10.2.3 Barrier Types

There are four types of barrier in common use in New York: cable guide rail, corrugated metal or W-beam guide rail, box beam guide rail, and concrete barriers. They are discussed in the following subsections in order of increasing rigidity. Note that W-beam may be mounted on either weak posts or heavy posts (see Section 10.2.3.5) and in the latter case is much more rigid.

The selection of an appropriate barrier is primarily governed by safety considerations and secondarily by cost. In general, the most flexible barriers will have the lowest lateral deceleration rates and will perform better at gradually redirecting an errant vehicle. Unfortunately, barriers with large deflections may not perform well adjacent to steep slopes. Additionally, when a flexible system is struck, it will usually require extensive repair work before it will function properly again. In areas with frequent accidents, this may result in a significant accumulation of time during which the barrier is not operational. Also, the regular presence of repair crews must be considered as a potential hazard, both for the motorist and for the workers themselves. In such circumstances, use of a heavy-post blocked-out corrugated barrier or a rigid concrete barrier may be warranted, as they seldom require repair work. Refer to Section 10.2.4.1 for further discussion.

The safety of a given barrier system will also vary depending on the type of vehicle involved. Most barrier systems presently in service have been crash tested with either a standard passenger car or a standard and a lightweight car. As a result, the barrier systems are well adapted to the protection of the most common vehicles, but may not be well adapted to larger vehicles such as pickup trucks, vans, and tractor trailers. The point should be stressed that the barrier systems that have been developed are a compromise intended to provide protection for occupants of the average, more common vehicles in a fleet with broad diversity. Preference should be given to improving clear zones where practical rather than simply installing barriers.

Because of their size, buses and large trucks are not well protected by W-beam and cable guide rails. Box beam and concrete barriers function better for large vehicles. The designer should review the distribution of vehicle types expected on a finished project as a factor in selecting appropriate barrier types. The Design Quality Assurance Bureau should be consulted for barrier selection and design guidance for areas where truck penetration is deemed unacceptable.

In some situations, it may be desirable to evaluate the cost of providing a barrier system for comparison to other options such as buying right of way so slopes may be flattened. When evaluating the cost of a barrier system, the designer should consider (1) the initial cost of the system, (2) the cost of the types of repairs that may be required, (3) the frequency at which the various repairs will be required, and (4) the anticipated relative safety benefit. The first factor may be estimated from previous bid prices which are published in the Department's "Weighted Average Bid Prices". The second factor should be available from maintenance records for that Region or, for new roads, predictions may be obtained by the use of the computer program Roadside. The third factor may be estimated based on a combination of traffic projections, accident history data, and maintenance records. The fourth factor will generally be based on
ROADSIDE DESIGN

professional judgement and consideration of such concerns as frequency, type, and severity of accidents. In some situations, the potential for damage to adjoining property and road closures due to truck overturning should also be considered.

In general, the initial cost of weak-post W-beam will be about twice the cost of cable guide rail. Heavy-post blocked-out W-beam will be about twice the cost of weak-post W-beam. The cost of box beam will be about five times the cost of cable, and the cost of concrete may be as much as ten times the cost of cable. The maintenance costs may be significant for weaker systems and will be strongly controlled by traffic conditions.

10.2.3.1 Cable

Various types of cable guide rail have been used in New York State since the early 1900s. The older configurations are still in service along many rural roads. The currently accepted standard details for cable guide rail are shown on the Standard Sheets for 606 items. The system is designed to yield more readily than any of the other barriers. The 19 mm cables are fastened to light metal posts. At impact, the cables are supposed to engage the vehicle either in grooves they form in the sheet metal or around projections such as bumpers. As the vehicle impacts the posts, they are bent aside and the lightly fastened cables pull away from the connections. Lateral movement is arrested by the combined effect of the bending of the posts and the tension built up in the cables.

Since it is essential that the cables develop tension to restrain the vehicle, each end of the run must be anchored. Details of the terminals are discussed in Section 10.2.5.1. To limit the total deflection distance, it is important that the system provide adequate tension in the cables prior to an accident. This requirement imposes a limitation on the curvature at which the cable guide rail may be installed. To prevent the posts from being pulled over by the centripetal force from the cable tension, the system is not to be installed on curves with a centerline or horizontal control line radius of less than 135 m. To avoid placing cable guide rail where the radius of the horizontal control line is less than 135 m, one of the following actions should be taken.

- Whenever it is reasonably possible to do so, eliminate the need for railing in the affected area.
- Use another type of guide railing that may be installed on the radius.
- Transition from cable to box beam before the area of the tight radius.

As indicated on the Standard Sheets, intermediate anchors should be used, if necessary, to limit the length between terminal sections to 600 m or less. Continuous runs which exceed that length would experience unacceptable amounts of thermal expansion and contraction. When measuring for payment, the overlapped sections are to be treated as separate runs.

There are also minimum length concerns for cable runs. On short runs, it is likely that all of the cable will be pulled from the posts, significantly increasing the deflection distance. Anchor to anchor lengths of less than 60 m should be avoided and lengths of less than 30 m should not be used.
The main advantages of cable guide rail are that it:

- produces the lowest deceleration rates,
- has the lowest initial cost,
- is relatively easy to repair,
- provides the least obstruction to snow plow cast,
- does not induce snow drifting, and
- produces little visual obstruction.

The last advantage is both a safety consideration and an aesthetic consideration.

The disadvantages of cable guide rail are that it:

- requires the largest distance between the barrier and the shielded object,
- should not be used on curves with a radius of less than 135 m,
- requires repair after every impact,
- should not be used adjacent to slopes steeper than 1:2, unless its post spacings are reduced to limit its deflection to 2.4 m or less,
- should not be used adjacent to vertical or mountable curb on medium- or high-speed highways,
- requires regular maintenance to maintain tension,
- may have problems stopping low frontal geometry vehicles from passing under the rail system,
- requires that a large area behind the guide rail be maintained free of trees larger than 100 mm in diameter, and
- is the least effective barrier for reducing headlight glare.

Note that extra length posts may be required when guide rails are used adjacent to steep slopes. Refer to Section 10.2.3.5.

Cable guide rail may be warranted if:

- the appropriate clear zone width cannot be economically obtained,
- the hazards are beyond, or can and will be removed from within, the relevant deflection distance of the cable, and
- any adjoining slope is 1:2 or flatter.

Because its impact durability is so poor, cable guide rail should no longer be installed on highways with AADTs in excess of 5,000 vehicles per lane per day. Furthermore, regardless of volume, the use of an approved barrier system other than cable will be acceptable if it is anticipated that there would be significant problems with maintaining a cable system in that location. However, cable guide rail may be used for roads with higher traffic volumes if the correspondingly increased effort can be made to provide timely repair and maintenance.
10.2.3.2 W-Beam

W-beam, or corrugated beam, guide rail may be mounted on either a weak post or blocked-out on a heavy post. The difference in the two post systems is discussed in Section 10.2.3.5. In many respects, the systems are similar except for the increased rigidity of the heavy-post system. Section A, below, describes the weak-post W-beam and is generally applicable to heavy-post except as noted in Section B.

A. Weak-post W-beam

W-beam guide rail consists of lengths of corrugated steel sheeting with a cross-section shape similar to a W. These are bolted directly to 75 mm x 8 kg/m I-beam posts with 8 mm bolts. Refer to the Standard Sheet for 606 series items for details of the W-beam system.

Weak-post W-beam has been a Department standard for many years. It successfully redirected four-door sedans during the NCHRP 230 testing. However, changes in the vehicle fleet have resulted in an increased percentage of high center of gravity vehicles on the road. In recognition of this, NCHRP 350 moved to a 2000 kg pickup truck as the primary test vehicle. The weak-post W-beam was crash tested with the new test vehicle. While the initial test at 70 km/h was satisfactory, the test at 100 km/h was judged not to be. The system was subsequently tested and found satisfactory at 80 km/h. Although the rail is still satisfactory for cars, its poor results with a pickup truck have led to the decision to stop installing new runs on highways with operating speeds in excess of 80 km/h. Because existing runs of weak-post W-beam rail will generally function satisfactorily for most of the passenger fleet, it is not judged necessary to have a separate program to replace them. In some instances, however, an accident analysis may indicate a significant number of crashes on a W-beam guide rail and a high percentage of penetrations. In these instances, alternative systems should be installed. (Note that, on lower volume roads, it may be helpful to examine more than three years of accident data to get a statistically significant evaluation of the penetration rate.) For the time being, the Department has decided to replace existing runs of weak-post corrugated barrier on reconstruction projects with operating speeds in excess of 80 km/h. It has also been decided to replace this system on 3R type projects on freeways. On other 3R projects, replacements of existing weak-post W-beam with another system may be made at the discretion of the Regional Design groups, but will not be considered necessary unless the first three of the following conditions are met or the last one is met:

- the operating speed is over 80 km/h,
- the rate of reportable accident impacts on the weak-post W-beam guide rail exceeds 0.2 crashes/year/km, and
- the percentage of impacting vehicles that penetrate through, over, or under the weak-post guide rail exceeds approximately 10%,

or

- the subject highway is an interstate or similar high-speed, high-volume facility.
Note, however, that replacements are encouraged if convenient for the particular project or if the run of existing guide rail requires significant work to be done, particularly if the run has a history of penetrations or rollover accidents.

