2.09 ROADSIDE BARRIER DESIGN AND REVIEW

Roadside barrier is installed to reduce the severity of run-off-the-road accidents. The primary purpose of roadside barrier is to prevent a vehicle from leaving the road and striking a fixed object or terrain feature that is more hazardous than the roadside barrier.

A roadside barrier is a longitudinal barrier used to shield motorists from natural or manmade hazards located along either side of a roadway, and may occasionally be used to protect bystanders, pedestrians, and cyclists from vehicular traffic. A barrier is installed when an obstacle cannot be removed or relocated or when the steepness of the roadside terrain prevents establishing an adequate clear zone. CDOT installs barrier only when it is not economically feasible to eliminate a hazard or make the feature traversable or when terrain conditions are such that an adequate roadside recovery area cannot be provided for the given design speed.

CDOT uses several types of barriers, primarily Guardrail Type 3 W-beam, Guardrail Type 7 F-shape and Type 9 Single Slope Concrete Barrier, and Tensioned Wire Cable Barrier. Thrie Beam Guardrail is also used.

In many cases, slope flattening and extending hazardous features such as culverts can be viable alternatives to barrier. Guardrail Type 3 (semi-rigid) and concrete (rigid) barriers can redirect errant vehicles when impacted. Semi-rigid barriers can deflect up to 5 feet upon impact. Rigid concrete barrier that is anchored has no deflection upon impact. In some cases, the available space between the barrier and the object may not be adequate. In such cases, the barrier should be stiffened as suggested in the AASHTO *Roadside Design Guide* in advance of and alongside the fixed object. Also, important is the need for a thrie beam transition between semi-rigid and rigid barriers or between a semi-rigid barrier and bridge rail to eliminate pocketing, snagging, or penetration of the vehicle at the point of connection.

Because guardrail is a hazard in itself, it should be installed only in accordance with the guidelines of the *AASHTO Roadside Design Guide.* See CDOT *Roadway Design Guide* Section 20.3.2.4 for guidance on offset distance for the guardrail. Placement of barrier is based on accident potential and severity. Since both barriers are hazards, they should be installed only where they result in a reduction in the accident severity compared to impacting the hazard being shielded.

Substandard bridge rail should be examined for upgrading on resurfacing projects.

The Resident Engineer is responsible for evaluating factors concerning safety, traffic control, hazards, and other constraints in the use of guardrail. Justifications and

warrants for guardrail design are best done after the scoping review. The Resident Engineer should use an analysis to warrant the use of guardrail based on the *AASHTO Roadside Design Guide*. Bridge rail designs and decisions should be coordinated with the Bridge Design and Management Branch.

The Resident Engineer should consider factors such as design speed and traffic volume in relation to barrier need as identified in the *AASHTO Roadside Design Guide*. The cost of slope flattening and hazard elimination compared with barrier cost should be considered.

The design sequence for the placement of barrier is as follows:

1. Provide the clear zone as determined from the *AASHTO Roadside Design Guide*.
2. Provide for slope flattening for traversable grades (4:1 slope) within the clear zone.
3. Remove the obstacle or redesign it so it can be traversed safely.
4. Relocate the obstacle or flatten the steep terrain. Relocate obstacles to a location where an errant vehicle is less likely to impact it. Location should be as far from the edge of travel way as practical.
5. Reduce impact severity by using appropriate breakaway roadway fixtures.
6. Shield the obstacle, terrain feature, or water hazard with longitudinal barrier, crash cushion, or a combination thereof when it cannot be eliminated, relocated, or redesigned.
7. Delineate the obstacle or hazard when the above alternatives are not appropriate due to type of project, low design speed, low volume, classification of the roadway as scenic, or classification of the obstacle as a historical feature.
8. If barrier is impeding the free passage of drainage flow or is causing ponding, consult the Region Hydraulics Engineer to address the drainage problem.

When the Resident Engineer recommends barrier, criteria in the *CDOT Roadway Design Guide*, *CDOT M Standard Plans,* and the *AASHTO Roadside Design Guide* should be followed. For resurfacing, rather than just replace in kind, the existing Type 3 guardrail should first be checked to ensure that the installation configuration meets the length of need criteria in the AASHTO *Roadside Design Guide* or current CDOT M Standard Plans. If Type 3 guardrail condition is such that it will function and safely perform as designed and the height is at least 26.5 inches following 3R work, the guardrail may remain in place. If guardrail would be less than 26.5 inches in height after the 3R work is complete, adjusting and resetting to a specified height of 29 +/- 1 inches may be an option under specific conditions. It is necessary to check to ensure that existing guardrail is in good condition before adjusting and resetting. If the height of guardrail will be less than 26.5 inches following 3R work, the following options are available:

1. Guardrail with a height less than 25 inches must be removed and replaced with 31 inch MGS guardrail per CDOT M-Standards.

2. Guardrail with steel posts at a height 25 inches to less than 26.5 inches may be modified by using additional predrilled bolt holes to raise block and guardrail assembly and reset to height to 29 +-/ 1 inches. If pre-drilled holes are present in W-beam rail, the rail shall be adjusted horizontally along guardrail run, so rail splice location is midspan between posts. Field drilling of steel posts or W-beam rail is not permitted, and only holes pre-drilled by the manufacturer shall be used.

3. Guardrail with timber posts at height less than 26.5 inches must be removed and replaced with 31 inch MGS guardrail per CDOT M-Standards. Field modification of timber posts in any kind is not permitted.

Raising, resetting and/or reuse of removed guardrail posts (steel or timber) in an attempt to attain acceptable guardrail height, in any manner, is not permitted. Consideration must be given to condition of assembly hardware (bolts, nuts) and guardrail components (blockouts, metal W-beam sections) when choosing to leave in place or modify. Replacement of hardware or individual blockouts and/or W-beam guardrail sections may be necessary to ensure overall integrity of guardrail system.

When completing the CDOT Form 463 Design Data in SAP, the designer should provide a detailed description of the barrier elements that do not meet current standards. The description should appear either in the comments section of Section 8, Safety Considerations or in Section 13, Remarks where additional text can be added.

Barrier installations should use the standard configurations as shown in the CDOT M Standard Plans. For situations not addressed in the CDOT M Standard Plans, barrier installations will need to be designed in accordance with the AASHTO Roadside Design Guide. Designers are to include the barrier design calculations as part of the project file. For those barrier designs that are project specific and different from the M Standard Plans, designers need to send the proposed design into the Standards and Specifications Unit for review and comment. Allow 2-3 weeks within the project schedule for this review.

Substandard existing guardrail end sections on all Interstate highway projects and on all National Highway System projects with a design speed of at least 45 miles per hour and an average daily traffic of 6,000 or more are to be replaced.

Replace them with end treatments passing the National Cooperative Highway Research Program Report No. 350 criteria or AASHTO Manual for Assessing Safety Hardware (MASH) 2009. When possible replace substandard end treatments on other roadway systems.

Additional References

1. CDOT *Cable Barrier Guide*
2. AASHTO *Roadside Design Guide*
3. CDOT *Roadway Design Guide*, Chapter 20
4. AASHTO Manual for Assessing Safety Hardware (MASH) 2009