TCB is the most commonly used temporary barrier type on Michigan roadways.

7.01.68 (revised 4-24-2023)

Ending Temporary Barrier

A. Temporary Concrete Barrier and Temporary Steel Barrier

The methods for ending temporary concrete barrier and temporary steel barrier are specified on Standard Plan R-126 Series.

B. Portable Water Filled Barrier

When the barrier ending is located within the clear zone, a crashworthy end treatment that is compatible with the portable water filled barrier must be installed. The crashworthy end treatment must meet or exceed the requirements of NCHRP 350, TL-3 or MASH, TL-3.

Some portable water filled barriers are designed such that the barrier itself is a crashworthy end treatment. In which case, when the barrier ending is located within the clear zone, a separate crashworthy end treatment is not required.

Payment for furnishing, operating, and relocating crashworthy end treatments for portable water filled barrier endings is included as part of the "Portable Water Filled Barrier, Furn" and "Portable Water Filled Barrier, Oper" pay items, and is not paid for separately.

7.01.69 (revised 4-23-2012)

Temporary Barrier at Bridge Deck and Railing Reconstruction

Temporary barrier is frequently used on bridge railing replacement projects. Its use, however, is not feasible if it results in lane widths of less than 10'-0", nor if the duration of need is short. In the latter event, alternatives are plastic drums, traffic signals at each end of the work site, or a detour. It may be noted that use of barrier on a bridge produces three points of constriction at about the same location: a narrower shoulder, introduction of the bridge railing, and the funneling down created by the barrier itself. If possible, it is better if these constrictions and driver decision points can be spread out along the approach roadway.

Bridge deck reconstruction usually requires more work area than bridge railing reconstruction, and will frequently result in bi-directional traffic control on a single lane. Temporary barrier is commonly used in this application and a detail showing placement is specified on Standard Plan R-126-Series. Maintaining traffic provisions should be included in the plans.

7.02 (revised 4-24-2023)

IMPACT ATTENUATORS

Questions regarding impact attenuators should be directed to the Geometric Design Unit of the Design Division.

7.03

GLARE SCREEN

7.03.01

References

A. Standard Plan R-76-Series, Concrete Glare Screen

7.03.02 (revised 10-22-99)

General

Glare screen was first used on median barriers within the limits of curves, where the headlight glare from vehicles rounding the curve would be momentarily aimed directly at on-coming vehicles in the opposite roadway. Various materials were tried, with expanded metal mesh finding favor in Michigan. Expanded metal mesh, while effective as a glare screen, is fragile and susceptible to damage by vehicle contact, fatigue, corrosion and wind. It thus requires almost constant maintenance. Its principal advantage is that it can be rather easily mounted on metal beam guardrail.

To overcome the shortcoming of expanded metal mesh, plastic paddles, or "Glarefoils", were developed around 1976. Varying in height from about 2'-0" to 4'-0" and made of polyethylene, they are fastened to metal brackets attached to concrete median barrier. Of hollow, oval cross-section, they are oriented at 45º to the line of barrier in such a manner that the line of sight is screened between the opposing directions of traffic, yet wind currents can pass through. Michigan's experience with plastic paddles has been mixed; they are more durable than expanded metal mesh, but they still require considerable maintenance. Plastic paddles may be considered if a temporary glare screen is required on temporary concrete median barrier, but we currently do not consider it for permanent installation.

7.03.02 (continued)

Concrete glare screen came into use in Michigan in 1973 as an "add on" to previously placed concrete median barrier. It soon became apparent that it was an economical, almost maintenance-free structure that, by comparison, ruled out further consideration of the other glare screen materials and designs. As techniques developed for slip-forming higher and almost vertical concrete walls, Standard Plan III-76D came out in 1978 requiring that, whenever glare screen was to be constructed in conjunction with a concrete median barrier, the wall must be cast monolithically, 51" high. Not only does this requirement achieve economy of construction, it lends strength and additional height to the concrete barrier as well. If concrete glare screen has a disadvantage, it is because it cannot be used in conjunction with steel beam guardrail.

7.03.03 (revised 4-24-2023)

Criterion for Use

It is current practice to place concrete glare screen on concrete median barrier whenever ***new*** concrete median barrier is constructed in urban areas. In rural areas the use of a glare screen will be as recommended on a project-by-project basis by the Geometric Design Unit, Design Division. (The terms "urban" and "rural" here refer to the characteristics of surrounding development, not the relationship of the project to city limit signs.)

7.07

NOISE BARRIERS

7.07.01 (revised 4-24-2023)

References

A. 23 CFR 772, ***Procedures for Abatement of Highway Traffic Noise and Construction Noise***, FHWA, October 1997

B. ***An Inventory of Traffic Noise Levels Along Limited Access Freeways in Michigan***, Revision of Research Report R-1013A, (formerly) Materials and Technology Division, July 1981.

C. ***A Policy on Geometric Design of Highways and Streets***, AASHTO, 2018 7th Edition

D. ***MDOT Highway Noise Analysis and Abatement Handbook,*** July 2011

7.07.02 (revised 4-24-2023)

General

The concept of traffic noise attenuation became an integral part of highway planning and design in 1976 when FHWA first issued ***Procedures for Abatement of Highway Traffic Noise and Construction Noise*** (currently 23 CFR 772). This regulation established two types of noise mitigation projects, which are continued to the present.

7.07.02 (continued)

Type I projects are for new highway construction, reconstruction of an existing highway, or the addition of one or more lanes to an existing highway. Guidelines for noise levels for residential, commercial, and special sites are listed in 23 CFR 772. If highway noise levels exceed the specified levels, on a regular basis, then noise mitigation must be considered. The warrants for noise barriers or other noise attenuation devices must include an economic cost-benefit analysis.

MDOT indefinitely suspended the Type II Noise Abatement Program in December 2007. Type II guidelines and procedures referenced in this, and subsequent sections are retained for historical purposes.

Type II projects are proposed Federal or Federal-aid projects for noise abatement on an existing highway, with no other concurrent reconstruction or lane addition being considered. This is a voluntary program and states wanting to participate must meet certain requirements. In order to be eligible for federal participation the Department had to establish a "Noise Barrier Policy", prepare an inventory of sites where highway noise levels exceed FHWA noise guidelines, and establish a priority system for treatment of the identified sites.

Noise attenuation is confined almost entirely to freeways, although there are one or two locations in the state where an earth mound sound barrier has been constructed along a free access route. Generally, the distance between access points, i.e., necessitating an opening in a barrier, are so close on a free access road that a barrier would not be practical.

7.07.02 (continued)

Responsibilities for noise barrier investigation, evaluation, and design are generally divided as shown in the following chart:

Technical investigation and analysis	Instrumentation and Data Systems Unit, Construction Field Services Division
Environmental Impact Statement	Bureau of Planning, Transportation Planning Services Division
Choice of noise barrier type, general details of design	Roadside Development Design Unit, Design Division
Noise barrier structural analysis	Bridge Design Special Assignment Unit, Design Division
Noise barrier design details	Road Design Unit, Region/TSC