With regard to 100% State-funded repair and maintenance contracts, weak-post corrugated guide rail and median barrier may be repaired and maintained, without replacement, under these contracts on facilities of all types, although replacements are encouraged in the situations noted above.

When W-beam is installed, individual pieces of corrugated beam must be mounted so that, for the normal traffic conditions (as opposed to a temporary construction condition), the trailing end of each, rather than the leading end of the next section downstream, is exposed to the predominant flow of traffic. That is, the direction of overlapping should shield the leading (upstream) ends. Individual sections of W-beam are fastened together so they can develop longitudinal tension and a restraining component similar to cable guide rail. As with cable guide rail, it is essential that the W-beam be properly anchored and continuously connected to provide the tension component. In addition, W-beams have significant lateral rigidity and therefore have lower deflection distances than cable. This lateral rigidity also requires that W-beam must be shop curved for installation on curves with radii of less than 45 m. Because of their lower deflection distance and their degree of in-plane rigidity, W-beam guide rail may be used adjacent to steep slopes. Refer to Section 10.2.3.5 for limitations on how close the supporting posts may be placed to the shoulder break.

The main advantages of W-beam guide rail are that:

- its lower deflection distance permits it to be placed closer to a hazard than cable guide rail may be,
- the system is more durable than cable, as the damage from a mild hit affects only the impacted zone rather than the entire run as with cable, and
- the system is not much more expensive than cable, and significantly less expensive than box beam or concrete barriers.

The main disadvantages of W-beam are that:

- its deflection distance does require a significant separation from shielded hazards,
- it is rigid enough to be considered a hazard in itself,
- it is more visually obstructive than cable,
- it frequently needs repair after being hit,
- it has a long-term tendency to be pushed over by the lateral force of snow plowing,
- exposed segment ends may present a snagging or spearing hazard to wrong way traffic,
- it may act as a snow fence and induce drifting, and
- in accordance with the NYSDOT Guidelines for the Adirondack Park, "corrugated beam guide rail (W-beam) shall not be used" within the Adirondack Park.

W-beam guide rail may be warranted when operating speeds are 70 km/h or less and:


- the appropriate clear zone width cannot be economically obtained,
- site conditions do not permit the use of cable, and
- the rail can be positioned so the distance from a nonremovable hazard to the roadside face of the rail meets or exceeds the relevant deflection distance.

B. Heavy-post Blocked-Out W-beam

To remedy the high repair incidence while still providing a yielding system, the heavy-post blocked-out W-beam guide rail was developed. The blockout piece holds the rail away from the post to reduce the chance that part of an impacting vehicle will extend under the rail and snag on the posts. The heavy posts are much stouter than the weak posts and snagging on them could cause a vehicle to turn and roll over. The typical details are shown on the Standard Sheets for 606 items. To limit deflections and the potential for pocketing and wheel snagging, the typical post spacing is only 1.905 m. The main advantages of heavy-post blocked-out corrugated beam guide rail are that it has a low deflection distance and it can survive mild hits with minimal need for repairs. The main disadvantage of the system is that it produces more severe lateral deceleration of impacting cars than do the weak-post systems. A secondary disadvantage of the HPBO system is its total width, which can be difficult to fit between the paved shoulder and a steep shoulder break. The heavy-post system may be warranted where barrier is needed and the traffic volume exceeds 50,000 vehicles/day. The decreased safety due to the high rigidity is offset by the increased safety obtained by limiting repair interruptions. In instances where a guide rail is needed but there is not enough clear area to accommodate cable, either heavy-post blocked-out W-beam or box beam are the logical alternatives to weak-post W-beam guide rail.

10.2.3.3 Thrie Beam

Thrie beam is a corrugated steel rail similar to W-beam, but with three corrugations instead of two. The third corrugation increases the height of the section from 311 mm to 508 mm. The section is significantly stiffer as a result, and can be placed to provide shielding over a larger vertical range. As a comparatively new product, its uses along mainline highway sections are limited but increasing. Its chief use to date has been as a transition section between the yielding W-beam guide rail along highways and the unyielding concrete parapet walls on bridges. Refer to the Bridge Detail sheets for further information on the thrie beam transitions.

Thrie beam has also been used as a side component in some proprietary impact attenuators.

In special instances, the Department has used thrie beam to assist in rockfall control along highway rock cuts.

The main disadvantage of thrie beam is its cost, and, in particular, the cost of the transition piece. Pending further crash testing and field testing, thrie beam is not warranted for normal highway use.
10.2.3.4 Box Beam

This railing is a square structural steel tube, 152 mm on a side with a 4.75 mm wall thickness. The rail is significantly more rigid than a W-beam and must be shop curved for radii under 220 m. Details of the system are shown on the Standard Sheets for 606 series items. The system develops most of its redirective strength through beam action and therefore does not require anchor blocks. Note that runs must be at least 38 m in length (measured as full length of rail, toe to toe of terminals) for the system to develop its intended deflection resistance.

The main advantages of box beam guide rail are that:

- It requires less space for deflection than an equivalently supported W-beam.
- Its splice connection detail practically eliminates spearing problems.
- It is less of a visual obstruction than W-beam.
- It has a stronger, more rigid rail element and is therefore better at bridging between points of support. (When struck, the corrugations in W-beam tend to flatten, reducing its beam strength and increasing its tendency to fold around objects behind the rail, rather than supporting itself as a rigid beam against them. This only becomes an issue when vehicles strike the rail and cause more than the standard deflection or objects are present within the deflection distance.)

The main disadvantages of box beam guide rail are that:

- It is less forgiving than cable or weak-post W-beam guide rail.
- It is significantly more expensive than cable or weak-post W-beam guide rail (but only about 20% more expensive than heavy-post blocked-out corrugated rail).
- It is more difficult to repair.
- Significant repair delays may occur if damaged rail must be replaced with sections shop-curved to the correct radius.

Box beam guide rail may be warranted when either of the following conditions apply:

- The appropriate clear zone width cannot be economically obtained and the available space between any nonremovable hazard and the edge of shoulder is adequate for box beam but not for cable or W-beam on weak-posts.
- It is necessary to transition to a rigid barrier system.
10.2.3.5 Post Systems

Most of the barriers discussed above (heavy-post, blocked-out W-beam being the exception) are supported on "weak-posts". These posts are S75 x 8s, designed to bend aside when struck, rather than contributing to vaulting or rapid deceleration problems. Depending on the system and rigidity desired, weak-post spacing may vary from as much as 5.0 m to as little as 0.915 m. (See Table 10-3.) The reduced post spacings are achieved through the use of backup posts which provide additional lateral resistance. To minimize the potential for snagging, the backup posts for W-beam and box beam rails are not fastened to the rails. All weak-posts require soil plates to enhance their lateral resistance to impacts. In many cases, the light steel I-beam posts may be bent back into position and reused. Because the posts are weak, however, they require maintenance after most of the impacts. In locations with a high frequency of accidents, the downtime and repair costs can be significant problems.

The "heavy post" is a W 160 x 14, which is approximately four times as rigid as the weak-post, and must, therefore, be considered as more of a potential hazard. To minimize the danger of vehicles snagging on the posts, the rail is blocked-out in front of the posts. The traditional metal block-out has been replaced with a solid block-out that provides 190 mm of separation between the rail and the post (versus the traditional 150 mm). The solid block-outs are to be made of either wood (Standard Specifications 710-20 and 710-13, issued by EI 97-016) or plastic and synthetic (Standard Specification 710-26, issued by EI 99-035). Steel block-outs should not be reset or used for repair of damaged HPBO guide rail. To maintain the usable shoulder widths, heavy steel posts should now typically be positioned 250 mm from the edge of usable shoulder.

When additional rigidity is needed in the heavy-post system, the post spacing may be reduced from its normal spacing of 1.905 m to 0.95 m. At this spacing, soil plates are required to be welded to the posts. The plates are positioned just below ground surface. They serve to increase the area of soil that is resisting overturning at impact. To ensure that a sufficient amount of soil is present to provide the lateral resistance, posts should be placed no closer than 0.3 m to shoulder breaks where the embankment slope is steeper than 1:4.

