(List of Figures)

Figure 7-1 Equal Severity Curve	View JPEG file	View PDF file*	*Requires Adobe Acrobat
Figure 7-2a Guardrail at Structure Approaches	View JPEG file	View PDF file*	Reader 4.0 or higher.
Figure 7-2b Clear Recovery Zones	View JPEG file	View PDF file*	
Figure 7-3 Position of Guardrail at Fixed Objects	View JPEG file	View PDF file*	
Figure 7-4 Guardrail on Narrow Embankments	View JPEG file	View PDF file*	
Figure 7-5 Long Span Nested Guardrail	View JPEG file	View PDF file*	
Figure 7-6 Adjustable Height Guardrail	View JPEG file	View PDF file*	
Figure 7-7 Freeway Median Barrier Warrants	View JPEG file	View PDF file*	

Section 7-01 - General Information

7-01.1 Introduction

Traffic safety systems are highway features designed primarily to reduce the severity of run-off-road accidents, prevent out-of-control vehicles from crossing the median, and decelerate errant vehicles. These features include guardrail, crash cushions, median barrier, end treatments, breakaway supports for signs and light standards, and truck escape ramps.

7-01.2 Standards

The Standard Plans contain design details for the construction of traffic safety systems. These designs are based on full-scale tests and typical conditions generally associated with new highway construction. Standard Plans cannot always be directly applied to all situations on existing roadways, and some design modifications may be needed. Modified or unique traffic safety system designs require review and approval of a Headquarters Traffic Operations Liaison.

As of October 1, 1998 all new, permanent installations of traffic safety devices shall meet NCHRP Report 350 crash testing criteria. This report is the "Recommended Procedures for the Safety Performance Evaluation of Highway Features." Procedures are presented for conducting vehicle crash tests and in-service evaluation of roadside safety features or appurtenances. The purpose of the procedures is to promote the uniform testing and in-service evaluation of roadside safety features so that highway engineers may confidently compare the safety performance of designs that are tested and evaluated by different agencies. The procedures are directed at the safety performance of roadside safety features; other service requirements such as economics and aesthetics are not considered.

The procedures are devised to subject roadside safety features to severe vehicle impact conditions rather than to typical or average highway situations. For vehicle crash testing, specific impact conditions are presented for vehicle mass, speed, approach angle and point on the safety feature to be hit. Three primary appraisal factors are presented for evaluating the crash test performance: structural adequacy, occupant risk and after-collision vehicle trajectory. In-service evaluation was used in the final stage of development of new or extensively modified roadside safety features and has the purpose of appraising actual performance during a broad range of collision, environmental, operational and maintenance situations for typical site and traffic conditions. This report updates the guidelines for in-service evaluation first provided in NCHRP Report 230, recognizing the complex nature of vehicular accidents and the limited resources of agencies responsible for monitoring the performance of new or modified safety features.

Standards for traffic safety systems have evolved over time and continue to change in response to changing technology, research findings, and changes in the design and speed of vehicles. Consequently, many existing traffic safety systems do not comply with the latest design standards. It is not always economically feasible or cost-effective to upgrade these existing installations each time revisions are made to the standards. Existing installations should be reviewed periodically so that cost-effective improvements may be made as necessary. When other major work is done in the area, such as rehabilitation or reconstruction projects, traffic safety systems should be brought up to current standards.

Section 7-02 - Clear Zone Concept

7-02.1 Introduction

An area clear of fixed objects adjacent to the roadway is desirable to provide a recovery zone for vehicles that have left the traveled way. Studies have indicated that on high-speed highways, a clear width of 9 m from the edge of the traveled way permits about 80 percent of the vehicles leaving the roadway out of control to recover. Therefore, 9 m should be considered the minimum, traversable clear recovery area for freeways and high-speed expressways. High-speed is defined as operating speeds greater than 70 km/h.

On most conventional highways, a 9 m clear zone distance may be difficult to justify for engineering, environmental or economic reasons. For these reasons, a minimum, traversable clear recovery area of 6 m on conventional highways is advised. The designer must keep in mind that site-specific conditions such as volume, speed, alignment, side slope, weather, adjacent development, and environmental conditions should be evaluated when determining the clear recovery zone. Obstacles located in the clear recovery zone should be removed, relocated, made breakaway, or shielded by guardrail or crash cushions where justified in accordance with the following guidelines.

Additional information regarding this subject is available in the *Roadside Design Guide*, American Association of State Highway and Transportation Officials (AASHTO), and the Caltrans *Highway Design Manual*.

7-02.2 Remove/Relocate the Obstacle

There are several locations where a fixed object can be relocated from the clear recovery zone. By order of preference, they are:

1. Remove it if practicable.
2. Move it to a location where it is unlikely to be hit, such as up a slope or behind a guardrail or wall that is required for other reasons.
3. Relocate it far enough from the traveled way to minimize its chances of being struck. Non-traversable ditches, drainage structures, columns, utility poles, and overhead sign structures may be handled by this method.
4. Relocate an obstacle in the median or gore to a location beyond the right shoulder, thereby reducing the risk of exposure to at least one direction of travel.

7-02.3 Make the Obstacle Breakaway

If fixed objects such as light standards and ground-mounted sign supports cannot be moved out of the clear recovery zone, they should be considered for breakaway treatment.

The standard breakaway support for light standards is a three-point triangular slip-base, see Standard Plans for details. All light standards located where they can be struck by a vehicle should have a slip-base, except where pedestrians might be struck by the falling standard or it could conflict with traffic.

The laminated wood box beam is the standard breakaway support system for large ground-mounted signs. Laminated wood box beam posts have replaced large timber poles for new installations.

Intermediate size ground-mounted signs may be mounted on dimensioned wood posts. Any sign post 100 mm x 150 mm or larger should be drilled to make it breakaway. Details for the size and location of the holes are contained in the Standard Plans.

Small ground-mounted signs may be supported on dimensioned wood posts or approved commercially available yielding steel supports. Contact your District Traffic Safety Systems Coordinator for information regarding commercially available yielding steel supports.

Mailboxes should be mounted on wood posts no larger than 100 mm x 100 mm or steel pipe no larger than 50 mm in diameter. Spacing between multiple mailbox posts shall be at least 3/4 the height of the post. Multiple mailboxes should never be mounted on a longitudinal rail within the clear zone. There is a commercially available yielding mailbox support system that will accommodate up to four mailboxes. The cluster mailboxes installed by the U.S. Postal Service do not perform acceptably on impact and should not be installed in the clear zone beside high-speed highways. For more information on mailbox support design and placement, see *A Guide for Erecting Mailboxes on Highways*, AASHTO. Contact Headquarters Office of Traffic Safety Program and Research for approval before the use of non-standard mailbox support design.

Call boxes and chain control signs should be mounted on slip-bases where appropriate. Other features in the vicinity should not impede the function of the breakaway device or adversely influence the vehicle response.

7-02.4 Shield the Obstacle

If it is not practical to eliminate, relocate, or make a fixed object break away, then the object should be shielded. All the systems available to shield fixed objects are also fixed objects. They do not prevent an accident but are intended to reduce the severity of the accident. Longitudinal barriers such as guardrail, median barrier, and bridge railing are designed to redirect a vehicle away from its errant path. These barriers have been tested for structural integrity and occupant risk.

Crash cushions are designed to safely decelerate a passenger car to a stop in head-on impacts. When a vehicle strikes the cushions, it expends its kinetic energy by, compressing or crushing material, tearing metal, displacing sand, or moving a metal cable or strap through a restricted path. Crash cushions are generally used to shield relatively narrow objects such as piers, columns, overhead sign supports, and median barrier installations. A list of approved crash cushions may be obtained from your District Traffic Safety Systems Coordinator, Headquarters' Traffic Operations Liaison or Headquarters' Office of Traffic Safety Program and Research.

Section 7-03 - Guardrail

7-03.1 Introduction

Guardrail, also referred to as guiderail, is the most common traffic safety system found on highways in California. Guardrail is installed to reduce the severity of run-off-road accidents. This is accomplished by redirecting a vehicle away from embankment slopes or fixed objects and dissipating the energy of the errant vehicle. However, guardrail will reduce accident severity only for those conditions where striking the guardrail is less severe than going down an embankment or striking a fixed object. Guardrail should only be installed where it is clear that accident severity will be reduced, or there is a history of run-off-the-road accidents at this location.

Consideration should first be given to eliminating or minimizing conditions requiring guardrail. This can be done by flattening embankment slopes and by determining alternative locations and designs of roadside appurtenances.

Special consideration should be given to eliminating or relocating solitary fixed objects that cannot be made breakaway or yielding. The cost of eliminating the object may be offset by savings from reduced collision frequency and reduced maintenance. Guardrail required to provide protection at such objects increases exposure and may result in an increase in the number of accidents.

Guardrail is not intended to and should not be used as a barricade or to prevent indiscriminate use of otherwise clear portions of the roadside.

7-03.2 Guardrail Types

Metal beam guardrail is the standard for embankment and fixed object protection.

The approved types of guardrail are:

(1) Metal Beam, and

(2) Concrete.

Concrete guardrail can only be used in place of metal beam guardrail to reduce recurrent delays to motorists caused by lane closures due to maintenance of metal beam guardrail, provide a damage-resistant barrier, and reduce exposure of Maintenance Division personnel to traffic if all the following criteria are met:

1. The proposed location is in a metropolitan area (population is greater than 200,000).
2. The distance from the edge of the traveled way to the face of the guardrail is less than 4.3 m.
3. There is less than a 6 hour working window for maintenance work during a 5 day work week, as determined by the District Traffic Operations Branch, based on traffic volume projections of growth for the next 5 years.
4. The proposed location has been struck three or more times in the last year.

Justification for the placement of concrete barrier on new construction should be based on criteria 1 through 3 only. Under special circumstances, exceptions to these criteria may be granted for metropolitan or rural areas on a case-by-case basis. Exceptions must be approved in writing by a Headquarters' Traffic Operations Liaison.

Three types of approved concrete barrier may be used. Types 50, 60 and 27B are best suited for permanent installations; for temporary or short-term installations, Type K barrier may be used.

