Choosing a Barrier

If the decision is made to shield an obstacle, the next step involves selecting an appropriate barrier system. In restricted areas where a long barrier installation might not be feasible, a crash cushion may be an acceptable option. Refer to Section 8C-5 for details.

Choosing an Appropriate Barrier

Three primary factors are involved when choosing an appropriate barrier: deflection of the system when impacted, its cost, and the types of vehicles it can be expected to contain and redirect. Table 1, below, summarizes these characteristics for the three most common barrier types.

Table 1: Barrier characteristics.

Barrier System	Deflection	Initial Cost	Maintenance Cost	Passed Crash Tests with the following
High-Tension Cable Guardrail	10 ft	Low	High	Cars, pickups, single-unit trucks[1]
Steel Beam Guardrail	4 ft	Low	Medium	Cars, pickups
Permanent Concrete Barrier	0 ft	High	Low	Cars, pickups, single-unit trucks, semi trucks[2]

Some other factors that may influence barrier choice include the following:

- Expected frequency of impacts into the barrier
- Ease of maintenance
- Exposure of workers when conducting maintenance/repairs
- Impact on snow removal operations
- Tendency to cause snow drifts
- Aesthetics
- Options for terminating the barrier or transitioning to other barriers

Refer to the following pages for background information on each type of barrier system.

[1] Designed to contain single-unit trucks when installed on a 6:1 or flatter slope

[2] Barrier heights of 42" and greater have been shown to contain semi trucks

Types of Barriers

High-tension Cable Guardrail

High-tension cable guardrail is a flexible barrier system that consists of tensioned steel cables held at varying heights by weak steel posts. The posts are installed in sleeves within concrete foundations, which ease post replacement. Tension in the cables is maintained by anchors at each end of the installation.

Figure 1: High-tension cable guardrail example.

When a vehicle impacts a high-tension cable guardrail, the posts bend or break away, leaving the cables to do most of the work. The cables capture and redirect the vehicle by adapting to its shape and 'grasping' onto portions of its bodywork. Due to this barrier's flexible nature, the forces acting on a vehicle's occupants during a crash tend to be lower than the forces generated by impacts into other barriers. However, this flexibility also means that the cables can deflect as much as 10 feet during a typical crash into the system.

High-tension cable guardrail has the lowest initial cost of all barrier types, but it can be maintenance-intensive. Though the number of posts bent or broken away during an impact depends on the vehicle's size, speed, and approach angle, almost every impact into the barrier will bend or break at least one post. Damaged posts need to be replaced and the tension in the cables should be checked following every impact. However, in most cases the tension should not need adjusting.

These barriers can be used within the median or on the outside of the roadway. Unlike other barriers, they can be installed on slopes as steep as 6:1 (up to 4:1 in some cases). High-tension cable guardrail is typically located a minimum of 10 feet in front of an obstacle in order to provide the necessary deflection distance. However, this distance can be reduced through the use of tighter post spacing. For more specifics regarding the design of high-tension cable guardrail installations, refer to Section 8C-3.

High-tension cable guardrail is the Department's preferred traffic barrier; it has passed crash tests with a wide range of vehicles, is aesthetically pleasing, drifts snow less than other barriers, and is one of the safest barriers available. When faced with an obstacle that must be shielded, consider using high-tension cable guardrail first.

Low-tension Cable Guardrail

Low-tension cable guardrail is also a flexible barrier system consisting of steel cables held at varying heights by weak steel posts. However the cables are under very little tension and the posts are driven directly into the soil, which complicates maintenance. This system was used extensively prior to the development of high-tension cable guardrail designs.

Low-tension cable guardrail lacks some of the benefits of high-tension cable guardrail. It is rarely installed anymore, so its use will be covered minimally in this manual. However, there are certain locations where low-tension cable guardrail may be suitable, such as on low-speed roads or in tight-radius curves. To discuss the possible use of low-tension cable guardrail on a project, contact the Methods Section.

Steel Beam Guardrail

Steel beam guardrail is a semi-rigid barrier system consisting of connected lengths of corrugated steel rail held in place by steel or wood posts and blockouts. The posts are installed directly in the soil and the blockouts are attached to the top of the posts. The rail is mounted on the blockouts, which offset the rail from the face of the posts. This reduces the chance that an impacting vehicle's wheels will become snagged on the posts. Each end of the rail is anchored to the ground or to a stiff object such as a bridge end post.