In addition to the steel heavy-post system, a pressure-treated wood post system with weathering rail has been used as an aesthetic treatment along some parkways. The posts and blockouts are 200 mm x 200 mm. To maintain the usable shoulder widths, the front of the wood post should be positioned at least 260 mm from the outside edge of the usable shoulder.

A Extra Length Posts

When the recommended offsets from the back of the posts to the shoulder break cannot be achieved, the lateral soil support at impact may not be adequate. To compensate, extra long posts, Items 606.48xx, should be used. Note, in the item specification, that the soil plates are placed deeper than on the standard posts. Extra long posts should be used when the embankment slopes away from the normal shoulder break at steeper than a 1:2 slope. Extra long posts should not be used past the shoulder break. (The shoulder break is the...
line of intersection of the plane of the embankment with the plane of the shoulder slope and should normally be located 0.7 m from the outside edge of the usable shoulder.) In situations where the normal offset and embankment slopes cannot be used, Table 10-4 provides guidance on post selection as functions of slope, offset and soil type.

When 2135 mm posts are required, the weak-post guide rail deflections should be considered to be 1.3 times the values in Table 10-3.

The designer should note that the driving of any post requires that extra care should be exercised in locating underground obstructions such as utilities, shallow culverts, and top of rock. As part of the normal design process, all utility companies with known facilities within the project limits need to be contacted to ascertain their facility locations. Street lighting conduits, ITS facilities, and telecommunications lines are particularly susceptible due to the fact that they are often approved for shallower depth installations.

Table 10-4 Minimum Shoulder Break Offsets (in mm) to Back of Guide Rail Posts

<table>
<thead>
<tr>
<th>Embankment Slope</th>
<th>2135 mm Long Weak Posts (S75x8)</th>
<th>1600 mm Long Weak Posts (S75x8)</th>
<th>2135 mm Long Heavy Posts (W160x14)</th>
<th>1676 mm Long Heavy Posts (W160x14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:3</td>
<td>0.0</td>
<td>150*</td>
<td>0.0</td>
<td>300*</td>
</tr>
<tr>
<td>1:2.5</td>
<td>0.0</td>
<td>300*</td>
<td>0.0</td>
<td>460</td>
</tr>
<tr>
<td>1:2</td>
<td>0.0</td>
<td>460</td>
<td>0.0</td>
<td>610</td>
</tr>
<tr>
<td>1:1.5</td>
<td>150</td>
<td>760</td>
<td>0.0**</td>
<td>760</td>
</tr>
</tbody>
</table>

*Use 2135 mm long posts if post is within 150 mm of the minimum offset and the soil is sandy or weak.
(Example: With embankment slope of 1:2.5, sandy soils, shoulder break at 400 mm from back side of weak-post, use 2135 mm extra long post since 400 mm is within 150 mm of the 300 mm minimum shoulder break offset.)

**Do not use with an offset of less than 150 mm in sandy or weak soil.
B. Vegetation Control Strips

Vegetation management is an important element to be considered when designing a project. Vegetation management is needed along roadsides to prevent the growth of (1) vegetation that would reduce safety by obscuring sight distances, (2) trees that would be potentially hazardous fixed objects, and (3) vegetation that would encroach into the shoulder area and effectively reduce the shoulder space available for safe walking and bicycling. A particular maintenance problem is the area close to and under guide rail. Mowing machines are difficult to maneuver in these locations and, even with very careful use, cannot be fully effective at controlling vegetation adjacent to posts. Furthermore, unintended contact can result in damage to both mowers and posts.

Two different control measures have typically been used as alternatives to mowing: total vegetation control herbicides or an Optional (hot-mix asphalt) Mowing Strip beneath the rail to suppress plant growth. The Department continues to strive to reduce the use of herbicides.

It is part of the Department’s vegetation management policy to encourage the use of vegetation control strips (VCS) under guide rail when that use will contribute to reducing the Department’s use of herbicides. The typical VCS shall consist of hot-mix asphalt with a minimum thickness of 75 mm. The width of the VCS will be dependent on the specific site conditions. In the normal shoulder section, the shoulder break is 0.7 m beyond the edge of shoulder and the width of the strip that can reasonably be compacted will be limited to 0.6 m for embankment side slopes of 1:6 or steeper.

Where the presence of a wider, sufficiently level area behind the rail permits placement and compaction of asphalt, the mowing strip should extend to 0.5 m beyond the guide rail and posts.

Rail-type median barriers and flared-back guide rail can normally be accessed from both sides. The aesthetic benefits to managing the vegetation by mowing may be sufficient to warrant that effort. Furthermore, running paved strips diagonally down a slope runs the risk of concentrating sheet flow and inducing erosion. However, if it is determined that vegetation management under a rail is required, but that mowing is not practical, then preference should generally be given to using a VCS rather than resorting to a total vegetation control herbicide. Where the guide rail or (rail-type) median barrier is not adjacent to the shoulder and there will be mowed areas between the shoulder and the railing, the width of the VCS should be 1 m, except that a width of 1.5 m should be used for HPBO median barrier. The strip should be positioned to permit equal mowing offsets from either side of the rail system. Where vegetation control strips are needed and the guide rail is not adjacent to, but is less than 1.5 m from the edge of a shoulder, the space between the shoulder and the mowing strip should typically be paved, unless it is judged that a mowed space has sufficient aesthetic or stormwater management value to warrant the effort and risk of mowing.

Where guide rail flares away from the road, the VCS, if required, should follow the line of...
the rail. This would typically result in an area requiring mowing between the rail and traffic. To minimize the danger to both the mowing crews and the traveling public, the mowing strip should be widened to cover the area between the shoulder and the railing in areas where both (1) the distance between the edge of traveled way and the railing is less than 4.0 m and (2) the traffic volume exceeds 2000 vehicles per day.

Measurement will be made on the basis of the number of metric tons satisfactorily placed and compacted. Where the VCS can be placed as an extension of the shoulder paving operations, the quantity will be included in the shoulder items. Where the VCS must be placed separate from the shoulder paving operations, payment will be under Item 608.020101 M Asphalt Concrete Sidewalks, Driveways and Bicycle Paths and the corresponding Plant Quality Adjustment Factor (Item 608.020110).
10.2.3.6 Concrete Barriers

In some situations, it is necessary to provide for redirection without deflection. In these instances, a rigid concrete barrier may be appropriate. The New Jersey Department of Transportation developed a cross-section that flared out at the base. It was intended that the base would deflect tires on low angle hits, thereby minimizing property damage. This shape came to be known as the Jersey Barrier and has been widely used. Details for the shape and the half section are shown on the Standard Sheets for 606 series items.

One potential problem with the standard Jersey shape, and with similar shapes that have “toes” projecting out in front of the face, is the possibility for small vehicles that impact at an unfavorable angle to ride up the face and roll over. To minimize the likelihood of this occurrence, the surface of the shape should be smooth to reduce the traction of tires that impact the barrier. Also, the height of the vertical face of the toe should not exceed 75 mm. Taller toe faces have been shown to increase the tendency of vehicles to “climb” the barrier.

Foundation and overturning support conditions for half sections should be reviewed for the specific conditions of use. A 0.23 m embedment is typical for most soil conditions. The designer should consult the Regional Geotechnical Engineer for any special foundation design requirements.

A specific concern with concrete barriers, particularly precast barriers with their more frequent joints, is the possibility that an impacting vehicle might cause one segment to displace laterally, which would then permit the vehicle to strike the end of the next segment. Several measures may be used to help avoid this problem and ensure that all segments act as one continuous barrier. First, for precast and cast-in-place (set-formed) half section barriers, either backup posts and continuity connections are to be used or compacted earth berm backfill is to be placed as shown on the Standard Sheets. For slip-formed half section barriers, since the longer lengths provide for substantially more massive segments, backup is only required at the expansion joints. Where the available space allows, properly embedded full sections may be used. Their wider base and greater mass will generally permit their use without backup or continuity connections.

Because of the added threat posed when vertical elements, such as bridge piers, are in close proximity behind concrete barriers, extra measures should be taken to reduce the likelihood of vehicles climbing or leaning over the top of the barriers. As shown on the "Pier Protection" Standard Sheets, a box beam should be mounted to the top face of the barrier to limit vehicle climb. Although no testing has been performed to confirm the premise, it is anticipated that the box beam would also help to limit roll angles and "lean over" of tall vehicles. Details of the above options are presented on the 606 series Standard Sheet titled "Pier Protection". Because the Pier Protection arrangement is essentially a rigid system, its use should be limited to the cases where it is specifically warranted. The arrangements on the Standard Sheet "Pier Protection" should be used when a bridge pier exists so close to the roadway that placement of guide rail, with its corresponding deflection distance, could not be made without encroaching onto the shoulder by more than 25% of its width. To reduce accident severity, guide rail should be used in preference to the arrangement on the Standard Sheet "Pier Protection" when the
guide rail would encroach on less than 25% of the shoulder’s width.