The approach end of the concrete barrier must be shielded from traffic. The following are recommended methods of shielding:

1. Bury the end of the concrete barrier in a cut slope.
2. Extend the end of the concrete barrier at a 1:20 or flatter flare to a point outside the clear recovery zone.
3. Install an approved crash cushion at the approach end of the concrete barrier.

Concrete barrier must be anchored to prevent movement. Type 27B is anchored by its continuous footing; Types 50 and 60 require a 3 m long footing at each end; Type K is anchored by four 24 mm diameter dowels, 1 m long, per section.

Types 50, 60, and Type K-rail barriers should have 50 mm thick asphalt concrete from the edge of the pavement to the back edge of the concrete barrier to prevent erosion. Pavement should extend to the base of the Type 27B rail.

7-03.3 Embankment Guardrail

The primary contributors to the severity of over-embankment accidents are the height and slope of the embankment or side hill. Guardrail is a fixed object and should be installed only at locations where going off the embankment would be more severe than hitting the guardrail, and there has been a history of over-embankment accidents. The procedure for embankment guardrail consideration at a given location is:

a. *Accidents*. Guardrail should be installed only at locations with a high run-off-road accident history or where there is a significant potential for such accidents. Evaluate the accident history, if available, or the potential frequency of accidents at the location based on the following general considerations:

b. *Alignment*. Isolated curves on otherwise high-standard roads increase the probability of running off the road. Also on roads with curves, run-off-road accidents are more likely to occur on the first curve in a series of curves, successive curves with a speed change greater than 15 km/h, curves that are sharper than those generally used, compound curves, or curves with larger central angles. The outside of curves of less than about a 300 m radius and especially those on sustained downhill grades in excess of 2 percent should be given special consideration.

c. *Volume of Traffic*. The higher the volume of traffic, the greater the probability that run-off-road accidents will occur.

d. *Roadside Recovery Area*. The narrower the recovery area, the greater the probability that a run-off-road vehicle will go down an embankment.

e. *Climatic Conditions*. Frequent dense fog or snow and ice conditions increase the probability of a vehicle running off the road and going down an embankment. In addition, locations subject to high velocity cross winds have an increased probability of vehicles running off the road.

f. *Severity*. Determine the relative severity of traversing the embankment vs. hitting the guardrail using Figure 7-1, Equal Severity Curve. The Equal Severity Curve was developed from a field review of over-embankment accidents on freeways and full-scale vehicle tests on flatter embankments. The line shown represents combinations of embankment height and slope that result in accident severity's generally equal to average guardrail accident severity. Overall, accident severity will be less if guardrail is used on embankments that plot substantially above the line. Where conditions close to the line are considered, accident severity at specific embankment locations may be either greater or less than those of striking guardrail. Thus the curve should be regarded as a band rather than a line.

Based on the accident history or accident potential and the relative severity, decide whether guardrail should be installed.

7-03.4 Guardrail at Fixed Objects

Guardrail should be considered at all fixed objects that are accessible to traffic and within the clear recovery zone. Guardrail may also be considered at fixed objects located beyond the clear recovery zone when such objects occupy an otherwise clear recovery area. This applies whether the fixed object is located to the right or left of traffic and includes medians or roadway separations. In some cases, the object of concern may be located outside the right-of-way. Objects with slip-bases or breakaway features and those that yield because of their small size are not considered fixed objects for this application.

The same general principles apply to shielding fixed objects on non-freeways; however, the wide variety of roadside conditions on conventional highways precludes the establishment of firm rules. Lower speed roads require less clear distance. This is discussed in considerable detail in Chapter 3 of the *Roadside Design Guide*. In addition, the installation of guardrail along the roadsides of conventional highways is sometimes incompatible with adjacent property use.

In general, guardrail is not installed to shield fixed objects located behind curbs in urban areas because of lower speeds and the presence of parked cars, poles, hydrants, etc. See the *Highway Design Manual* for recommended horizontal clearances to fixed roadside objects. Individual trees, signal poles, lighting standards and utility poles are usually not shielded because the guardrail used to provide such protection increases overall fixed object exposure.

Figure 7-2a, Guardrail at Structure Approaches regarding the following applications:

Structure Approaches. This applies to the ends of bridge railings or parapets exposed to approaching traffic.

a. Two-Lane Conventional Highways. When the roadbed width across the structure is less than 18 m, guardrail should be placed on both sides of the roadbed at each end of the structure. When the roadbed width is 18 m or more, guardrail should be placed only to the right of approaching traffic. A roadbed is that portion of highway extending from curb line to curb line or shoulder line to shoulder line. Divided highways are considered to have two roadbeds.

b. Multi-Lane Freeways and Expressways with Separate Structures. Guardrail should be placed to the right and left of approaching traffic. Railings, guardrail, and bridge railing should not be placed transversely across the median or separation openings between adjacent or parallel structures. Protection should be provided by bridge approach guardrail with adequate length and an appropriate flare. Details regarding guardrail length and design are contained in the Standard Plans and Section 7-03.5 in the Traffic Manual.

c. Multi-Lane Freeways and Expressways with Decked Medians. When the bridge clear width is less than 18 m, guardrail should be placed on both sides of the structure. When the bridge clear width is 18 m or more, guardrail should be placed only to the right of approaching traffic.

Figure 7-2b, Clear Recovery Zones regarding the following applications:

Roadside Objects and Embankments

a. Guardrail should be placed at the following fixed objects within the clear recovery zone that are not shielded by other traffic safety systems:

(1) Steel overhead sign posts.

(2) Structure piers, columns, and abutments.

(3) Exposed ends of walls.

b. Guardrail should be considered for rows of trees with trunks 100 mm or greater in diameter and spaced less than 30 m apart.

c. Guardrail may be considered at all fixed objects listed in (a) above that are located beyond the clear recovery zone when such objects occupy an otherwise clear recovery area.

d. In medians or roadway separations that are less than 30 m wide and are traversable by traffic, structure piers or columns should be shielded with guardrail and/or crash cushions.

e. Guardrail placed to shield a fixed object on a two-lane highway shall shield both directions when the object is within the clear recovery zones. Clear recovery zone on the right starts at the beginning of the shoulder and moves right (including the shoulder), and the clear recovery zone on the left starts at the centerline and moves left and will include the opposite traveled lane, the shoulder and beyond. For more information on clear zones on conventional highways, expressways and freeways see Section 7-02 in the Traffic Manual or Figure 7-2b.

7-03.5 Design Considerations

1. *Length*. Guardrail should only be as long as necessary to provide protection. Guardrail approaching fixed objects should typically have a minimum length of 15 m preceding the object exclusive of an approved end treatment. Longer lengths of guardrail may be needed on embankments where, in effect, the approach guardrail becomes an embankment guardrail. Where fixed objects are added behind existing guardrail, care should be taken that all fixed objects are within the area shielded by the guardrail. Fixed objects should not be allowed behind breakaway anchors.

2. *Anchorage*. Guardrail functions as a tension member, much like a bowstring, redirecting the errant vehicle away from the obstacle. Thus it is necessary that both ends of all guardrail installations be anchored. When end anchors are damaged in a collision, they should be reconstructed to current standards. Revisions may include extension of the guardrail to place the approach end in a safer location, revision of the approach flare, upgrade of guardrail, removal of dike, or installation of an end treatment.

3. Buried End Anchor. This is the preferred treatment for the approach end of the guardrail. It may be necessary to extend a guardrail installation a reasonable distance to reach a cut section where a buried end anchor can be used. To minimize vaulting, care should be taken that the top of the rail remains at 685 mm above the ground until the cut slope is reached.

4. Anchor Assembly - Type SFT. This anchor is intended for use on the trailing end of guardrail installations. The Type SFT anchor is not intended for breakaway use on the approach end.

5. Anchors Assembly - Type CA. The Cable Anchor Assembly (non-breakaway) shown in the Standard Plans should be used only where the end of a guardrail installation cannot be impacted by an approaching vehicle. An exception is its use at the ends of double barrier and guardrail. No breakaway anchor is currently available for these installations. Also, a non-breakaway anchor should be used to add intermediate anchorage where there is an abrupt change in the alignment of the guardrail, such as when the guardrail is continued down an intersecting road. A breakaway anchor with drilled posts set in a foundation should not be used for intermediate anchorage.

Guardrail approaching structures is anchored to or at the structure. In general, guardrail may be anchored to abutments and structure railings that are designated barrier railings. Guardrail should not be fastened to structure columns. Holes drilled for anchor bolts can compromise the integrity of earthquake reinforcement. Where existing masonry and lightly reinforced concrete walls are involved, an independent anchor should be used. Connections may be made to new installations of concrete barrier.

6. End Conditions. In general, the approach end of all guardrail end treatments is shown in the Standard Plans. For more information on which end treatments are approved for use on California highways and for assistance in choosing an appropriate system, contact your Traffic Safety Systems Coordinator or Headquarters' Traffic Operations Liaison.

7. Transitions. Metal beam guardrail is a semi- rigid barrier and must be gradually stiffened as it approaches connections to or at rigid objects such as bridge railings, retaining walls, abutment walls, or other structure supports. Gradual stiffening permits an impacting vehicle to be smoothly redirected away from the rigid object. Gradual stiffening is accomplished by reducing the post spacing for the six posts closest to the rigid object. In addition, the three posts closest to the object are increased in size.

Transitions are required for guardrail approaching structures. Transitions are also necessary where the face of the guardrail is less than 1.2 m in front of the rigid object. Such locations may be a structure column, wall, or sign support. Where there is a row of structure columns with less than 8 m between columns, the reduced post spacing with larger posts should be continued between the columns. Where the column spacing exceeds 8 m, a new transition may be started.

