

Guardrail and End Treatments (1 of 2)

ROADSIDE

DESCRIPTION AND DEFINITION

Guardrail and end treatments are used to prevent vehicles from hitting fixed objects along the roadside and to minimize the severity of a road departure crash. The latest practice is to use modern hardware and current standards on guardrails and end treatments to reduce the severity of collisions with guardrail.



Current End Treatment

ROADWAY OPERATIONS

Implementing guardrail along a roadway does not affect traffic operations.

TYPICAL COSTS

Implementation Costs

- Impact attenuator = \$2,500
- Guardrail terminal = \$2,000
- Guardrail transition = \$1,000
- W-Beam or cable guardrail = \$45,000 to \$110,000 per mile

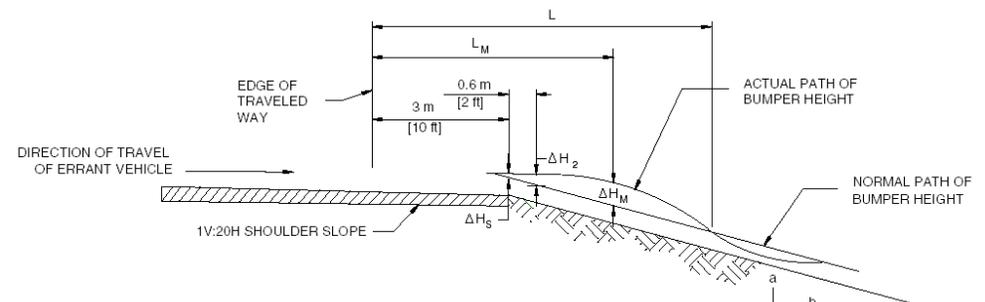
SAFETY CHARACTERISTICS

Guardrail itself is a roadside hazard and should only be placed when the roadside conditions pose a greater threat than the guardrail itself.

DESIGN FEATURES

Guardrail and end treatments come in a wide variety of designs for different applications; the design should match the application. Some key characteristics of guardrail that should be considered with design and implementing include the following:

- **Angle of Impact**—Guardrail is not meant to be hit head-on. It is intended to be hit at angles of less than 30 degrees by passenger cars and light trucks.
- **Deflection**—Vehicles hitting guardrail will be deflected; the plate beam has less deflection than cable guardrail.
- **Curbs**—If possible, guardrail should not be installed behind curbs. Even at modest speeds and shallow impact angles, curbs can cause vehicles to either vault over or dive under guardrail. If guardrail is placed behind a curb, it should be parallel to the curb and within 9 inches of the face of the curb.



- L = Lateral distance where bumper height returns to normal height
- L_M = Lateral distance when maximum bumper height occurs
- ΔH_S = Height of bumper above normal height at outer edge of shoulder
- ΔH_M = Maximum height of bumper above normal height
- ΔH_2 = Height of bumper above normal height at 0.6 m [2 ft] from outer edge of shoulder

Design parameters for vehicle encroachments on embankments

Guardrail and End Treatments (2 of 2)

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PROVEN, TRIED, INEFFECTIVE, OR EXPERIMENTAL

- The only three-star quality rated or higher guardrail study in the FHWA Crash Reduction Clearinghouse documented crash reductions in the range of 10 to 45 percent for the various crash severities.
- Providing guardrail along the roadside is considered a **TRIED** safety strategy.

TYPICAL CHARACTERISTICS OF CANDIDATE LOCATIONS

There is no analytical way of precisely determining whether the guardrail is needed in a given situation. Guidelines and methodologies have been developed but must be supplemented with engineering judgment.

Before guardrail is implemented, a prioritized approach should consider the following strategies before guardrail is installed:

1. **Remove the object**—Completely remove the object that the guardrail was going to be constructed around (see Clear Zones).
2. **Redesign the object**—Redesign the fixed object so it can be safely traversed.
3. **Relocate the object**—Move the object to a point where it is less likely to be struck.
4. **Do nothing**—Sometimes, adding guardrail only provides another hazard for a vehicle to hit.



Examples of Guardrail Creating a Greater Hazard than the Object

BEST PRACTICE

Guardrail is an obstacle and should only be considered when engineering judgment suggests that hitting the obstacle it protects would be worse.

SOURCES

AASHTO *Roadside Design Manual*.

Minnesota *State Aid Manual*.

MnDOT *Guardrail Replacement and Maintenance Guidelines, Final Report #2010RIC13*.



Guardrail and End Treatments Policy

ROADSIDE

POLICY PURPOSE/INTRODUCTION

The purpose of this policy is to establish uniformity and consistency in the application, installation, and maintenance of guardrail on the *<Insert Agency>*'s roadway system.

DEFINITIONS

Three-strand cable guardrail—Three strands of cable are mounted on breakaway posts. Penetration of the vehicle is prevented by the tensile strength of the cable. Cable guardrail contains errant vehicle through the development of lateral forces, which gradually redirect the vehicle through the roadway.

W-beam guardrail—A W-beam is mounted on wood posts with blockouts. Upon impact, the posts break away and the tensile strength of the beam contains the vehicle.

POLICY

It is the policy of *<Insert Agency>* that installation of guardrail will be considered as part of new construction or reconstruction projects and not part of maintenance projects. Installation will be consistent with MnDOT and AASHTO guidelines; engineering judgment will be used for the location and type of guardrail installed.

POLICY CRITERIA

The following guidance should be used in the consideration of guardrail installation:

- Guardrail is an obstacle and should only be considered when judgment suggests that hitting the obstacle would be worse.
- If guardrail is placed behind a curb, it should be parallel to the curb and within 9 inches of the face of the curb.

- No curb configuration has good redirection characteristics at high speeds and large impact angles.
- Guardrail is a hazard and can cause serious injury.
- Guardrail is intended to be hit at angles of less than 30 degrees and by passenger cars and light trucks.
- The choice between plate beam or three-strand cable guardrail is usually a function of dynamic deflection, with three-strand cable being preferred if there is room for deflection and no snow drifting issues.
- Check state aid rules; typically, guardrail is not required if the average daily traffic is less than 400 vehicles per day, but it may be used based on engineering judgment.
- If guardrail is used, the location must have standard end treatments and be maintained.
- Guardrail will not be used where speeds are less than 40 mph unless determined to be needed based on an engineering evaluation. Engineering judgment must be exercised in the application of the guidelines with regard to special hazardous locations.
- Based on MnDOT's Road Design Manual, if maintenance activities are being conducted along a roadway with twisted-end treatments and if it has fewer than 1,000 vehicles per day the guardrail is permitted to remain until a reconstruction project, as long as the in-place guardrail is not disturbed.

FINANCIAL CONSIDERATIONS

All guardrail is to be maintained. The amount of guardrail on *<Insert Agency>*'s system should match the available funding for maintaining the guardrail. If funding is not available for maintenance, a review of existing guardrail and potential removal of guardrail should be considered based on engineering judgment.