In any case where encroachments are to be retained inside of the shoulder width specified for the project, a nonstandard feature justification should be prepared as indicated in Chapter 2 and retained in the Design Approval Document or, if determined after Design Approval, in the permanent project record.

Other concrete barrier alternatives have been successfully used for protection of large vehicles. These have primarily involved increased heights, either as vertical extensions of half shapes or straight-faced walls. If the designer encounters a situation that may warrant a nonstandard concrete barrier, the Design Quality Assurance Bureau should be consulted for information on acceptable options. Refer to Section 10.2.4.9 for a description of innovative barriers.

The main advantages of concrete barriers are that they:

- provide redirection when there is no space available for barrier deflection,
- require very little maintenance or repair, and
- may effectively block headlight glare.

The disadvantages are that they:

- are unyielding hazards that may produce severe decelerations at all but low-angle impacts,
- may restrict horizontal sight distance,
- have a high initial cost,
- may interfere with drainage, and
- are considered aesthetically unappealing and visually obstructive.

Concrete barriers are warranted where positive redirection must be obtained and very little deflection space is available.
10.2.3.7 Barrier Options for Aesthetically Sensitive Areas

Designers will occasionally encounter projects where visual considerations are a major priority. The conventional barrier types may not be considered appropriate from an aesthetic standpoint. The systems that are briefly described below provide some alternatives. Other designs may prove acceptable. In general, these systems will be more or much more expensive than the standard alternatives. There may also be some reduction in safety. For these reasons, there should be strong reasons for using one of these systems instead of one of the normal standard types. In any event, before proposing use of an 'aesthetic barrier', it should be verified that the system has had an adequate safety evaluation. Any new systems proposed for use should be reviewed by the Design Quality Assurance Bureau.

- **Steel Guide Rail Systems (Rustic)**

In some circumstances, typically along parkways and roadways within the Adirondack and Catskill Parks, rustic (weathering or "controlled oxidizing") steel guide rail and median barriers may be required. These systems are intended to be less visually obtrusive than the normal galvanized systems. As a result of this lower visibility, reflectorization should be provided. Typically this will consist of 125 mm by 67 mm reflectorized panels for cable guide rail, as shown on the 606 series Standard Sheets, mounted to the posts. An approved reflectorization scheme for weathering W-beam (which shall not be used within the Adirondack Park) has not yet been developed, but use of a system similar to that for cable is encouraged. Where weathering box beam systems are used and the rail will be close to the road and protection of the reflectors from snow plowing is important, consideration should be given to mounting the reflectors to the posts, below the box beam and its support angle, in the manner depicted for the reflectors on posts for cable guide rail. Where damage from the snow plowing operations is expected to be minimal, the reflectorization should conform to that shown on the Standard Sheets for box beam guide rail: specifically, reflectorized angles mounted on top of the rail. Details are shown on the M606-3 Standard Sheet. On curves with radii of less than 600 m, the reflectors should be placed at half the spacing of tangent sections. No reflectors should be placed on portions of the rail or end treatments that flare away from the road as this might mislead nighttime drivers as to the location of the edge of the shoulder.

- **Stone-faced Masonry Walls**

Several specialized designs have been used on New York's state highways. Additional designs have been tested and approved by other states. With any of these designs, the primary consideration is that the wall should be able to provide a fairly smooth redirection. This means that there should be very little in the way of projections that could act to snag a vehicle and cause it to yaw and roll over. Similarly, the barrier should have sufficient strength that a vehicle will not start to break through it. Should that occur, the front of the vehicle would, in effect, be running into the end of a stone wall.

Any of these walls should have an essentially vertical face for at least the first 750 mm of
the barrier’s height. This is to avoid vehicle climb that could contribute to destabilization and rollover. As noted elsewhere, the toe on NJ barriers has been implicated in accidents that resulted in small vehicles rolling over. A suspected component in the accident is the tendency of rotating tires to ‘climb’ the toe and face. The smooth concrete surface of a NJ barrier tends to minimize this effect. By contrast, a comparatively rough rock face would provide good friction and could significantly increase the roll imparted to an impacting vehicle. For this reason, sloped stone-faced barriers should not be used.

- Timber-faced Steel Guide Rail Systems

The purpose of these systems is to provide the strength and continuity available with a steel guide rail, but to provide the appearance of wooden elements. Because of the wide range of ways in which such a complex system could fail, any new system will have to undergo crash testing in conformance with NCHRP 350.

Several systems have been installed as ‘special case’ uses on Department projects. These include 10606.4771 M "Steel Backed Timber Guide Rail with Timber Posts and Blockouts", 10606.4791 M, its median barrier equivalent, and 08606.1801 M for a single steel backed timber rail element fastened to steel posts. Before considering use of any of these on a project, the designer should verify with DQAB that the system is still approved.

One recent system that has passed crash testing is the proprietary "Ironwood Guide Rail and End Terminals", issued by Engineering Instruction 00-022, as items in the 91606.13 M through 91606.2350 M series. This system has a “peeled log” appearance that may be suited for use on certain parkways, scenic overlooks or scenic highways in the Adirondack, Catskill and Southern Tier regions as is deemed appropriate in consultation with the Regional Landscape Architect. Its use is authorized on an “experimental” basis, meaning that it has been crash tested successfully, but is not in general or widespread operational use.
10.2.4 Median Barriers

Median barriers differ from roadside barriers in that they are designed to withstand impacts from either side. Descriptions of the various types of median barriers are presented below in Sections 10.2.4.4 through 10.2.4.6 and in 10.2.4.9. The design of medians is discussed in Chapter 3 of this manual. Barriers may be warranted in medians to either (1) reduce the potential frequency of crossover accidents, (2) limit access, or (3) shield potential hazards, fixed objects, steep slopes, etc. When objects within the median require shielding, it will typically be necessary to use roadside barrier. When a median warrants a barrier system purely for separation of opposing traffic, median barriers will usually be the preferred choice both for economy and for the added clear area that they permit when compared with using roadside barriers on both sides of the median. Sections 10.2.4.2 and 10.2.4.3 present barrier design guidance for wide and narrow median geometries. Figure 10-7 is a graphical summary of the guidance for use of barriers in medians on high-speed (80 km/h or greater) freeways and expressways.

In general, appropriate barriers should be installed in medians when:

- on freeways and expressways with high-speed (80 km/h or greater), high-volume (AADT > 20,000) traffic, the median is level (slopes ≤ 10%) and less than 11 m wide,
- an existing facility has a history of median crossover accidents,
- potential hazards within the median of a limited access highway compromise the clear zone width for one or both directions of traffic,
- midblock turns need to be limited and there is not adequate space for a raised median,
- opposite direction ramps are adjacent to each other, or
- wrong-way movements would otherwise be possible onto exit or entrance ramps.

Serious consideration should be given to providing a median barrier on divided multilane rural and urban arterials that meet the first condition (particularly where operating speeds are 100 km/h or higher) and where cross-median access is not required. Restrictions on the use of curbs with barriers in medians are discussed in Section 10.2.2.4.

Additionally, if an existing facility has a history of accidents related to headlight glare from opposing traffic, this factor should be taken into consideration when determining whether a median barrier would be appropriate. In this case, the need for glare screens on top of the barrier (Section 10.2.4.7) should also be evaluated.

Median barriers should generally not be used when cross slopes exceed 1:10. Cable median barrier (Section 10.2.4.9 D) may be used on slopes up to 1:6. Placement of barriers in uneven medians is discussed in Section 10.2.4.8. Both the deflection distance of the selected median barrier and its placement within the median should be such that it will not deflect into either stream of opposing traffic when subjected to a standard impact (described in Note 1 of Table 10-3). When selecting an appropriate type and location of barrier for narrow, curved medians, the designer should review the horizontal sight distance requirements. Similarly, intersection sight distance requirements should be reviewed when selecting a type and location of a median barrier at intersections.
While not required by the warrants shown in Figure 10-7, consideration should be given to placing cable median barriers in the middle of wide, traversable medians on high-speed highways, particularly where the AADT exceeds 5000. The central location will minimize the potential for damage by snow plows and from brush hits, while providing an unobtrusive, low cost means of limiting the number of head-on, cross-median fatalities. Where provision is needed to permit mowing machine access, breaks in the runs should be provided, with the ends overlapped in the direction of traffic.