8. *Length and Position*. Nearly all vehicles that run off the road do so at angles less than 25 degrees. The majority of run-off-road accidents occur with departure angles between 10 and 15 degrees, or typically 12.5 degrees. Generally, a 15 m length of guardrail provides adequate coverage for these conditions. Greater lengths of guardrail, if necessary, may be extended along the roadway or away from the roadway in an otherwise clear area. Figure 7-3, Position Of Guardrail At Fixed Objects, illustrates how additional guardrail may be needed to shield an area extending back from the edge of the roadbed on a one-way road. Figure 7-3 also illustrates how the length of a guardrail installation may be reduced where there is a clear recovery area between the edge of the shoulder and the fixed object, and the cross slope is 1:10 or flatter. The guardrail may be placed as far as possible from the edge of the pavement, but no closer than 1.2 m from the face of the rail to the object. This clearance between the guardrail and the fixed object is necessary, since guardrail deflects up to 0.9 m during impact. The extra 0.3 m is to allow for those instances where a guardrail post would intrude into the 0.9 m clearance. Where an object is so close to the road that guardrail installed with 1.2 m of clearance would intrude into the roadbed, it is permissible to fasten the guardrail to the face of the object, other than a structure column, as shown in the Standard Plans. Where guardrail is fastened to a fixed object or passes within 1.2 m of a fixed object the guardrail should be stiffened with larger posts at closer spacing, as shown in the Standard Plans.

Gaps of less than 60 m between guardrail installations and gaps between the end of cuts and the beginning of guardrail should be avoided. Where such a gap is essential for maintenance purposes, removable rail elements can be installed. For additional information on rail panels, consult the Headquarters' Traffic Operations Liaison or the District Safety Coordinator. A gap for maintenance use may be left at the departing end of embankment guardrail on one-way roadbeds, or two-way roadbeds where the departure end is outside the clear recovery zone. Where there is recovery area between the edge of the traveled way and the edge of a high embankment, the guardrail should be installed near the edge of the embankment, preserving the recovery opportunity.

To prevent a vehicle from vaulting over guardrail when it is used in conjunction with a curb or dike, the guardrail face should be on a vertical line with the curb face or on line no more than 50 mm behind the flowline of the dike. The sole exception to this is where the end of the guardrail at a bridge approach is blocked out to overhang the bridge curb face. This is done to minimize the possibility of a vehicle's wheel hitting the end of the bridge curb or sidewalk.

As a general rule, a curb or dike greater than 50 mm in height, ditches, drainage structures, and slopes steeper than 1:10 should not be placed in front of guardrail. If a dike is required in front of the guardrail, Type C dike may be used.

Possible vehicle trajectory must be checked where guardrail placement is proposed on an embankment slope steeper than 1:10. A discussion of trajectory may be found in California Department of Transportation Traffic Bulletin No. 15, Method for Checking the Integrity of Cable and Beam Barriers.

9. *Flares and Tapers*. Guardrail flares and tapers are designed to place the ends of guardrail installations away from approaching traffic and provide a smooth transition. How they are placed is controlled by such factors as embankment width, distance between roadways, clear roadside width, and the design of the guardrail itself. The flares shown in the Standard Plans are both general and typical. They are most applicable to new construction, however, any installation may require some modification to fit special circumstances. Deviations to recommended guardrail flares must be approved by the Headquarters' Traffic Operations Liaison.

The Type 1A and 1B Flares are the basic flares for shielding walls, abutments, and bridge railings. They may be used to the right or left of traffic.

The Type 2 Flare has been deleted from the Standard Plans, but a modified version of it can but used as a construction detail when a designer determines it is the appropriate treatment for a specific installation. This modified Type 2 Flare version can be obtained by contacting your Headquarters Traffic Operations Liaison. It is intended for use at approaches to structures in wide medians. It is used to shield the median approach to the space between two structures. The Type 2 Flare has a blocked out metal beam on the backside and can be used where there is a chance of an errant vehicle striking the back of the installation. This flare uses an approved crashworthy end treatment.

The Type 2A and 2B Flares are intended for use at the approach end of guardrail installations employing a buried-end anchor. Care should be taken to maintain a 685 mm height of rail and eliminate all fixed objects over 50 mm in height in front of the rail. Drainage ditches in front of the rail should also be avoided. The slope approaching the rail should not exceed 1:10.

The Type 3A Flare is designed to close the median gap between parallel structures. It is designed for a separation of 3.6 to 7.6 m between the edge of shoulders or bridge rail. This is to minimize the angle that the guardrail makes with the road. This flare uses a cable anchor (non-breakaway) at the nose. To provide a crashworthy end, a crash cushion shall be placed in front of the nose.

The Type 4A Flare is designed for use between parallel structures where there is 3.8 m or less between the edges of shoulders. Another use occurs where collector, frontage, or other service roads are close to each other. In any situation the nose of the adjoining rails must be set as far from approaching traffic as possible. This flare also uses a cable anchor (non-breakaway) at the nose. To provide a crashworthy end, a crash cushion shall be placed in front of the nose when the end of the guardrail is within 9 m of the edge of the traveled way of approaching traffic.
The Type 5A Flare is intended to shield a fixed object in a median or separation between opposing traffic. The object may be a structure support, an overhead sign support, or some other object. The approach end of the envelope is set away from approaching traffic. The face of the guardrail should be set out 1.2 m from the object. If it is not possible to get 1.2 m clearance, then the reduced post spacing of a transition should be used past the object. This flare uses a cable anchor (non-breakaway) at the nose. A crash cushion shall be placed in front of the nose when the end of the guardrail is within 9 m of the edge of the traveled way of approaching traffic. A crash cushion on each approaching end of the fixed object may be considered in place of the guardrail.
The Type 6A Flare is an open-end envelope for use at structure supports, overhead sign supports, or other objects located in separations between traffic proceeding in the same direction. This flare uses a cable anchor (non-breakaway) at the nose. A crash cushion shall be placed in front of the nose when the end of the guardrail is within 9 m of the edge of the traveled way of approaching traffic.
The Type 7A Flare for new installations has been discontinued. Existing installations may remain until replacement is necessary.
The Type 8A Flare is intended for shielding roadside objects such as bridge columns and overhead sign supports. This flare also facilitates the extension of guardrail along a series of objects such as structure supports. The guardrail posts should be set at a distance 1.2 m from face of rail to face of columns. If the rail encroaches into the shoulder, a rail may be fastened to a retaining wall or closed-end abutment, with approval from the bridge representative, provided a positive anchorage is used at the downstream end of the rail. This flare is appropriate for the approach end of embankment guardrail.
***The Type 9 Flare* has been renamed Type 2A and 2B.**
Details. Metal beam guardrail is made up of a 4.8 mm, "W" shaped metal beam nominally 310 mm wide by 80 mm deep mounted on wood or galvanized steel posts and wood blocks. Additional details are shown in the Standard Plans.
The rail is blocked out from the post with a block. All blocks shall be wood. Wood line posts are normally 150 mm x 200 mm x 1.83 m with the 200 mm dimension installed perpendicular to the rail element. All wood posts and blocks for guardrail must be pressure treated to resist decay. The approved steel post is a galvanized MW150 x 14 hot-rolled, wide-flange post 2.0 m long. Steel posts must be longer than wood posts in order to develop the same soil bearing resistance. Generally only one type of post, either wood or steel, should be used in a run of guardrail.
Where embankment width between the edge of shoulder and hinge point is less than 0.9m, there is not sufficient soil to support a standard length guardrail post. If there is at least 0.6 m but less than the normal 0.9 m of embankment, a 2.1 m long, 200 mm x 200 mm wood post should be used. This design may also be used where embankment material is non-cohesive. If there is less than 0.6 m between the hinge point and the edge of shoulder, a 0.6 m diameter cast-in-drilled-hole pile should be used to support a 150 mm steel post. Details for these alternate designs are shown in Figure 7-4, Guardrail On Narrow Embankments. For further details, see the Standard Plans.
When it is necessary to continue a roadside guardrail across a low-fill box culvert, pipe culvert or overside drain, full embedment of the guardrail post(s) may not be possible over the culvert due to the shallow soil cover. Posts located in the overside drain are undesirable and are often set back behind the drain with multiple blocks. The use of more than two blocks can cause guardrail rotational problems and should be avoided. One or two posts located directly over the culvert or drain may be eliminated and the guardrail spanning the gap doubled to provide the necessary stability. Design details are shown in Figure 7-5, Long Span Nested Guardrail. This design should not be used in transition areas.
Where larger posts are required in guardrail transitions approaching fixed objects, the wood posts are 250 mm x 250 mm with 200 mm x 200 mm blocks. The alternate steel posts are a MW150 x 22 section and the blockouts are 150 mm x 200 mm wood blocks. All steel parts shall be galvanized. Backup plates, which are 300 mm lengths of guardrail, must be used between the rail element and all blockouts at posts without rail splices. This minimizes the possibility of the rail element tearing on the edge of a blockout during an impact. Details of the guardrail transition are shown in the Standard Plans.

Adjustable rail-height guardrail posts may be used where it is anticipated that an overlay will be placed on the shoulder within the next 10 years. The adjustable post has three predrilled holes that allow the rail element and block to be raised when an overlay is placed on the shoulder. Details are shown in the Standard Plans. Figure 7-6
Guardrail can be installed on curving alignment without special fabrication where the radius of curvature is more than 45 m. Where the radius of curvature is 45 m or less, down to a minimum radius of 1.5 m, the rail elements require shop rolling to the required radius. Installations of guardrail with specially fabricated components should be held to a minimum to reduce the need to stockpile special components for maintenance. Also, where special components are not stockpiled, the delay in ordering and receiving replacements unnecessarily extends the exposure for traffic. The rail elements for guardrail are available in two lengths, 3.8 m and 7.6 m. The longer elements create problems for later maintenance work because trucks with longer beds are required to haul the rail elements.
Where guardrail is to be installed on an existing highway or in conjunction with existing roadside features, slopes, clearances, dimensions, underground utilities, and material relating to the roadside feature should be verified. This is especially important where connections to existing structures are proposed. Masonry walls and lightly reinforced concrete bridge railing parapets should not be used as anchorage for guardrail. Details for assembling guardrail are shown on the Standard Plans or Special Details of Contract Plans. The layout of guardrail installation should be shown on the Contract Plans.
Galvanized steel guardrail provides some supplemental value as a delineation device. Where necessary, this delineation ability can be enhanced with reflective delineation devices as described in Chapter 6 of this manual. Reflective delineation devices used on guardrail installations should be aimed to provide optimum visibility. Guardrail located more than 3.6 m from the roadbed should not have reflective delineation devices installed. Guardrail intruding on the roadbed, such as at approaches to narrow bridges, warrants additional delineation treatment as described in Chapter 6.
Weathering steel or ungalvanized steel is not to be used for new installations or upgrading of guardrail or median barrier on state highways.
Thrie Beam Barrier should be used as guardrail only in special situations where additional height of rail is required. The rail elements are 50 percent heavier than metal beam guardrail. It uses a nominal 510 mm wide x 80 mm deep, three-ribbed, galvanized metal beam with the top of the beam generally 810 mm above the surface beneath the rail. Other installation details are similar to those for metal beam guardrail.

