January 2003

Guide Rail: Choosing the Right Guide Rail

Cornell Local Roads Program Tech Tips

There are five basic types of guide rail: cable, weak post W-beam, heavy post blocked out (HPBO) W-beam, and box beam. Each type behaves differently in a crash. To choose the right rail, compare the situation to the strengths and limitations of the different rail types and find the best match.

Guide rail is tested according to a procedure called NCHRP 350. Pickup trucks and economy cars are run into guide rails and other roadside hardware at speeds up to 62 mph. Guide rail needs to be strong enough to contain the heavier vehicles without causing too severe a collision for the lighter ones. Municipalities should use systems that have passed this testing (this is required on federal aid projects). Municipalities are not required to follow NYSDOT approved lists, but it might make getting replacement parts easier.

Guide rail designs are frequently being improved because of testing and real world performance. Double posts on box beam end sections and wood blockouts on HPBO W-beam are examples. When installing new rail make sure you have the latest design information.

DEFLECTION DISTANCE

When a vehicle collides with guide rail, the guide rail bends and absorbs some of the impact energy. Deflection distance is how far the rail will bend under a normal impact. If the guide rail's deflection distance is greater than the distance from the rail to the hazard, it will not adequately protect vehicle occupants from the hazard. This will reduce the chances of the rail getting hit. See Table 1 on Page 2 for deflection distances of the most common guide rail types.

Flexible rails (cable and weak-post W-beam) tend to produce lower impact forces when hit. This reduces the chances of injury to vehicle occupants compared to semi-rigid types and concrete barriers. On the other hand, they have some significant limitations not shared by the semi-rigid rails like box beam and HPBO W-beam. You can also take advantage of the lower deflection of box beam and heavy post blocked-out W-beam by placing the rail closer to the hazard. This moves it farther from the road and makes it less likely to get hit.

CORNELL LOCAL ROADS PROGRAM
416 RILEY-ROBB HALL, ITHACA, NY 14853
PHONE: (607) 255-8033
FAX: (607) 255-4080
E-MAIL: *clrp@cornell.edu*
INTERNET: *www.clrp.cornell.edu*

Tech Tips are published by the Cornell Local Roads Program with support from the Federal Highway Administration, the New York State Department of Transportation, and Cornell University. The content is the responsibility of the Local Roads Program.

Figure 1: This rail does not have enough deflection distance to protect traffic from the tree

Figure 2: This rail deflected into the concrete bridge column and failed to protect the people in the car

INFORMATION ABOUT SPECIFIC GUIDE RAIL TYPES

Cable

Cable guide rail is one of the least expensive types, but the most easily damaged. Even minor contact during snow plowing can put the system out of service. Because cable is so easily put out of service, the system should only be used on high volume roads if you can solidly commit to promptly repairing it. Another consideration is the need to ensure that mowing or other means can be used to prevent trees from growing within the deflection distance.

Steep slopes should not be shielded with cable if the deflection distance of the cable will exceed 8 feet and the slope is in close proximity to the run of the rail. Vehicles under standard impact conditions will deflect a cable rail about 11 feet if the cable is supported on posts spaced 16 feet apart. While tighter post spacing can reduce deflection distances to 8 feet or less, the best practice is not to use cable next to steep (1:2) slopes.

Table 1: Deflection Distance

Rail type	Post spacing	Deflection distance*
Cable	4'' 0''	7'
	8'' 0''	8'
	12'' 0''	11'
Weak post W-beam	4' 2''	5'
	6' 3''	6'
	12' 6''	8'
Box beam	3' 0''	4'
	6' 0''	5'
Heavy post, blocked-out W-beam	3' 1.5''	2'
	6' 3''	4

*Deflection distance is measured from the face (road side) of the rail to the front of the object

Curb can cause or permit serious accidents on high-speed roads. Because of its flexibility, cable will not right a vehicle that has “tripped” over curb during a sideway skid. Similarly, cable rail, unless a cable snags on some part of a vehicle, will offer little resistance to a vehicle that has begun to vault because of hitting a curb.