Figure 10-7 Guidance for Median Barrier Use on High Speed Freeways and Expressways

*For two-lane divided facilities, median barrier becomes optional at 5000 AADT, rather than at 10,000.

**Warranted for Freeways and Expressways. Strong consideration should be given to applying this guidance to high-speed, divided multi-lane rural and urban arterials where cross-median access is not required.

***Where wide clear medians have a history of cross-over accidents, strong consideration should be given to installing a centrally located barrier. Where aesthetics are a concern, consider cable barrier.
10.2.4.1 Traffic Volume and Maintenance Considerations

As with roadside barriers, traffic volume and maintenance considerations are key issues in median design. On high-volume divided highways, a cross-median accident greatly increases the probability of a severe outcome. Higher volumes also increase the maintenance problems as barriers will tend to be hit more often. If they are one-hit barriers, they will be ineffective more often as they await repair. High volumes hamper repair work, which is, in turn, an increased danger to both the motorists and the workers. Where possible, the median barriers on high-volume roads should be positioned so that repair and emergency vehicles can approach at least one side of the barrier without encroaching on travel lanes. For example, rather than placing a median barrier in the middle of a 4 m wide median, it may be offset to permit a 2.5 m emergency parking width on one side. Concrete median barrier, however, should normally not be set more than 3.0 m from the edge of the traveled way as higher angle, more severe impacts become more likely with increased distance from the traveled way.

When the design speed of a ramp is less than 80 km/h and the collision rates with the barrier are low, corrugated-beam-type median barrier should generally be used to separate opposite direction ramps, particularly on lower volume exits, since (1) its installation cost is less than other barrier types, (2) it is easier to maintain than box beam, (3) it is more forgiving than concrete, and (4) because of the lower speed and the catenary effects due to the curve, the deflection will be less than shown on Table 10-3. For ramps with a design speed of 80 km/h or greater, the normal barrier selection process should be used.

10.2.4.2 Wide Medians

For the purposes of this document, wide medians will be defined as those with widths that exceed the relevant Desired Minimum Clear Zone distance (see Appendix A) for either direction of traffic.

Unlike the passive threat of stationary hazards, opposing traffic is a mobile, active threat. Clear zone widths should only be relied upon for traffic separation under special conditions. Each of the following cases is considered sufficient to permit the use of clear zones instead of median barriers for traffic separation.

1. Each direction of traffic has a satisfactory design clear zone width (approaches or exceeds the desired) in the median and the two do not overlap by more than fifty percent. (If each has a 9 m clear zone that is considered satisfactory, use of a 13.5 m clear median would be sufficient.)
2. The AADT is less than 10,000 vehicles per day.
3. For medium- and low-speed highways (<80 km/h), the desirable clear zone width for each direction is satisfied between the edges of traveled way using a symmetrical depressed median with slopes of 1:6 to 1:4, inclusive, or a raised berm median with berm slopes of 1:4 or steeper.
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These allowances shall not be applied to existing facilities with a significant history of crossover accidents. Where the median geometry and traffic conditions are between those given above and the warrants given in Section 10.2.4, barriers are not required in medians, but should be considered, with the final decision being based on the designer's professional judgement and consideration of the many factors involved.

10.2.4.3 Narrow Medians

For the purposes of this document, narrow medians will be defined as those with widths less than the relevant Desired Minimum Clear Zone Width (see Appendix A) for either direction. Median barriers should be considered for all narrow median, limited access highways.

For narrow median highways, where access is not limited, the need for median barriers is a function of the traffic volume and speed and the number of barrier openings required for median crossings. Barrier end treatments at openings are, in themselves, hazards and, if too many are required, the barrier may not be advisable. Barriers may not be warranted on narrow medians in each of the following cases.

1. The AADT is less than 10,000 vehicles per day (5000 for two-lane divided facilities).
2. The operating and design speeds are less than 70 km/h.
3. The distance between required median openings is less than 100 m and the median width is at least 3 m.

These allowances shall not be applied to existing facilities with a significant history of crossover accidents. Where the median geometry and traffic conditions are between those given above and the warrants given in Section 10.2.4, barriers are not required in medians, but should be considered, with the final decision being based on the designer's professional judgement and consideration of the many factors involved.

In developed areas with medians less than 3 m wide, frequent openings in median barriers should be avoided as the terminals at each opening require a more expensive treatment and constitute more of a potential hazard than a straight run of barrier. If median barrier is warranted in medians less than 3 m wide, midblock openings should be eliminated or separated by 100 m or more.

Where median barriers will be close to traffic, and particularly where there are curves, appropriate delineation should be provided on or above the barrier.

Rigid or semirigid barriers (rather than open medians) should be considered for separating adjacent opposite direction ramps. For ramps with operating speeds below 80 km/h, corrugated beam median barrier may be preferred. With higher traffic volumes and more "hits", concrete barriers may be preferred. (See Section 10.2.4.1.)
10.2.4.4 W-Beam Median Barriers

There are two forms of W-beam median barrier: the weak-post system and the heavy-post blocked-out system. Both have two W-beams, one on each side of the post. The typical details are shown on Standard Sheets for 606 items. The advantages and disadvantages of W-beam median barriers are similar to those for W-beam used as roadside guide rail. The restrictions on the use of weak-post median barriers on high-speed facilities are the same as those for weak-post guide rail. (Refer to Section 10.2.3.2 A.) Table 10-3 lists the deflection distances required with standard impacts for the different W-beam mounting arrangements. The heavy-post W-beam system is significantly more durable than the weak-post. The disadvantage of this increased durability is that the increased rigidity tends to produce more severe lateral decelerations. However, the accidents are generally less severe than those involving rigid concrete barriers.

W-beam median barriers may be the appropriate choice when:

- There is sufficient space in the median to accommodate both the barrier and its deflection distances on either side (to arrest the lateral movement of impacting cars before they enter opposing lanes).
- A more flexible barrier than concrete is desired. Note, however, that the heavy-post is considered a semirigid system and has the same warrants as concrete median barrier discussed in Section 10.2.4.6.

For new projects, the heavy-post system should be selected over the weak-post system if either:

- The design speed is 80 km/h or greater.
- The median is less than 7 m wide and the AADT exceeds 40,000 vehicles per day.
- The location is likely to receive more than one hit during a single icy weather event. Likely locations might include curves that follow long tangents, long downgrades or crest vertical curves, curves that are shaded, or where maintenance or accident records indicate a problem.

For new projects on the National Highway System, the heavy-post system shall be selected over the weak-post system if the operating speed is greater than 70 km/h.
10.2.4.5 Box Beam Median Barrier

The box beam median barrier is a weak-post system similar to the roadside box beam guide rail. The main difference is that the median box is wider. Its dimensions are 150 mm by 200 mm with a 6.35 mm wall thickness. Its standard deflection is listed in Table 10-3 and is greater than that for the heavy-post W-beam median barrier, but less than for the weak-post W-beam median barrier.

The disadvantages of box beam median barrier are that it:
- must be shop curved for curves with radii less than 465 m,
- is heavy to work with,
- cannot be conveniently bent back into shape, and
- has less vertical range for protection against vaulting, under-run and headlight glare.

The main advantages of box beam median barriers are that it:
- may be the most economical choice, depending upon prevailing supply conditions,
- produces lower lateral deceleration on impact (more forgiving) than either concrete median barrier or heavy-post corrugated median barrier, and
- may be considered aesthetically preferable.

Its use may be warranted when:
- a median barrier is warranted and
- a barrier with more deflection cannot be used.

Because of the cost differential between median barrier systems, where permitted, it is advantageous to transition from box beam median barrier to weak-post corrugated beam median barrier when the deflection criteria no longer warrants the use of the box beam median barrier, but continuation of a median barrier is appropriate. Refer to the 606 series Standard Sheets for details of the transition.

10.2.4.6 Concrete Median Barrier

Concrete median barriers (CMB) are similar to the concrete roadside barrier discussed previously. The main difference is that it is designed to be hit on either side. This requires extra base width which provides greater stability. The barrier is assumed not to deflect upon impact by personal passenger vehicles. Therefore, impacts are more likely to be severe. Another potential disadvantage is that CMBs may contribute to horizontal sight distance problems on curves with narrow medians and/or median shoulders.
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The main advantages of concrete median barriers stem from their durability. They are:

- seldom out of service, so there is
- little potential for accidents related to repair and maintenance operations, and
- their maintenance costs are low.

In addition, the barrier is more easily seen than others and is the most effective barrier at preventing crossover accidents and reducing headlight glare problems.