Section 7-03 Figures:

Figure 7-1 Equal Severity Curve

Figure 7-2a Guardrail at Sturcture Approaches

Figure 7-2b Clear Recovery Zones

Figure 7-3 Position of Guardrail at Fixed Objects

Figure 7-4 Guardrail on Narrow Embankments

Figure 7-5 Long Span Nested Guardrail

Figure 7-6 Adjustable Height Guardrail

For PDF versions of these graphics, click here:

Figure 7-1
EQUAL SEVERITY CURVE
(See Text for Instructions)

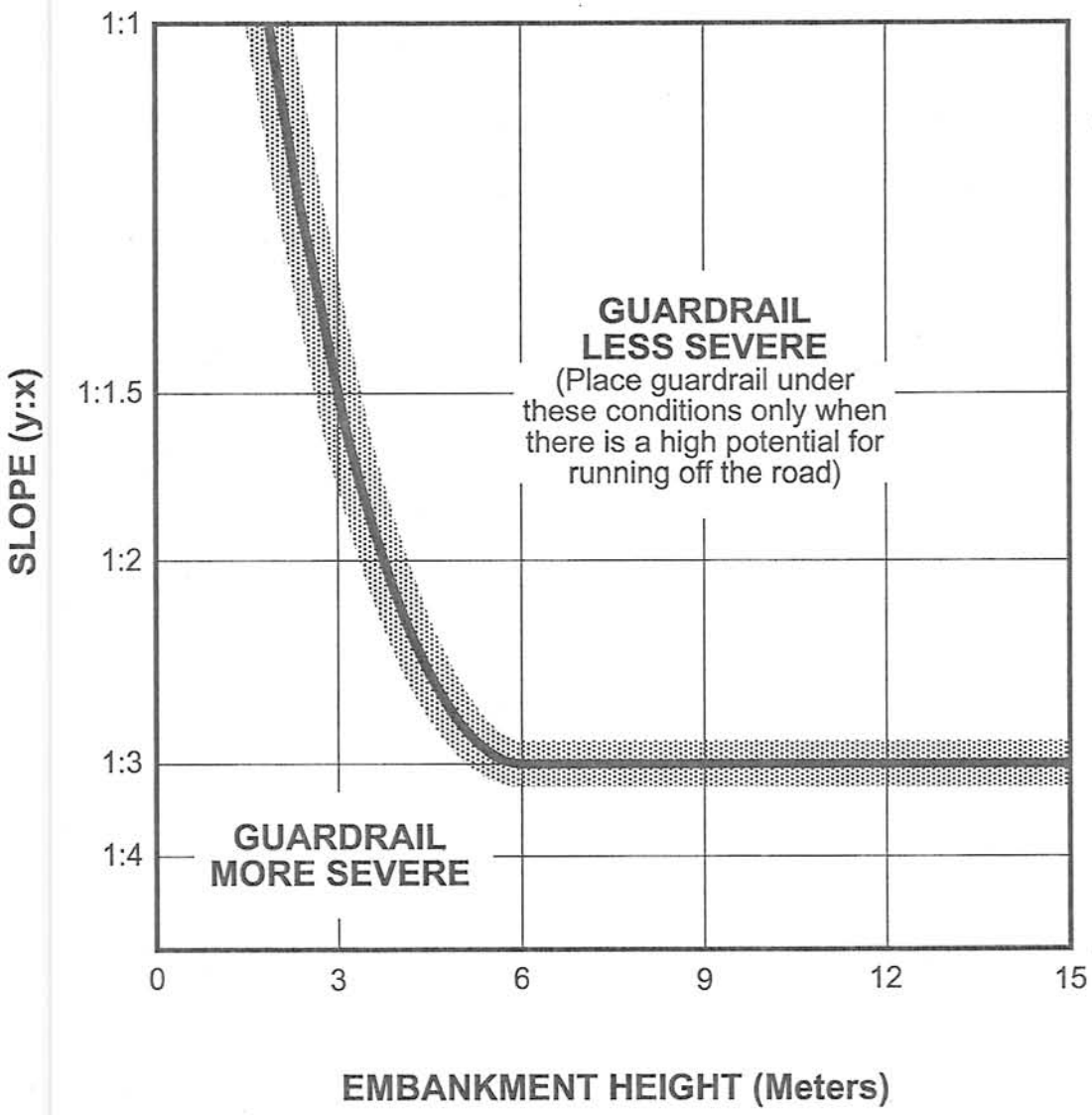
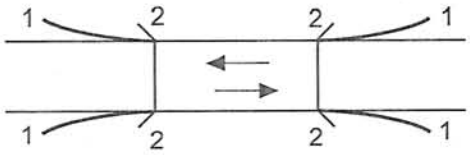
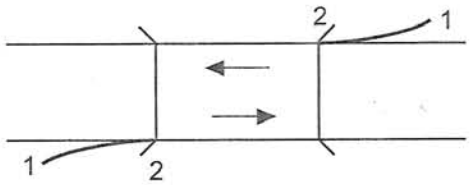


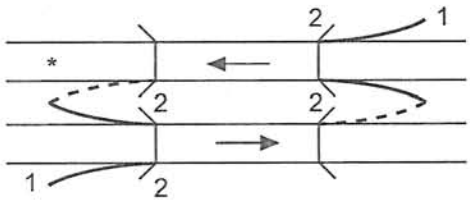
Figure 7-2a
GUARDRAIL AT STRUCTURE APPROACHES



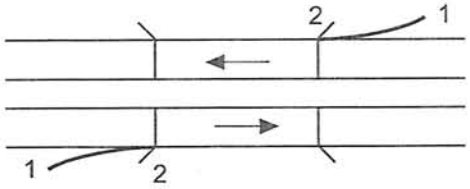
TWO-WAY HIGHWAY BRIDGE ROADBED < 18 m.



TWO-WAY HIGHWAY BRIDGE ROADBED • 18 m.



MULTI-LANE WITH SEPARATE STRUCTURES
*(See Standard Plans for determination of flare type and crash cushion placement.)

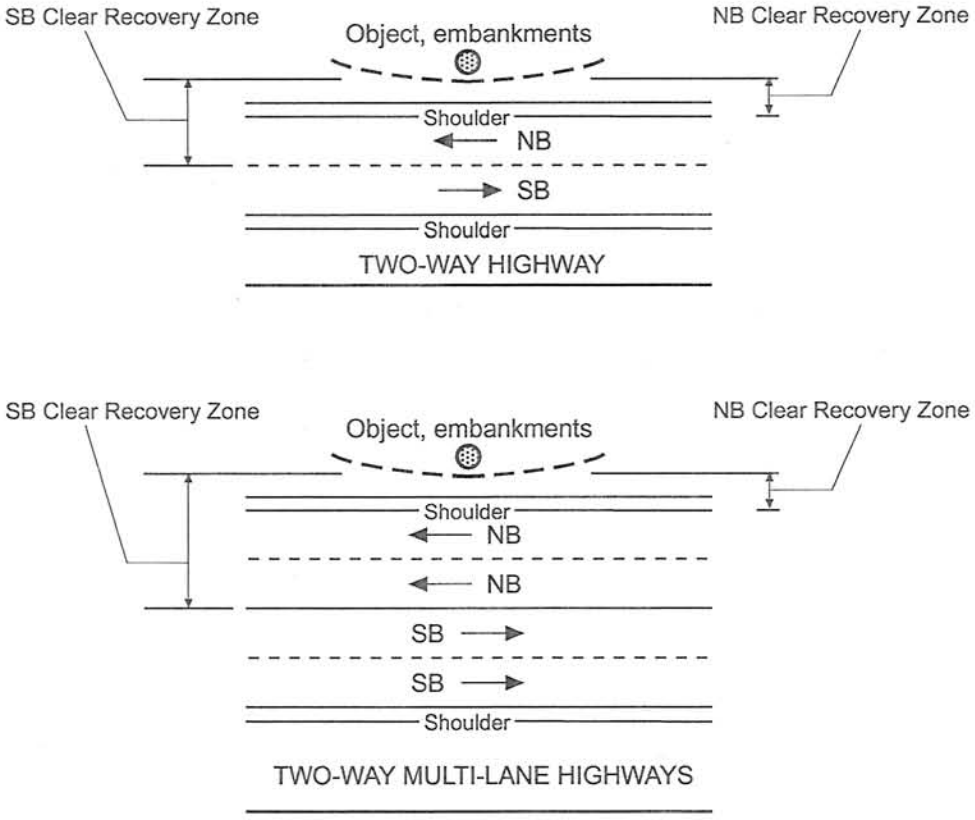


MULTI-LANE WITH DECKED MEDIAN ON BRIDGE

LEGEND:

1. End Treatment - See Standard Plans
2. Positive Anchorage to Structure

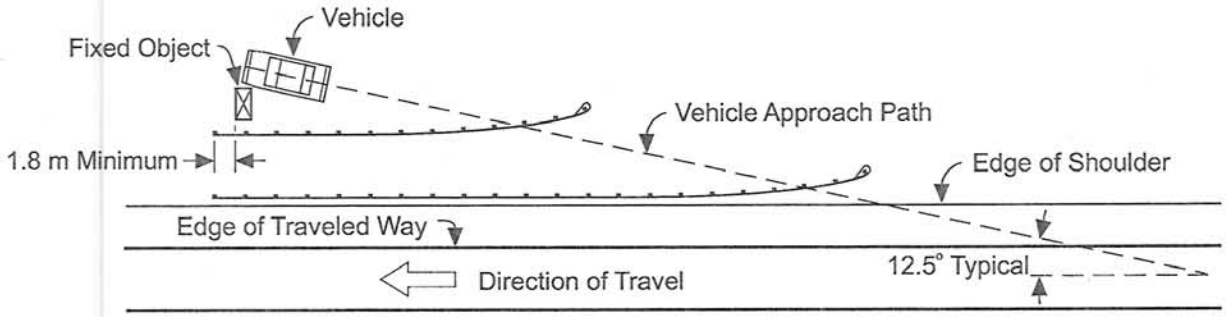
Figure 7-2b
CLEAR RECOVERY ZONES



NOTE:

1. Object, embankment within the clear recovery zone should be shielded with the appropriate end treatment.
2. For additional information, please contact your District Trafic Safety Systems Coordinator, Headquarters' Traffic operations Liaison or Headquarters' Office of Traffic Safety Program and Research.