Figure 2: Steel beam guardrail example.

Steel beam guardrail behaves differently depending on the severity of a vehicular impact. Minor impacts into the system are handled by kinking or flattening of the rail and by the resistance of the posts rotating through the soil. Major impacts into the system result in the posts breaking away and the rail capturing and redirecting the vehicle in a manner similar to the behavior of a cable guardrail system. Steel beam guardrail can be expected to deflect as much as 4 feet during a typical crash—significantly less than a cable guardrail. Therefore, occupants of an impacting vehicle would likely experience higher crash forces than they would if they were to impact a flexible barrier.

Steel beam guardrail costs marginally more than high-tension cable guardrail initially, but it requires less maintenance. Minor impacts cause little damage to the system, and the guardrail can often remain in service without the need for repair. Following a major impact, however, damaged posts and rail sections need to be replaced.

Two types of steel beam guardrail are available for use: W-beam and Thrie-beam. A W-beam rail has two corrugations, while a Thrie-beam has three, making it the stiffer of the two types (see Figure 3). W-beam is more common and is used almost exclusively when steel beam guardrail is required. Thrie-beam has sometimes been used as a standalone barrier in locations where a smaller deflection distance is desired, such as at railroad signal footings. Thrie-beam is also used when transitioning from W-beam to a stiffer barrier type or to a fixed object.

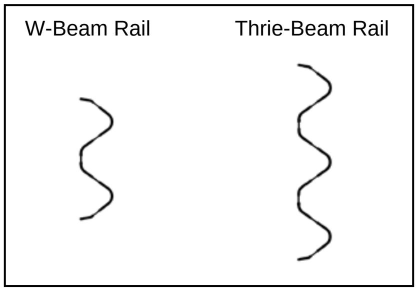

Figure 3: Comparison of rail cross sections.

In 2009, the Iowa DOT adopted a modified W-beam guardrail as the standard. Compared to the old design, the top-of-rail height was raised from 27 inches to 31 inches, the blockout depth was increased from 8 inches to 12 inches, and the rail splices were moved to the midpoint between posts. These changes resulted in a higher-performing system compared to the old W-beam design.

Steel beam guardrail has passed crash tests with passenger cars and light trucks, and it can be used within the median or on the outside of the roadway. However, there are restrictions regarding its placement on or near slopes steeper than 10:1. And because it can deflect up to 4 feet when impacted, proper placement in front of obstacles is critical. For more specifics regarding steel beam guardrail installations, refer to Section 8C-2.

Permanent Concrete Barrier

Permanent concrete barrier is a rigid barrier system consisting of reinforced concrete shaped to withstand a vehicular impact. Concrete barriers can be tied to an underlying pavement with reinforcing bars, attached to pavement with dowels, or mounted on a footing. Although concrete bridge rails may share the same shape and basic design as permanent concrete barriers, their function is different, so they will not be discussed in this manual. For more information on bridge rails, refer to Section 5.8.1 of the Office of Bridges and Structures Design Manual.

Figure 4: Permanent concrete barrier example.

Permanent concrete barriers do not deflect under impact. Therefore, when a vehicle impacts a permanent concrete barrier, all the energy of the impact is absorbed by the vehicle through bending and crushing of its structure and sheet metal. Additionally, crash forces experienced by the vehicle's occupants would tend to be higher compared to impacts with other barrier types.

The initial construction cost of permanent concrete barriers is significantly higher than other barrier types. However, they require very little, if any, maintenance. Repair is usually only required following an extreme impact by a heavy vehicle.

Permanent concrete barriers have been crash tested with a wide range of vehicles, and they are the only type of barrier that can be designed to withstand an impact from a semi truck. Depending on their shape, they may be located within the median or on the outside of the roadway. However, they should not be installed on slopes steeper than 10:1.

A permanent concrete barrier is usually chosen when deflection of the barrier is unacceptable, in areas with high truck traffic, or when penetration of the barrier by some vehicles must be avoided. Because of the danger of high-angle impacts, they should generally not be placed more than 15 feet from the edge of a roadway, and they should not be used when another type of barrier will suffice. For more specifics regarding permanent concrete barrier installations, refer to Section 8C-1.

Chronology of Changes to Design Manual Section:

008B-005 Choosing a Barrier

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