The use of concrete median barrier may be warranted whenever:

- a median barrier is required on a freeway, expressway, or parkway with a free-flowing operating speed of 80 km/h or greater,
- the clearance from the edge of travel lane to the barrier is less than 3.0 m (or the barrier is placed at the edge of wider shoulders) and
- the peak average volume exceeds 12,000 vehicles per lane per day (Level of Service C).

The types of concrete median barrier are shown on the Standard Sheets for series 606 items. There are several types of concrete barrier. The two that are currently Department standards are the Single Slope and the New Jersey barrier shapes. Additional types may be used and are discussed in Section 10.2.4.9 Innovative Median Barriers.

The single-slope concrete median barrier may be used for any barrier applications that the standard NJ barriers may be used for, as the warrants for the two barriers are the same. The single-slope concrete median barrier has been crash tested in accordance with the requirements of NCHRP Report 350. The reports of the tests are published in Transportation Research Record 1302 (TRR 1302). The single-slope concrete median barrier has several advantages over the standard NJ shape. The following is a partial list.

- Increased safety, especially for the small car, because of lower roll angles.
- The extra height and thickness of the barrier will increase its strength and mass. Therefore, it will better contain a large vehicle.
- The extra height will lessen headlight glare without the use of glare screens.
- Resurfacing of the roadway adjacent to the barrier that changes the grade by more than 80 mm may be made as long as the resurfacing does not reduce the height of the barrier to less than 810 mm.
- The grade from one side of the barrier to the other can differ without the necessity of a complex asymmetrical barrier, provided the height of the barrier on the high side is not less than 810 mm.
- The single-slope barrier is easier to construct because of its simple shape.

Two possible disadvantages surfaced in the research report. The first is that computer simulations indicate that the occupant risk of the single-slope concrete median barrier is slightly higher than the New Jersey barrier. However, the crash tests indicated that the occupant risk was within the limit of NCHRP Report 350. The second is that the extra height may reduce the sight distance of the operator of a vehicle. In addition to the standard crown width of 205 mm...
(see Figure 10-9), a 305 mm wide version is permitted for mounting of objects such as light poles.

Due to its long history of use as the primary concrete barrier in New York, the New Jersey Barrier has often been referred to simply as 'Concrete Median Barrier'. There has been a significantly increased use of single-slope median barrier in recent years, to the extent that single-slope is now the more commonly used barrier on new installations. The Jersey barrier has been used in several widths and is now also being used with a greater height as an Innovative Median Barrier called the Truck Barrier (see Section 10.2.4.9). The Type "A" (symmetrical, narrow-stemmed, 150 mm crown width) median barrier is for general use in all cases where it is not required to accommodate truck traffic or to mount lamp posts or other similar objects on top of the barrier. Where appropriate for urban truck traffic, the Type "B" barrier, with a 230 mm crown width should be used. The Type "C" barrier, with a 305 mm crown width, should be used when it is necessary to accommodate lamp posts or similar objects on top of the barrier. When objects are mounted on top of the barrier, box beam should be mounted to the top face to limit the vehicle climb. As noted previously, although no testing has been performed to confirm the premise, it is anticipated that the box beam would also help to limit roll angles and "lean over" of tall vehicles. The box beam should be tapered on the approach end to reduce the chances of snagging. Contact the Design Quality Assurance Bureau for examples of possible taper arrangements.

10.2.4.7 Glare Screens

While glare screens are not barriers, they can be a useful addition when there is a need to block headlight glare from opposing traffic. Glare screens are vertically mounted panels that may be fastened in series to the tops of concrete median barriers, box beam barriers, and the posts of heavy-post barriers. Several different fastening arrangements have been developed. The designer should consult the Design Quality Assurance Bureau for information on the currently accepted alternatives.

Glare screens may be warranted on divided highways where there is a significantly increased chance of headlights shining directly into the eyes of drivers. Typical situations would include gradual curves where the inside roadway is slightly elevated above the outside roadway.

Glare screens should be considered where frontage roads carry traffic opposing the mainline. Glare screens may also serve to minimize "rubbernecking" in construction zones.

It has been the Department's experience that glare screens are a valuable safety device that should be used wherever it is appropriate. However, because of maintenance issues, increased height concrete barriers should be considered as an option to limit glare problems where concrete median barriers are to be placed or poured. Glare screen paddles have been susceptible to snowplow damage when used on guide rail, but have fared better on higher concrete barriers. While damaged paddles can be conspicuous and the replacement effort can be complicated by access concerns and rusted bolts, the benefits justify their use.
10.2.4.8 Uneven Medians

In many instances, medians will divide highways into roadways at different elevations. The resulting uneven median will influence the selection of an appropriate position for a median barrier. In general, the median barrier should be placed on the high side of the median since a decline will extend the required clear zone width while an incline will decrease it. However, if the maximum slopes do not exceed 1:10, a central placement should be used to maximize the clear zone space available to both roadways (note a possible exception in 10.2.4.1 for narrow medians). Barriers should be placed at any median side where the appropriate clear zone width cannot be reasonably obtained due to the presence of fixed objects. The various cases are displayed in Figure 10-8, which is adapted from AASHTO’s Roadside Design Guide. In all cases, it is assumed that a barrier is, in fact, warranted. Narrow uneven medians may present special design challenges. The Regional Geotechnical Engineer should be consulted on any applications where a barrier must be placed on a steep slope or where consideration should be given to constructing a wall that will serve both as a retaining wall and as a barrier. In such instances, the bottom of the wall exposed to traffic should have the same shape as one of the currently approved concrete barriers. Various types of asymmetrical concrete barriers have been developed and used for narrow, uneven medians.

10.2.4.9 Innovative Median Barriers

The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) mandated that 2.5% of the median barriers installed each year by any state on Federal-aid projects on the National Highway System (NHS) be of an innovative design type. With the Transportation Equity Act for the 21st Century (TEA21), that mandate was dropped. Consequently, several median barrier systems that were being classified as innovative are now being upgraded to standard items. This process will take some time and may not result in all of the innovative types being made standard. Until the issue is fully resolved, designers should continue to use the following barriers in appropriate situations.

- Single-Slope Concrete Median Barrier
- Movable Concrete Barrier
- Truck Barrier (Extra High)
- Cable Median Barrier
- Self Restoring Median Barrier
- Modified Thrie Beam Barrier

These median barriers are briefly discussed in the following sections. The designer should consult the Design Quality Assurance Bureau for a description of additional systems that are under consideration. It should be noted that the Movable Concrete Barrier is a proprietary system which requires additional approval as described in HDM Chapter 21, Section 21.3.
### Figure 10-8 Recommended Barrier Locations for Uneven Medians

#### DEPRESSED MEDIANS

<table>
<thead>
<tr>
<th>Case 1: Non-recoverable slope in median</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Case 2: Median width, W, is less than 1.5 times Desirable Minimum Clear Zone width and AADT &gt; 10,000</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Case 3: Same as case 2, but median slopes are flat enough for barrier to be effective.</th>
</tr>
</thead>
</table>

#### STEPPED AND SLOPED MEDIANS

<table>
<thead>
<tr>
<th>Case 4: Hazards are present in median.</th>
</tr>
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<table>
<thead>
<tr>
<th>Case 5: Same as case 2</th>
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</table>

Note, in Cases 2 and 3, and again in Cases 5 and 6, that slope as steep as 1:6.

<table>
<thead>
<tr>
<th>Case 6: Same as case 3</th>
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</table>

#### RAISED MEDIANS

<table>
<thead>
<tr>
<th>Case 7: Design Speed &lt;80 km/h, W is greater than Desired Minimum Clear Zone Width, $CZ_{DM}$, but less than 1.5 x $CZ_{DM}$ (Berm helps redirection) See note 2.</th>
</tr>
</thead>
</table>

| NOTES: 1. In cases 1 through 6, assume barrier is warranted for given conditions of speed, volume and available clear zone widths. 2. In case 7, provide barrier at crest if either berm slope is flatter than 1:4, W approaches the Desired Minimum Clear Zone Width, or there is a history of crossover accidents. |

Adapted from AASHTO's ROADSIDE DESIGN GUIDE, 1989
A. Single-Slope Concrete Median Barrier

This barrier is now a Department standard and is shown on Standard Sheet M606-26 and discussed in Section 10.2.4.6.

B. Moveable Concrete Barrier

The moveable concrete barrier (MCB) consists of a set of concrete barriers that are pinned together to form an articulated chain. A special transfer and transport vehicle can move along the chain, lifting and transferring the chain laterally for a distance of one lane width or up to 5.5 m. The cross-section of the barrier is similar to that of a standard safety-shaped barrier except for its "T"-shaped top. See Figure 10-10. An adjustable conveyor on the transfer vehicle has sets of rollers that engage the undersides of the arms of the "T" to lift the barrier. The rollers can lift the barrier up to 250 mm off the pavement so that it can be moved up on top of a curbed surface. The transfer vehicle itself moves at approximately 8 km/h and may be positioned so that it is always in the lee of the barrier rather than being exposed to oncoming traffic.