Figure 7-3
POSITION OF GUARDRAIL AT FIXED OBJECTS



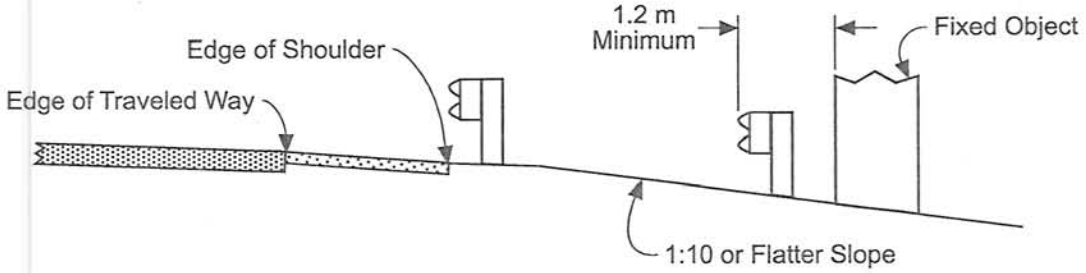
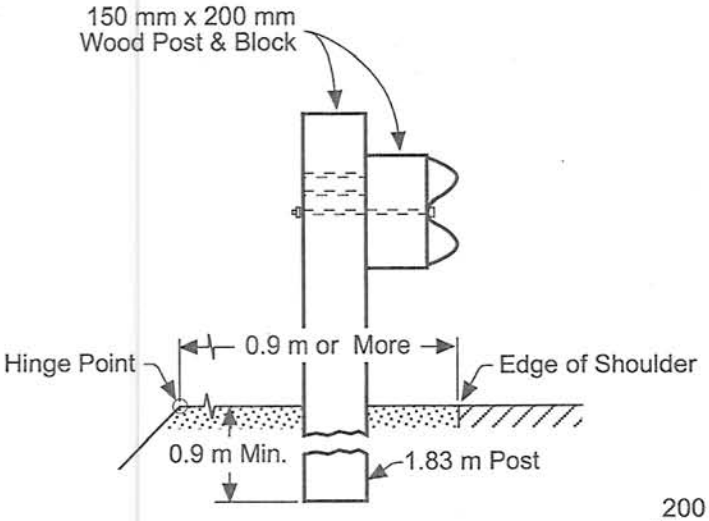
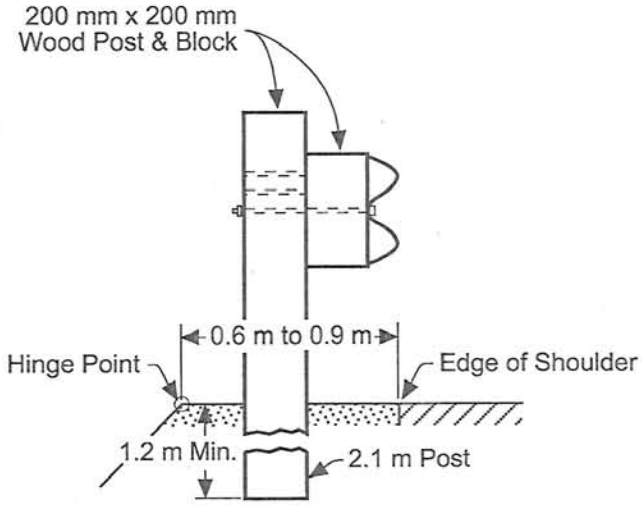


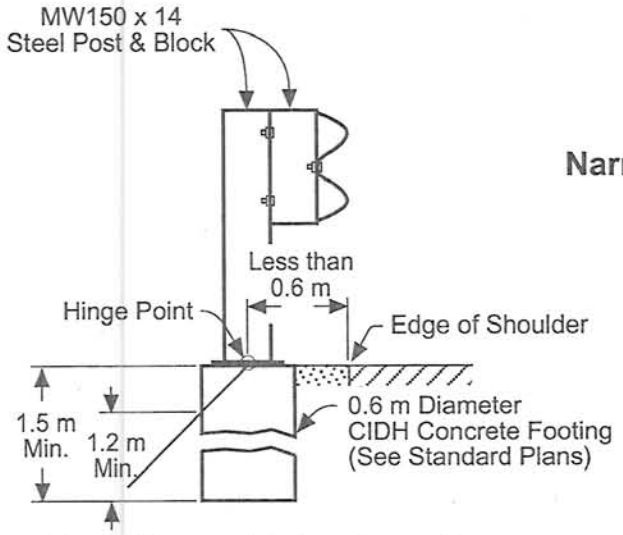
Figure 7-4
GUARDRAIL ON NARROW EMBANKMENTS



Standard Condition

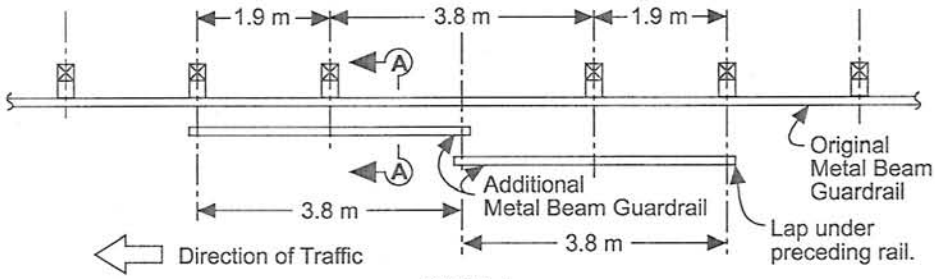


Narrow Embankment or Non-Cohesive Soil

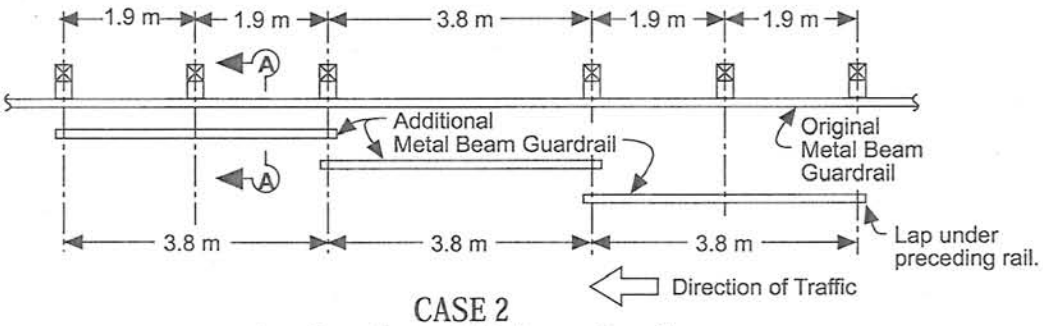


Very Narrow Embankment

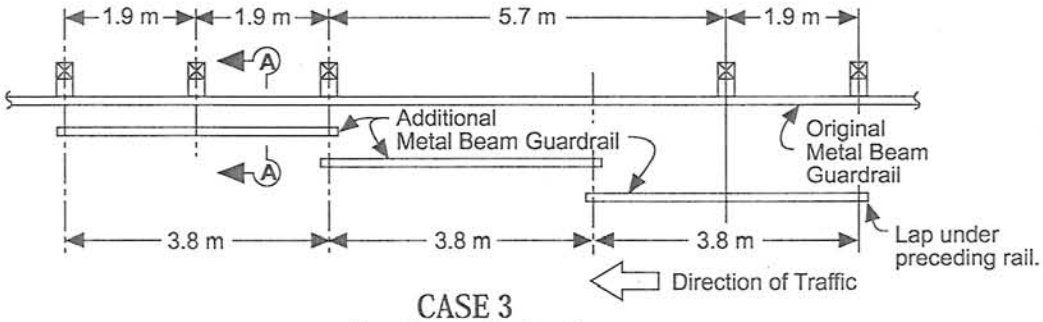
Figure 7-5
LONG SPAN NESTED GUARDRAIL



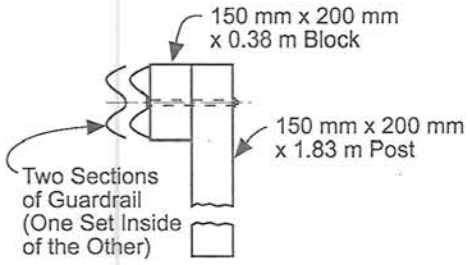
CASE 1
One Post Omitted (Splice in Center)



CASE 2
One Post Omitted (Splice at Posts)



CASE 3
Two Posts Omitted

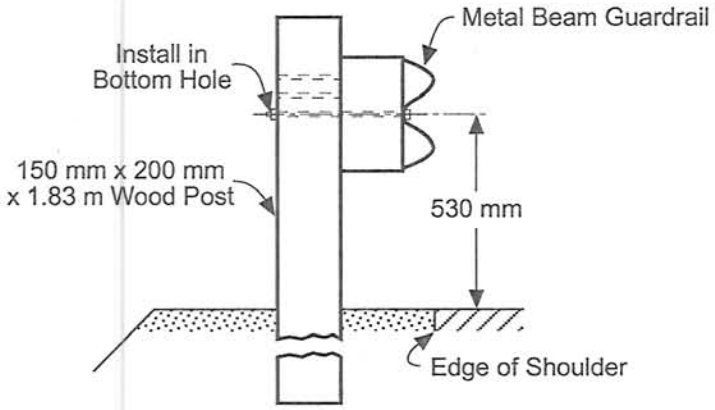


Section A-A

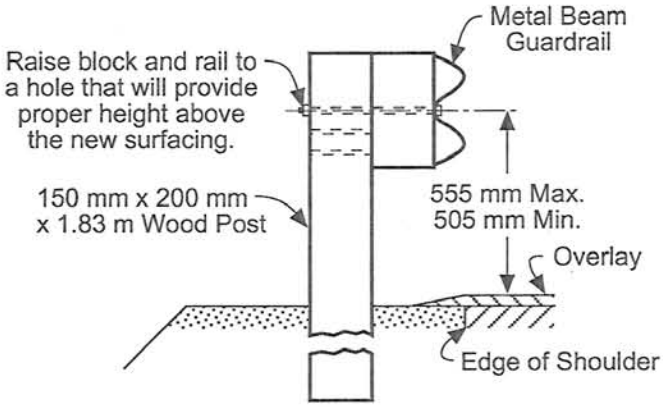
Notes:

1. **Use Case 1 or Case 2 when one post is omitted.**
2. **Use Case 3 when two posts are omitted.**
3. **For other details, see Standard Plans A77A, B, and C.**

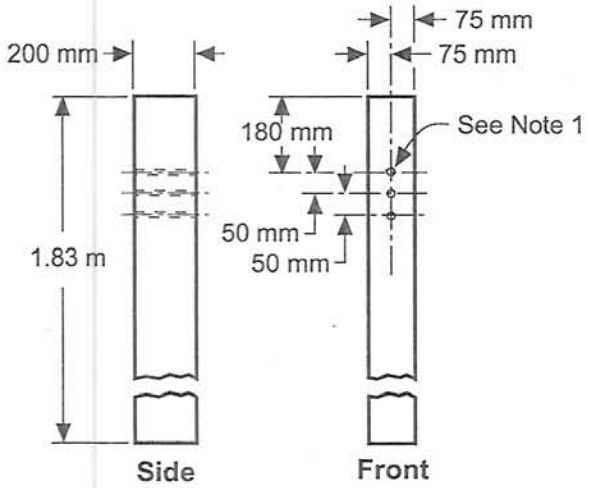
Figure 7-6
ADJUSTABLE HEIGHT GUARDRAIL



Initial Installation



Adjusted Rail Height

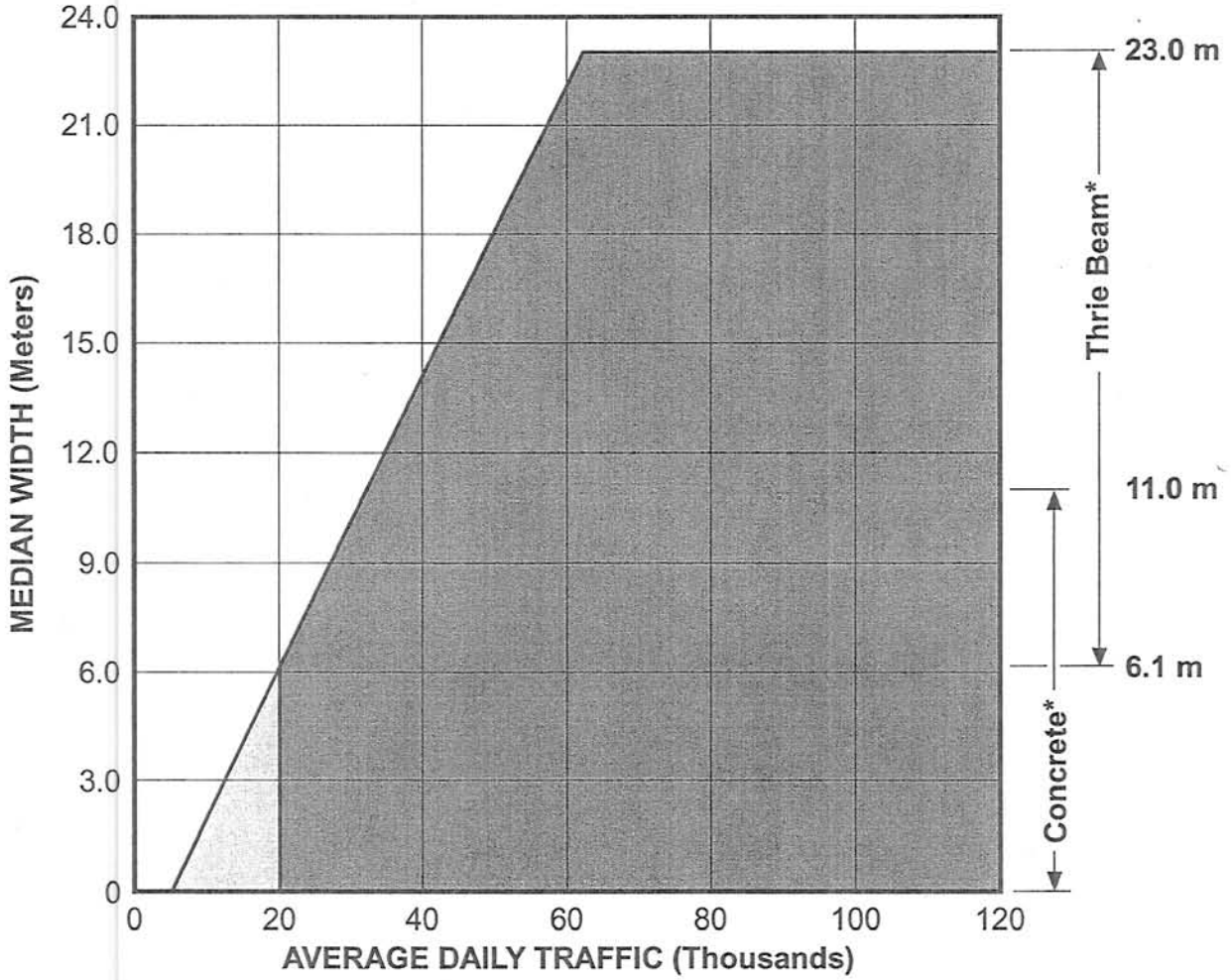


Post Detail

NOTES:

1. All holes in wood posts and blocks shall be 20 mm in diameter ± 1.6 mm.
2. For additional details, see Standard Plans.

Figure 7-7
FREEWAY MEDIAN BARRIER STUDY WARRANTS



Barriers in these cases should be considered only if there is an unusually high number or rate of cross-median accidents.

Study Warranted

*For additional guidance on barrier type, see Section 7-04.4.

Section 7-04 - Median Barrier

7-04.1 Purpose

Ideally, median barriers should:

1. Reduce the risk of an out-of-control vehicle crossing the median and colliding with opposing traffic.
2. Reduce the risk of deflection back into the traffic stream of a vehicle colliding with the barrier.
3. Decelerate the errant vehicle within tolerable limits.

While median barriers are capable of preventing nearly all of the cross-median accidents, their installation will result in fixed-object accidents that might not otherwise occur.

7-04.2 Barrier Types

The approved standard types of median barriers for new installation are: (1) concrete median barrier, and (2) thrie beam barrier (single or double). Headquarters approval is required for any new installation or reinstallation of metal beam barrier or cable barrier.

7-04.3 Study Warrants

1. *Freeways*. The median barrier study warrants shown in Figure 7-7 have been developed through extensive study of freeway cross-median accidents. The need for a barrier should be considered on freeways whenever these study warrants are met. Any decision to install or not to install a barrier where study warrants are met should be thoroughly documented.

When the ADT is less than 20,000, the probability of an out-of-control vehicle crossing the median and colliding with an opposing vehicle is low. When the median width is more than 23.0 m the probability of an out-of-control vehicle reaching the opposing lanes is low. Barriers in these cases should be considered only if there is an unusually high number or rate of cross-median accidents involving opposing vehicles. A cross-median accident is strictly defined as one in which an out-of-control vehicle crosses the median of a 4 or more lane road and strikes, or is struck by, a vehicle from the opposite direction.

With any ADT or median width, barriers should be considered if there has been a high rate of out-of-control cross-median accidents involving opposing vehicles. A rate, based on at least three accidents in 5 years, of 0.31 cross-median accidents per kilometer per year of any severity or 0.073 fatal cross-median accidents per kilometer per year involving opposing vehicles justifies analysis to determine the advisability of a barrier. Where less than 5 years of accident data exists and the rate criteria is met, further analysis should be conducted to determine the advisability of a barrier.

Median barriers should be provided on new construction whenever it is anticipated that they will be justified within five years after construction.

Temporary median barriers should be considered for narrow construction zone detours with large traffic volumes. Temporary Railing (Type K) is the appropriate barrier for most situations, although other temporary barriers are available and should be considered where appropriate. Temporary Railing may also be used for falsework protection and as a roadside barrier to protect construction sites.

2. *Non-freeways*. Median barriers can be an appropriate solution to cross-median accidents on multi-lane (two or more lanes in each direction) expressways and multi-lane conventional highways. The volume/median width and accident study warrants apply to freeways only, but they may be used as a guide for non-freeways.

When installing median barrier on non-freeways, a problem is created at each intersection opening in the barrier. The two ends of the barrier in this situation require special treatment. Careful consideration of the number of intersections, accident history, alignment, driveways, grade, and sight distance as well as traffic volumes and median width must be given for non-freeway installations. It is the engineer's responsibility to determine, decide, and document the best improvements.

7-04.4 Criteria for Choice of Type

Each barrier system exhibits characteristics that make a given type of barrier more desirable in one location than another type of barrier. These characteristics are:

1. *Concrete Barrier*. This rigid barrier does not deflect upon impact, but dissipates impact energy within the vehicle suspension system at shallow angle impacts and by displacement of vehicle sheet metal at severe impact angles. The severity of impact can be greater with concrete than with thrie beam barriers at high impact angles. Impact angles tend to be larger with wider medians. This barrier requires little maintenance; consequently, traffic is not disrupted by extensive maintenance operations, and maintenance workers are not exposed to large volumes of relatively high-speed traffic. Concrete barrier is believed to have the highest percentage of unreported "accidents" since, in flat angle collisions with this barrier, most vehicles are redirected with minimal damage and are able to drive away. Finally, this is the cleanest barrier, with no projections to collect debris.
2. *Thrie Beam Barrier*. This barrier may deflect up to 0.6 m on impact and provide some dissipation of energy through the displacement of posts and flattening of rail elements. Maintenance costs are higher than concrete barrier. Thrie beam barrier can sustain minor impacts without requiring immediate and extensive restoration work. This barrier system occupies more median than concrete barrier.