Advantages:

- It is the least expensive type to install
- It deflects the most, which softens the impact to the occupants of a car that hits it
- It does not cause snow drifting
- It blocks visibility the least

Disadvantages:

- It deflects the most, so it requires the largest distance between the barrier and the shielded object
- After it is hit, the effectiveness of the whole run is drastically reduced – even away from the crash site
- It requires repair after every impact. Because of this, use on high volume roads is not recommended
- It should not be used on curves with a radius less than 440 feet, because the cable tension will bend the posts
- It should not be used above slopes steeper than 1 on 2, unless the post spacing is reduced to limit deflection to 8 feet or less

Weak post w-beam

Weak post w-beam is one of the most common types used. This rail is stiffer than cable, and needs less maintenance. It has a major drawback in that pickup trucks and SUV’s tend to go over it at higher speeds.

Weak post W-beam failed the high-speed portion of the NCHRP 350 testing, so it should only be used where traffic speeds are 42 mph or less. A new design for weak post w-beam rail has passed the 62 mph test, but here is no approved high-speed end section for it yet

Advantages:

- Deflects less than cable rail, so it can be placed closer to the hazard
- It is more durable than cable. A crash usually just affects the impact area, not the whole run
- Light post w-beam guide rail costs less than box beam and heavy post blocked out w-beam

Disadvantages:

- Should not be used if traffic speed is > 42 mph. At higher speeds, pickups and SUV's can go over it
- Deflects enough to need 5 to 8 feet of clear space behind the rail
- Often needs to be repaired after crashes
- It may act as a snow fence and cause drifting
- Aesthetic restrictions. The rail obstructs views, so this rail is not welcome in many parks and areas with high visual values.

Box beam

Box beam is a hollow six-inch square beam mounted on light posts. The rigidity of the beam spreads the impact out over many posts. Because of this, box beam runs less than 125 feet long will deflect more than shown in Table 1.

Advantages:

- It needs less room for deflection than light post w-beam or cable guide rail.
- Less visually obtrusive than w-beam

Disadvantages:

- It is expensive (20 percent more than heavy post w-beam rail, according to NYSDOT)
- Because of its rigidity, "shop-curved" sections need to be special ordered for radii less than 725 feet.
- If shop-curved sections are damaged, the need to special-order curved sections may delay repairs.
- It is difficult to repair because of the weight of the beam sections.

Heavy post blocked-out (HPBO) w-beam

This uses the same type of beam as weak post w-beam, but it is mounted on heavier posts. Wood or plastic blockouts hold the rail out away from the posts, so that the vehicle's front wheel doesn't snag on a post. Do not use heavy posts without blockouts. The posts are strong enough to flip the vehicle when the wheel snags on the post, which can cause serious injuries to the occupants. Steel blockouts were formerly used, but they collapsed in testing and allowed snagging.

Advantages:

- Durable – it can survive mild hits with minimal need for repair
- Its deflection is low, so it can be used when the hazard is close to the road

Disadvantages:

- Because it doesn't deflect much, the impact forces tend to be high and car occupants are more likely to be injured. It should be used when little deflection distance is available, or on high volume roads where the safety increase due to its durability offsets the safety decrease because of its rigidity.
- More expensive than softer systems.
- Same aesthetic restrictions as weak post W-beam

Other rail systems

Other types of guiderail have been developed, mostly for park settings or other areas where aesthetics are important. These include steel-backed timber rail, and Ironwood™ guiderail. They are expensive, and crashworthy end sections are not always available. Because of the cost and end section problems, they will not be discussed further.

TERMINALS

Once you've chosen a rail, the next step is choosing terminals or end sections for it. Terminals have two requirements. They must act as an anchor to resist impact forces, and they need to be crashworthy, to reduce the chances of injury to occupants of a vehicle that hits one.