Refer to Section 10.4.4 for a discussion of the possible uses of MCBs on construction projects. At permanent installations, the MCB may be used to increase the capacity of a highway without adding additional lanes by making one traffic lane contraflow (opposite direction) in the peak hours. The MCB has been crash tested and the results of the tests are published in Transportation Research Record 1258 (TRR 1258). In addition to the crash test data in TRR 1258, NYSDOT Research Report 145 Movable Concrete Median Barrier: Risk Analysis of Deflection Into Opposing Traffic gives additional information.

The following is a partial list of identified advantages.

- The roll angle of an impacting vehicle is lessened because of the special shape at the top of the barrier.
- The cost of increasing capacity by using this movable barrier may be significantly less than the cost of adding an additional lane or lanes in urban or heavily populated areas.
- The barrier movement from one location to another is relatively fast (up to 8 km/h) and may be performed with traffic running adjacent to the barrier.
- After an impact, the barrier may be rapidly realigned by the transfer vehicle without the need to place workers on the ground to manually adjust the barrier.
- The transfer vehicle can readily replace damaged units of the barrier thereby reducing maintenance crew effort and time required to repair the barrier.
Figure 10-9  Single Slope Concrete Barrier

- **25 mm Chamfers (Typical)**
- **205 mm**
- **230 mm**
- **610 mm**
- **1065 mm**

*May be 305 mm for mounting poles, etc., in which case, base width increases to 710 mm.*

**Difference in grade elevation on opposite sides of barrier should not exceed 250 mm.**

Finished Grade** *(Paved Surface)*
Figure 10-10 Moveable Concrete Barrier

Nominal barrier height = 0.8 m.
Maximum Dynamic Deflection (Standard Impact) = 1.0 m
Possible complications include the following:

- The need for staff to operate the transfer vehicle and a shed or sheds to house it.
- Problematic amounts of snow and ice can be left behind after each move when an MCB is utilized in areas where snow accumulates.
- Special compressible hinge arrangements are necessary when the barrier must be used at a location with significant horizontal curvature.
- During research, the barrier translated 1.25 m when impacted with a 2000 kg car at 96 km/h at a 15° angle.

It should be noted that the amount of translation reported in the fourth item is judged to be acceptable for most situations in which an MCB will be used, since conditions will usually limit either speeds or approach angles or both. For this barrier, a small deflection into the opposing traveled way is deemed acceptable. The benefits of using an MCB system should be weighed against the cost of supplying and operating the system, including the cost to house and staff the transfer vehicle. Quantifiable benefits of using the system include reduced delay to the public, the cost of which can be estimated using the Highway User Cost Accounting (HUCA) computer program and available in Lotus or Quattro-Pro formats from the Mobility Management Bureau. Safety and public relations factors are less tangible, but should be considered.

C. Truck Barrier (Extra High)

Truck barrier may be used on divided highways with heavy truck traffic of 3000 or more trucks a day or at locations with a high rate of truck accidents. This concrete median barrier is a "configuration F"-shape barrier that is 1.065 m tall with a 305 mm thick stem. (The F shape designated a testing configuration which had a 7" high (178 mm) sloped section near the base as opposed to a 10" high (255 mm) sloped section on the New Jersey shape.) See Figure 10-11. This barrier has been impacted with and contained a 36 000 kg vehicle in a crash test. The passenger car impacts were within the limits of NCHRP Report 230. The truck barrier has specialized advantages in areas where it can be justified. The following is a list of some of the advantages over the traditional New Jersey barrier.

- The F-shape barrier will impart a lower roll angle to a heavy truck thereby increasing the vehicle's stability after an impact.
- The extra 0.25 m of barrier height (above the normal CMB) better contains heavy trucks and helps to keep them from penetrating the line of barrier by rolling over the top of the barrier.
- The extra mass of the truck barrier helps to contain heavy vehicles.
- The extra height reduces headlight glare problems.

A possible disadvantage of truck barrier is that the extra height may reduce the sight distance for operators of lower height vehicles.
Figure 10-11 Truck Barrier

25 mm Chamfer

305 mm 86 mm

30 mm 124 mm 813 mm 1065 mm

178 mm 75 mm

230 mm 724 mm

Finished Grade
D. Cable Median Barrier

Cable median barrier is used to prevent crossover accidents on wide traversable medians (over 6.7 m). Because of their large deflection distance, cable median barriers must be located well away from traffic, typically placing them close to the center of the median. This barrier is substantially the same as standard cable guide rail except that the center cable is mounted on the opposite side of the post from the upper and lower cables. The cable median barrier is presently in service on the Palisades Interstate Parkway. An in-service field evaluation of this installation has been made by the Department and the results are published in Client Report 37 Performance of Cable Median Barrier on the Palisades Interstate Parkway. The following list covers the identified advantages of this barrier.

- It uses standard cable guide rail hardware.
- The deflection characteristics are the same as the deflection characteristics of cable guide railing.
- In terms of repair costs, the cable median barrier is economical. Even though longer sections must be repaired, the cables are rarely damaged, and the simple design of the system facilitates repairs.
- On projects where aesthetics are a factor, the cable median barrier offers a less obtrusive appearance than other median barriers.
- The cable median barrier may be used with median cross-slopes as steep as 1:6.

Disadvantages are listed below.

- Damage to the barrier, placing it out of service, may be expected even with moderate impacts. However, the number of impacts will be minimized due to the barrier's location near the center of the median.
- Cable barriers are basically "one hit" systems and impacts on damaged barrier may allow penetration. Therefore, cable median barrier will require maintenance after every impact and may require periodic inspections to ascertain if there is any damage from unreported impacts.
- Cable barriers may have problems stopping low frontal geometry vehicles from passing under the rail system.
E. Self-Restoring Median Barrier (SERB)

The self-restoring median barrier (SERB) is a staged system that is designed to restore itself after most impacts. It consists of two thrie-beam elements bolted to two truss web members supported on special posts designed to allow the rail to deflect up and back during contact. The barrier is illustrated in Appendix B of AASHTO's *Roadside Design Guide*. The SERB is for use in narrow curved medians that experience a high number of impacts. The SERB should be considered as an alternate to heavy-post blocked-out corrugated beam median barrier on narrow medians with a high likelihood of vehicular impacts. It should be noted that the system has rarely been used. The following is a list of advantages a designer should consider:

- During testing the SERB redirected a passenger car with only minimal damage to the vehicle and also restored itself to full service.
- The SERB has contained vehicles that weigh up to 18,000 kg.
- This system weighs only 77 kg/m, so its use on structures may be considered.

The following disadvantages should also be considered.

- The SERB has high initial costs.
- Maintenance must stock specialized hardware for repair and has had difficulty in getting parts. If the system is proposed for use, it should be discussed with the Maintenance personnel who will be responsible for its maintenance.

F. Modified Thrie-Beam Median Barrier (MB9 Modified)

This barrier is a modification of AASHTO's Thrie-Beam Median Barrier (MB9). Refer to Figure 10-12. This barrier may be used as a median barrier in narrow medians on highways with heavy truck traffic. The system passed NCHRP 350 testing with a steel blockout, but does not appear to offer any significant advantage over the Department's normal median barriers. Furthermore, it is anticipated that its large vertical extent will contribute to snowdrifting problems and be more visually obtrusive. Parties interested in pursuing use of this system may obtain more information from DQAB's Standards and Specifications Section.
Figure 10-12 Modified Thrie Beam Median Barrier (MB9-Modified)

- W150 x 13.5 Post
- 16 mm diam. Bolts (F-8-76)
- 30 mm
- 16 mm diam. Button Head Bolt
- 32 mm long (No washer)
- Thrie Beam Backup Plate (RE-63-76)
- Use at posts where thrie beam splice does not occur (12 gauge)
- Thrie Beam (RE-63-76)
- (12 gauge)
- W360 x 33 Spacer
- (Except at terminal)
- Finished Grade
10.2.4.10 Median Transitions

Median transitions refer to locations where there are significant geometric, landscape, and safety-related changes to the features separating adjacent streams of traffic. Of specific concern are those situations where traffic will be approaching raised curbed medians containing fixed objects.

As mentioned elsewhere, it is not desirable, from a safety perspective, to introduce features such as vertical faced curb or trees and other fixed objects into medians near medium- or high-speed traffic. However, there will be situations where it is judged appropriate to include trees and other fixed objects in medians, typically on aesthetically sensitive arterials. When a landscaped median with fixed objects will be introduced on a medium- or high-speed highway, a transition should be designed to alert drivers that they are approaching a change in the roadside (median) environment that has safety implications. The design of the physical transition may be complicated by a desire to achieve a simultaneous speed transition, specifically a traffic-calming reduction in speed.