After the decision to use permanent median barriers has been made, the following guidance shall be used to determine whether concrete or thrie beam barrier is appropriate at a given location. (Note: All median barrier offset dimensions are measured from the edge of traveled way to face of barrier.)

If there is widening or other type of work that will reposition barriers in five years or less, consider an interim barrier such as K-Rail. This applies to all median widths with or without plantings. The interim barrier (type and offset distance) shall be approved by the Department's headquarters (HQ) Division of Traffic Operations liaison. The project which repositions the barrier shall include the cost of installing the permanent median barrier.

	Median Width	**Equal to and Less than 11 meter (m) 36 feet (ft)**	**>11 m to <14 m (>36 ft to <46 ft)**	**Equal to 14 m (46 ft)**	**Greater than 14 m (46 ft)**
NO PLANTINGS	**Barrier Type**	Type 60 concrete[1]	Consult HQ traffic liaison	Type 60 concrete or thrie beam	Thrie beam
	Placement	On centerline[2] pave up to face of barrier	Consult HQ traffic liaison	Offset 4.3 m (14 ft) and pave up to it or on centerline (no median paving), respectively	On centerline
PLANTINGS	**Barrier Type**	Type 60 concrete[1]	Thrie beam	Thrie beam	Thrie beam
	Placement	On each side of planting, pave up to barrier, maximum offset 5.2 m (17 ft)	On each side of plantings, minimum offset 4.9 m (16 ft)	On each side of plantings, minimum offset 4.9 m (16 ft)	On each side of plantings, minimum offset 4.9 m (16 ft)

[1] Consult with headquarters Division of Traffic Operations liaison and headquarters Devision of Maintenance liaison for using thrie beam

[2] Except when offset for barrier openings

In all cases where thrie beam barriers are used, a minimum distance of 4.9 m – 5.5 m (16 -18 ft) between face of rail and the edge of travel way must be provided for maintenance activities.

For median widths equal to and less than 11 m (36 ft), concrete barriers are the preferred barrier type. However, thrie beam barriers may be installed in medians where there is a history of an accumulation of sand in the median due to high wind, or in designated Federal Emergency Management Agency floodplain areas. Written concurrence for installing thrie beam barrier must be obtained from the Department's headquarters Division of Traffic Operations liaison and headquarters Division of Maintenance liaison.

Any exception to this policy shall be concurred by the Department's headquarters Division of Traffic Operations liaison and both Deputy District Director's for Maintenance and Traffic Operations within appropriate district and approved by the headquarters Division Chief's of Maintenance and Traffic Operations or their designee.

7-04.5 Barrier Design Details

Construction details for concrete and thrie beam barriers are shown in the Standard Plans. Concrete barrier Type 50 series has "Jersey-style" sides and has been the standard concrete barrier for many years. Concrete barrier Type 60 series, the current standard, has a single-sloped design on the sides. The width of the base is generally 610 mm. The standard height of Type 60 barrier is 915 mm. If glare screen is required, the 1420 mm tall Type 60G concrete barrier should be used. The Type 60S concrete barrier is 810 mm tall and may be used where stopping sight distance would be impaired if the standard Type 60 barrier were used. The basic concrete barrier is normally constructed by slipforming without a footing on pavement. Ends of the barrier at gaps or contraction joints where the concrete and reinforcement is not continuous require a 250 mm deep by 3.0 m long footing under the end of the barrier. This is intended to prevent displacement of the barrier in an impact at the discontinuity. Other versions of concrete barrier usually require fixed forms for construction.

Thrie beam barrier is made up of a 12 gauge triple corrugated galvanized steel beam nominally 510 mm wide by 81 mm deep mounted on wood or galvanized steel posts and wood blocks. The top of the rail element is 820 mm above the surface at the face of the barrier. The rail is blocked out from the post with a wood block. Wood line posts are 150 mm x 200 mm x 1.83 m with the 200 mm dimension perpendicular to the rail element. All wood posts and blockouts must be treated to resist decay. The steel line post is a galvanized MW150 x 14 hot rolled wide flange post 2.0 m long. The ends of thrie beam barrier must be anchored to ensure expected performance.

Where larger posts are required in transitions approaching fixed objects or transitions to concrete barrier railings, the wood posts are 250 mm x 250 mm with 200 mm x 200 mm wood blockouts, steel posts MW150 x 22 section and the wood blockouts are 150 mm x 150 mm.

Where a double-faced thrie beam barrier is proposed and a saw-toothed median section requires the rail elements to be mounted at different elevations, steel posts should be used. Thrie beam requires two mounting bolts that pass through the blockouts and post. For normal installations, the two parallel holes are drilled in a jig at the manufacturing plant. Field drilling a second pair of holes parallel to each other and the original pair is quite difficult and should not be done. Furthermore, the added holes in the line of the grain create a weakened plane in the post that can affect the barrier's performance.

Pavement rehabilitation projects placing thick layers of new paving can compromise the performance of existing median barriers. Normally, Type 50 concrete barrier can tolerate the addition of 75 mm of added pavement against its base without remedial measures being required. This reduces the effective height of this barrier to 735 mm. Where thicker pavement overlays are planned, either replace with new rail or taper pavement to maintain effective height of barrier.

Thrie beam barrier can tolerate a height deficiency of 50 mm. Where pavement overlays will result in more than a 50 mm height deficiency, corrective measures are necessary. Where the thrie beam barrier is supported on wood posts and the ground around the post is paved, the rail installation may be jacked up and a 50 mm x 150 mm x 300 mm treated Douglas Fir block nailed to the post at the pavement surface. The post may be jacked up no more than 125 mm without adding surfacing around the post. In unpaved areas, it is necessary to remove and reconstruct thrie beam on wood posts to ensure that it will remain at its functional height.

Isolated freestanding ends of median barriers are substantial fixed objects. Hence, they must be protected from impacts by approaching traffic. This may be done by flaring the end of the barrier away from approaching traffic or placing an appropriate crash cushion at the approach end of the barrier. Sloping ends or ends that are turned down into the ground are not acceptable.

The total cost of barrier installation can vary considerably from project to project depending on the amount and type of site preparation required.

7-04.6 Median Design Considerations

Many of the difficulties encountered with irregular medians or continuous obstruction in the median can be avoided by the following considerations:

1. *Longitudinal Median Dikes*. When required, the dike should be as close to the thrie beam barrier as possible. When placed in front of thrie beam barrier, dikes should be 100 mm high or less. The dike should not be placed between 0.3 and 4.0 m in front of the barrier. Dikes over 100 mm high shall not be placed directly under the barrier. Dikes shall not be placed in front of concrete barriers.
2. *Median Ditches*. Drainage ditches should be as shallow and as flat as possible. Where deep ditches are unavoidable, a barrier may be needed on both sides of the ditch.
3. *Median Drainage*. Thrie beam barrier is adaptable to most median drainage conditions. Concrete median barrier, however, may require special designs to provide drainage. Slotted drain inlets are the recommended means of providing drainage in paved medians with concrete median barrier. Design details for these are contained in the Standard Plans. Where a concrete barrier must span or cross an existing drainage inlet, special barrier gap closure details are available. Passing runoff under a concrete median barrier with scuppers on an all-paved cross section is not desirable. What was sheet flow becomes concentrated into streams across the lower roadway. Scuppers, if used, should not extend higher than 75 mm at the base of the barrier. Also, each scupper should be no more than 0.9 m long and a series of scuppers should not occupy more than 25 percent of any 6.1 m length of concrete barrier. Where a highway requiring median barrier is located in a flood plain and it is necessary to allow floodwaters to pass over the highway, thrie beam barrier should be used. For an additional discussion of median drainage, see Section 834.2, Median Drainage, of the Highway Design Manual.
4. *Raised Medians*. Barrier height should be measured from the median surface. Median barriers should not be placed on raised medians.
5. *Flat Medians*. On paved flat medians, the barrier height should be measured from the paved surface exclusive of any localized ditch surface. Medians adjacent to concrete barriers should be paved.
6. *Planted Medians*. Where plants are located in the median, and the plantings cannot be removed, two single barriers, one on each side of the plants, should be placed. See Section 7-04.4, Criteria for Choice of Type, to determine if the use of concrete or thrie beam barrier is appropriate. Earth berms used with median plantings should be eliminated.
7. *Maintenance*. Care must be taken that median maintenance or construction work done after a median barrier is in place does not change the effective height of the barrier.
8. *Future Construction*. Where traffic lanes are to be added to the median within five years of barrier construction, the median grade line should be adjusted and the barrier installed for the ultimate condition. If it is not practical to do this, concrete barrier should not be used since, unlike the other barrier types, the height of concrete cannot be readily adjusted.
9. *Median Cross-Slope*. Where median cross-slopes are greater than 1:10, vehicle trajectory can affect barrier performance. Using the procedures outlined in Traffic Bulletin No. 15, the relationship between median and traveled way cross-slopes should be checked to ensure desired barrier performance.
10. *Adding Lanes in the Median*. Where lanes are added in the median reducing the width of the median, the median barrier type to be used should be selected in accordance with Section 7-04.4, Criteria for Choice of Type. In some cases it will be necessary to remove existing non-concrete barrier and replace it with concrete barrier. Costs associated with the change in barrier type should be included in the preliminary scoping document estimate.

7-04.7 Emergency Passageways/CHP Enforcement Area

Except for emergency passageways/CHP enforcement area in median barriers, median openings are not allowed on freeways. The use of passageways shall be kept to a minimum and carefully located to provide good stopping sight distance to and from the opening along the freeway. Emergency passageways may be appropriate for highway patrol vehicles, emergency service vehicles such as tow trucks, ambulances, fire fighting apparatus and maintenance equipment. The need for such openings and their locations shall be established by the District in cooperation with the local Department of Highway Patrol office, fire district and emergency services. Emergency openings in glare screens for limited passage of stretchers or personnel are covered in Section 7-04.8.