The purpose of this section is to provide guidance on preferred treatments and to describe features that the designer may consider for inclusion in the median transition design. This section is not intended to address how to design the median features on either end of the transition; merely how to design the transition between those conditions. The guidance is intended to apply primarily to medium- to high-speed arterials.

A. Purposes of Median Transitions

The primary purpose of median transitions is to alert drivers to changes in the roadside (median) environment that have safety implications. As a secondary purpose, there may be the simultaneous intent to reduce operating speeds by changing the character of the highway environment. (See also Chapter 25 - Traffic Calming.) Where a traffic calming effect is intended, changes to the median, traveled way, and roadside environment should be coordinated, as practical, to work in harmony towards that end.

B. Locating Median Transitions

At any medium- or high-speed location where a median begins, a transition should be provided along the approach. The transition treatments should, to the extent practical, merge with the median. As discussed later, the transition should begin far enough in advance of the point of concern to provide sufficient advance notification for drivers. This distance will be a function of the approach operating speed and the desired/anticipated speed in the area being transitioned to.

Consideration should be given to the location of the transition with respect to current development and reasonably anticipated (planned) development. For instance, if the transition is intended to contribute to reducing speeds prior to a landscaped median in a village or city, it is desirable that the transition be positioned at the approach to the community so that the speed reduction will be encouraged before the vehicles enter the village or city.
The planned development of the adjoining area should be discussed with municipal planning officials. If it is likely that the desired zone of speed reduction will soon extend further out from the municipality than at present, then a correspondingly longer transition zone should be considered. Consideration should also be given to adjusting the type and the location of the features to facilitate shifting the speed reduction zone in the future.

C. Median Transition Progression

Progression refers to the recommended sequences for the addition of features into a median area. Speed zone and other signing should be provided in accordance with the MUTCD. If the speed limit is being reduced, the signs should precede the features that are intended to encourage the corresponding speed reductions. The following list indicates a typical order in which features could be added to a median.

- Full Barrier (double yellow) lines. (Solid white lines if the lanes to be separated are not in the opposite direction.)
- Split double yellow lines with crosshatching between the pairs. (White lines with chevron pattern if the lanes are in the same direction.)
- Consider the use of milled-in rumble strips along the approach side. Also consider the potential for neighborhood objections to the noise that might be generated and balance that against the urgency of warning of the widening of the median area and any accident history that might develop.
- Flush median with color-contrasted and/or textured pavement materials. The Landscape Architecture Bureau should be consulted for information on options.
- Raised paved median with traversable curbs.
- Landscaped median with low plantings (flowers and shrubs, no trees over 100 mm in diameter) and traversable curbs.
- Landscaped median with trees and traversable curbs.
- Landscaped median with trees and curbs as permitted for the operating speed.
- Landscaped medians with pedestrian refuge areas and structural shielding.

A given transition may be between a median that already contains some of the features and a median that contains most of the features listed.

As with the design of the median itself, the design of the transition should be coordinated with and reviewed by the project stakeholders. Of particular importance are the Landscape Architect, Maintenance, Traffic and Safety, and, where takings are involved, Real Estate. Particularly where plantings are involved, maintenance jurisdiction must be resolved.

Additional features that can be considered as means of reducing traffic speeds, or at least alerting drivers to changing conditions, include the following:

- Discourage the use of left-turn lane drops by through traffic by including:
  - appropriate regulatory lane designation signing supplemented by prominent left-turn arrow pavement markings well in advance of the drop,
  - plowable speed humps at the point where turning traffic would slow, and
  - milled-in rumble strips along the dividing line between through and turning traffic lanes, provided they are not near a residential area.
• Use of signs, plantings, and breakaway street hardware along the roadside. Signs should be included to announce the village or city.
• Where sufficient warranting factors exist, traffic signals may be added at intersecting streets to periodically control traffic.
• Provision of dedicated enforcement sites, if requested by local authorities. The ideal site will include a paved entry point to permit an enforcement vehicle to enter the road with a full view of approaching traffic. Grading and other landscaping features should be provided to prevent easy determination of when the site is not in use.
• Placement of warning signs in advance of periodically active enforcement sites.

D. Lengths of Median Transition Areas

The appropriate lengths for transitions will be a function of their purpose and the speeds involved. If no speed change is involved and the purpose of the transition is merely to make the driver aware that a median will begin soon, then the length of the transition may be shorter than if a speed reduction (traffic calming) is intended. Obviously, the faster traffic is moving, the greater the length that is required for drivers to react to the median features. Similarly, the greater the change in the median conditions, the longer the length of the transition should be. The following transition lengths are recommended minimums. The operating speeds are the free flow (off-peak) 85th percentile operating speeds that are reasonably anticipated after construction of the project (including any adjacent programmed projects). Refer to Chapter 25, Section 25.6.3 for a discussion of reduced operating speeds.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Recommended Minimum Transition Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Speed of 60 km/h or less. Transition from median turn lane to a treed median with a similar width.</td>
<td>20 m of curbed area with low plantings.</td>
</tr>
<tr>
<td>Consistent Operating Speed of 70 km/h. Transition from a median turn lane to a treed median of similar width.</td>
<td>100 m (50 m with markings, 50 m with low plantings.)</td>
</tr>
<tr>
<td>Consistent Operating Speed of 70 km/h. Transition is from a center line marking to a treed median.</td>
<td>200 m (100 m to widen markings to full median width, 50 m with color contrast or crosshatching, 50 m with low plantings)</td>
</tr>
<tr>
<td>Consistent Operating Speed of 80 km/h. Transition is from a median turn lane to a treed median of similar width.</td>
<td>200 m (100 m with markings, 100 m with low plantings.)</td>
</tr>
<tr>
<td>Consistent Operating Speed of 80 km/h. Transition is from a center line marking to a treed median.</td>
<td>300 m (100 m to widen markings to full median width, 100 m with color contrast or crosshatching, 100 m with low plantings)</td>
</tr>
<tr>
<td>Speed Reduction from Operating Speed of 80 km/h to 70 km/h. Transition starts from a median turn lane and ends at a treed median with a similar width.</td>
<td>200 m (100 with color contrast or crosshatching, 50 m with raised paved median with traversable curbs, 50 m with low plantings)</td>
</tr>
</tbody>
</table>
Speed Reduction from Operating Speed of 80 km/h to 70 km/h. Transition is from a center line marking to a treed median. 350 m (150 m to widen markings to full median width, 50 m with texture, color contrast, and/or crosshatching, 50 m with raised paved median with traversable curbs, 100 m with low plantings)

Speed Reduction from Operating Speed of 90 km/h to 70 km/h. Transition is from a center line marking to a treed median. 450 m (200 m to widen markings to full median width, 100 m with texture, color contrast, and/or crosshatching, 50 m with raised paved median with traversable curbs, 100 m with low plantings)

Speed Reduction from Operating Speed of 90 km/h to 60 km/h. Transition is from a center line marking to a treed median. 500 m (200 m to widen markings to full median width, 100 m with texture, color contrast and/or crosshatching, 100 m with raised paved median with traversable curbs, 100 m with low plantings)

Speed Reduction from Operating Speed of 90 km/h to 70 km/h. Transition is from a grassed median to a treed median. 400 m of low plantings. Roadside signs and speed enforcement sites should be considered.

E. Other Median Transition Considerations

Section 10.2.2.7 discusses some options for shielding pedestrians in median refuge islands. While it may be appropriate to use such fixed object measures in medians that contain numerous other fixed objects, bollards or concrete barriers should not be used for pedestrian shielding in the transition areas leading up to those medians.

In some treed median settings, typically on high-volume, medium- to high-speed urban arterials, it may be appropriate to provide barriers to shield errant vehicles from the trees. The low profile barrier described in Section 10.2.2.7 has a face configuration that may be used for this purpose. The median could be raised to the height of the barrier and landscaped. The primary points of safety concern would be at leading ends of the barrier, such as the start of the median or where breaks in the median are required for intersections. The recommended leading end treatment is to ramp the barrier up from the pavement level to full height over a length of about 10 m. In addition to eliminating any vertical faces that could be struck, this ramping would facilitate establishing access for mowing equipment. No nonbreakaway fixed objects (includes trees) should be permitted in the vicinity of the ramp. For operating speeds of 70 km/h, there should be a minimum clear area of 20 m longitudinally from the start of the ramp. For operating speeds of 80 km/h or 90 km/h, a clear length of at least 30 m should be used.