Where emergency openings are provided, they shall be designed based on the following considerations:

1. *Types of Vehicles*. Passageways are designed for motorcycles or for motor vehicles. Motorcycle openings are 1.8 m to 2.4 m long, and openings for motor vehicles are 3.7 m to 4.9 m long.
2. *Types of Passageways*. Permanent openings and temporary openings with removable sections of barrier are the two types of passageways used. Permanent openings for motorcycle passage only may be provided in concrete and thrie beam barriers. Passageways for motor vehicles shall be by use of temporary, removable sections of barrier or permanent openings where the barrier ends are offset away from approaching traffic. All temporary openings shall be closed immediately after use.
3. *Spacing of Passageways*. By a combination of interchange ramps and passageways, provisions for access to the opposite side of the freeway may be provided. Access shall not be more frequent than at 5 km intervals.
4. *Median Widths*. The median must be wide enough to accommodate turning vehicles safely, and contain the barrier with any necessary flares. Therefore, motorcycle passageways should not be provided where the median is less than 6.7 m wide. Motor vehicle passageways should not be provided where the median is 9.8 m or less in width, unless there are unusual circumstances.
5. *Barrier Design Details*. Designs for barrier passageways are shown in Barrier Passageways in the Standard Plans.
6. *CHP Enforcement Area.* For CHP enforcement area design details, please refer to the HOV Guidelines.

7-04.8 Glare Screens

1. *General*. Glare screens are designed to screen out the headlight glare of opposing traffic. Glare screen may be considered on new or existing median barriers where the median is 6.1 m or less in width except on horizontal curves where glare screen would reduce sight distance to less than the stopping distance for the design speed. Glare screen should not be installed in medians wider than 6.1 m.

Glare screen should be installed where engineering evaluations show that the glare screen would be of overall benefit to the motorist considering the cost and other impacts of the glare screen. An engineering evaluation is required for all projects involving construction within the median for medians 6.1 m wide or less. Engineering evaluations should consider glare due to the combined effects of grades, horizontal alignment, and traffic volumes. Public complaints are considered in the evaluation. On route segments with scenic views, the sensitivity of the public to the blocking of these views should be considered. The engineering evaluation shall be incorporated in the appropriate project development report as specified in the Project Development Procedures Manual.

Based on engineering evaluations, glare screens may be installed on segments or spot locations along frontage roads or at entrance and exit ramps. Chain link fence with slats may be appropriate in these situations.

1. *Thrie Beam Barrier*. Glare screen is not generally used with thrie beam barrier.
2. *Concrete Barrier*. When glare screen is determined appropriate, the standard permanent glare screen for this barrier is concrete glare screen.
3. *Plantings*. Where plantings exist in the median, glare screen may be considered on structures with decked medians. When plantings are not in place but are planned, decked medians may include provisions to accommodate glare screen in the future.
4. *Emergency Openings*. When glare screen is included with the barrier, openings may be provided at approximately 180 m intervals if requested by the California Highway Patrol. In areas with above average traffic collision rates, openings may be spaced at 90 m intervals. Spacing may be varied to provide such an opening at each structure crossing over the highway.

7-04.9 Delineation

Commercial retroreflector units are available where it is necessary to provide enhanced delineation along median barriers. Reflective delineation along thrie beam barriers is provided by installing approved retroreflective units on top of the posts. Retroreflective delineation for concrete barriers is obtained by securing approved units to the top of the barrier. For further details regarding delineation for median barriers, please refer to Section 6-04.9 of the Traffic Manual.

Section 7-04 Figures:

Figure 7-7 Freeway Median Barrier Warrants

For a PDF version of this graphic, click here:

Section 7-05 - Crash Cushions

7-05.1 Purpose

Crash cushions, also known as impact energy attenuators, are intended to protect a motorist from the consequences of a collision with a fixed object that cannot be removed or where other protective systems are not suitable. A prime example occurs at gores on elevated structures. Here the intersecting structure railings, often with a vertical pier or sign support, create a fixed object.

7-05.2 Available Crash Cushion Types

Types currently available include arrays of sand-filled plastic drums and several mechanical systems relying on a crushable medium and metal deformation to dissipate impact energy. Information about designs and types of crash cushions currently approved for use on California highways is available from your District Traffic Safety Coordinator, your Headquarters Traffic Operations Liaison or Headquarters' Office of Traffic Safety Program and Research.

7-05.3 Placement

Crash cushions should be installed at fixed objects that cannot be economically removed or made breakaway. They should also be installed to shield fixed objects where guardrail is inappropriate.

Section 7-06 - Movable Concrete Barrier

7-06.1 Introduction

A Moveable Concrete Barrier (MCB) is similar in appearance to common safety-shaped concrete barrier. A typical MCB can be transferred laterally from 1.2 m to 5.5 m in one continuous operation and at speeds of about 8 km/h. It has the ability to reconfigure a road quickly, and to safely offer numerous solutions to the difficult construction staging and traffic handling problems. An MCB system can be operated indefinitely within an improved freeway median to provide a reversible traffic lane which can accommodate peak hour flows where additional highway widening is prohibitive and the directional traffic split is significant (i.e. 60-40 or greater). See Section 7-06.3 for a list of applications for which a MCB could be used.

7-06.2 Warrants

The following guidelines are to be used to establish the warrants for using a MCB system to achieve an efficient and effective Traffic Management Plan (TMP). A MCB system may provide additional traffic capacity lanes for accommodation of both AM and PM peak traffic, a safe and expeditious means of expanding the Contractor's work area, and/or the opportunity to stage projects in a more efficient method.

A MCB system should be a type that can be quickly moved laterally from 1.2 m to 5.5 m in one continuous operation and at speeds of about 8 km/h. The decision to use a MCB system should be made by the designer with capacity, safety and economics as the guidelines, and should include the following considerations:

1. Additional lanes can be utilized during peak hour traffic periods.
2. Additional working area can be gained during off peak hours that can reduce construction time and increase safety by reducing accidents and shielding highway workers.
3. Construction time can be shortened either through staging or increased productivity by the contractor.
4. Timing required to set up staging can be kept to a minimum.
5. Construction sites with limited work zones in urban or restricted areas where frequent day or nighttime lane closures will be required.
6. This system will provide a continuous, positive separation that will increase the degree of safety for motorists and highway workers.

Input for justification should be obtained from a Headquarters Traffic Operations Liaison.

7-06.3 Applications

A MCB system may be considered as a design alternative to traditional highway widening along highly congested urban corridors. The most common improvement strategy would utilize a MCB system to create a reversible traffic lane in a freeway median in order to accommodate peak hour traffic flows (with significant directional split). Since the MCB system requires higher operating and maintenance costs, it should only be considered where the cost and/or impacts of the traditional freeway widening alternative is prohibitive.

When developing a TMP, the use of these MCB systems should be limited to projects where a greater benefit can be attained than if standard methods and equipment were used. Listed below are types of projects where it would be a viable option for use.

1. Widening or reconstruction projects on highways, freeways or expressways with high peak hour traffic volumes (i.e. 50,000 AADT and greater for 4 lane facilities and 90,000 AADT and greater for 6 lane facilities).
2. Projects where a reversible traffic lane would be beneficial during peak traffic durations when significant directional traffic patterns exist. This would allow for better staging.
3. Median and shoulder reconstruction projects. Examples include shoulder/median improvements or widening, such as a new permanent concrete barrier being installed. The MCB is especially beneficial when the size of the work zone is either very restricted or if repeated lane closures are anticipated.
4. Resurfacing projects. By closing one side of a divided highway and creating opposing traffic lanes on the open side of the road, a contractor can resurface one side of the roadway at night without interference from traffic.
5. Reconstruction of parallel structures. Design of a reversible lane to increase the capacity of one structure while closing down the other.
6. Alternate routes do not have excess capacity for suitable detour.
7. Alternate routes do not exist.

7-06.4 Safety and Cost Considerations

In construction projects, a MCB system is generally used to open traffic lanes during peak traffic periods and close the lanes during off peak periods to allow improved access to the work zone. In this application, the MCB system has the unique ability to provide continuous positive protection before, during and after the opening and closing of traffic lanes. Once these barriers are on the road, it takes significantly less time to perform a lane closure with this barrier than it does using traditional methods. A determination should be made by the designer that this feature and resulting increased worker safety makes the use of a MCB system a viable alternative to conventional traffic control devices. Its use should be clearly described in the TMP.

When considering this product the designer should also prepare a cost comparison of the MCB and the next best alternative. The following items should be considered:

1. Cost of the MCB. The designer should work with the supplier to determine operational costs and a lease price to contractors.
2. The next best alternative and its cost.
3. If possible, the accident cost savings associated with the use of the MCB and the next best alternative. It is assumed that there is no difference in accident costs when MCB is compared to precast concrete curb construction barrier of other types.
4. The savings in time for the project schedule should also be considered with the overall savings.

When using a MCB system, a buffer zone of 0.61 m is desirable to allow for the deflection of the MCB system upon impact.

Use of a MCB system on land service roads should take into consideration access to properties and business. Access must be maintained during construction.

When using a MCB system, consideration for additional wide load signing in the TMP may be appropriate. If the barrier is used to reverse traffic flow and there is a single lane in one direction, it shall not be less than 3.05 m

When using a MCB system on an unrestrained bridge shoulder, the distance between the edge of the bridge and the face of the MCB should not be less than 1.22 m. If the distance between the edge of the unrestrained bridge shoulder and the face of the MCB is less than 1.22 m, then the installation of angle connecting the bridge to the MCB system must be made in order to increase the stiffness of the MCB system.

A MCB system should be used on tangent sections and curves where an angle of impact of not more than seven degrees exists and where an allowable movement of the barrier of no more than 0.5 m is acceptable when struck by a vehicle. The MCB system can be used on sharp curves where an allowable movement of the barrier of no more than 1 m is acceptable when struck by a vehicle.

Approved safety end treatments such as inertial barriers (sand barrels) must be used in conjunction with the MCB to shield the approach ends of the barrier.

End of Chapter 7
Back to Top of Chapter 7
Back to Traffic Manual Home Page