600 SAFETY ELEMENTS CHAPTER

600 SAFETY ELEMENTS CHAPTER TABLES

600 SAFETY ELEMENTS CHAPTER FIGURES

610
SAFETY BARRIERS

610.01 ROADSIDE BARRIER INDEX NOMOGRAPH

The nomograph in Figure 610.A is used to determine a barrier need index number based on the roadside conditions. Prior to referring to Figure 610.A, the designer should design the roadside according to the Clear Zone guidelines outlined in section 620 Roadside Safety. The roadside barrier index should only be evaluated in locations where it is not cost effective to achieve the clear zone distance.

610.02 CONCRETE LOW BARRIER INSTALLATIONS

610.02.01 Background

This section deals with expanding the highway locations where the 460 mm Concrete Low Barrier (CLB) may be installed (refer to the Standard Specifications for Highway Construction, drawing SP941.01.01.02). CLBs are currently permitted to be installed:

a. in left turn slots as a form of median barrier on multi-lane roads;

b. on the inside of curves alongside ditches in rock-cuts;

c. in parking areas to form boundaries and contain traffic.

From a review and analysis of the performance of the CLB in computer modeling and practical service experience of their use in many B.C. locations, it has been decided to expand their installation to situations where they could contribute to road safety. [(1)]

610.02.02 Supplementary Guidelines for Installing Concrete Low Barrier on the Outside Shoulder of Highways

A. Required Conditions:

In addition to locations listed in 610.02.01, the CLB will be permitted when two critical conditions are met. These are:

i. The Design Speed or Posted Speed Limit is not greater than 70 km/h.

ii. The B.C. Warrant Index value is less than 90. No lower limit warrant will be required, i.e. CLBs may be installed for much lower index values than 90.

B. Application Guidelines

a) The CLB may be installed instead of curb and gutter where vehicles riding over the curb may enter a hazardous area. CLB will not be installed if vehicles are permitted to park beside the curb. On 2-lane roads, the face of the Concrete Bullnose (CBN) (SP 941-01.01.01) will continue to the face of the curb. On multi-lane roads, the inside face of the CBN will be placed 25 mm in front of the curb face when the traffic flow direction is from the CBN to the curb & gutter. When the traffic flow is from the curb & gutter to the CBN, the inside face of the CBN will be placed 25 mm behind the curb & gutter face. The CBN and CLB should be placed on pavement with 50 mm minimum paved width behind the barriers.

b) The CLB may be installed to prevent vehicles from striking frangible luminaire poles.

c) The CLB may be considered for installation along unnumbered roads where the maximum winter or summer ADT is less than 1,500 vehicles per day, usually on School bus routes. It is advisable that CLB not be used on roads where the posted or unposted (i.e. statutory) speed limit is greater than 70 km/h. The CBN and CLB units may be ordered and used without the 100 mm drainage holes in locations where local surface drainage and catch basins are provided. They will not need any further treatment to function as drainage curbs.

d) Approach and Opposing flare layouts will be required when the CBN and CLB are the terminals of barrier installations, i.e. when no curb and gutter is present. The dimensions of flares are to generally conform to those listed in Figure 640.C. The number of units may differ from those listed in Figure 640.C to account for CLB pieces being longer than CRB pieces. In most cases, this will result in a longer flare length. In these situations, maintain the flare rate for the applicable speed.

e) The CLBs will connect with taller CRB and CMB units using the Transition units in the BC MoTI *Standard Specifications for Highway Construction*.

Figure 610.A Roadside Barrier Index Nomograph

N.T.S.

EXAMPLE

DATA:

Design Speed 90 km/h, Radius 340 m (Outside Curve), Fill height 2.4 m above H.W.M., Depth of still water 1.2 m, Fill slope 1.5 : 1, Shoulder width 3.0 m, S.A.D.T. 7000 vpd, Freezing moderate.

SOLUTION:

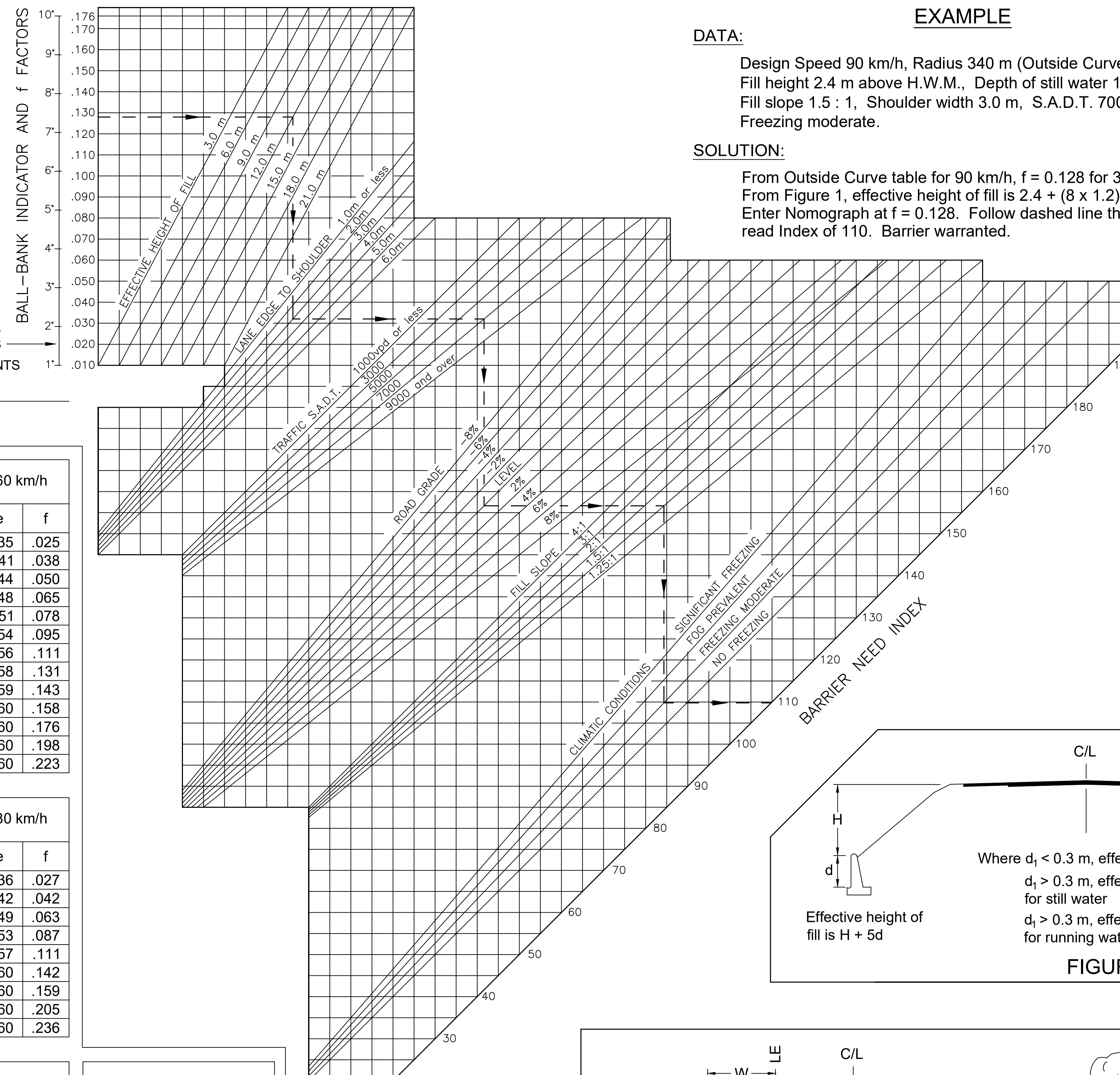
From Outside Curve table for 90 km/h, f = 0.128 for 340 m radius. From Figure 1, effective height of fill is 2.4 + (8 x 1.2) = 12 m. Enter Nomograph at f = 0.128. Follow dashed line through to read Index of 110. Barrier warranted.

BARRIER USUALLY NOT WARRANTED

1. When in a cut or on a fill with less than 3m effective height.
2. When fill slope is 4:1 or flatter.
3. When Barrier Need Index is less than 90.

The Principal Highway Safety Engineer should be consulted when barrier is being considered for the above situations.

NOTE:
Do not extrapolate beyond the minimum or maximum values shown on the nomograph. For f > 0.176 (ball-bank 10°) to max. f of 0.220, use the Barrier Warrant Calculator spreadsheet.



OUTSIDE CURVES

For 6% max. superelevation

Design Speed 50 km/h			
Radius	e+f	e	f
330	.060	.035	.025
300	.066	.037	.029
250	.079	.040	.038
220	.089	.043	.047
190	.104	.046	.058
170	.116	.048	.068
150	.131	.051	.081
130	.151	.053	.098
110	.179	.056	.122
*90	.219	.060	.159
80	.246	.060	.186
75	.262	.060	.202
70	.281	.060	.221

Design Speed 60 km/h			
Radius	e+f	e	f
475	.060	.035	.025
360	.079	.041	.038
300	.094	.044	.050
250	.113	.048	.065
220	.129	.051	.078
190	.149	.054	.095
170	.167	.056	.111
150	.189	.058	.131
140	.202	.059	.143
*130	.218	.060	.158
120	.236	.060	.176
110	.258	.060	.198
100	.283	.060	.223

Design Speed 70 km/h			
Radius	e+f	e	f
630	.061	.035	.026
450	.086	.042	.043
360	.107	.047	.060
270	.143	.053	.090
230	.168	.056	.112
*190	.203	.059	.144
170	.227	.060	.167
160	.241	.060	.181
150	.257	.060	.197

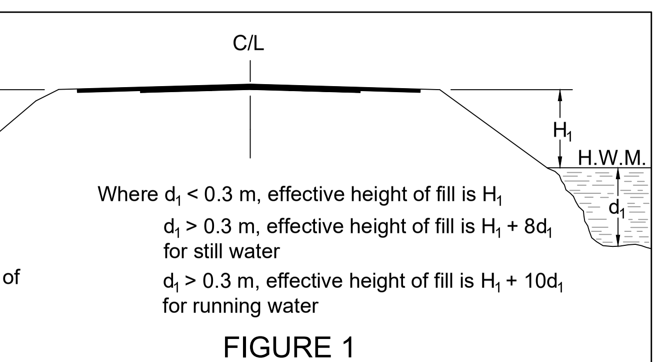
Design Speed 80 km/h			
Radius	e+f	e	f
800	.063	.036	.027
600	.084	.042	.042
450	.112	.049	.063
360	.140	.053	.087
300	.168	.057	.111
*250	.202	.060	.142
230	.219	.060	.159
190	.265	.060	.205
170	.296	.060	.236

Design Speed 90 km/h			
Radius	e+f	e	f
1050	.061	.036	.025
800	.080	.042	.038
600	.106	.048	.058
450	.142	.054	.088
380	.168	.058	.110
*340	.188	.060	.128
300	.213	.060	.153
250	.255	.060	.195
230	.277	.060	.217

Design Speed 100 km/h			
Radius	e+f	e	f
1250	.063	.037	.026
1000	.079	.042	.037
800	.098	.047	.051
600	.131	.053	.078
450	.175	.059	.116
*440	.179	.060	.119
380	.207	.060	.147
340	.232	.060	.172
300	.262	.060	.202

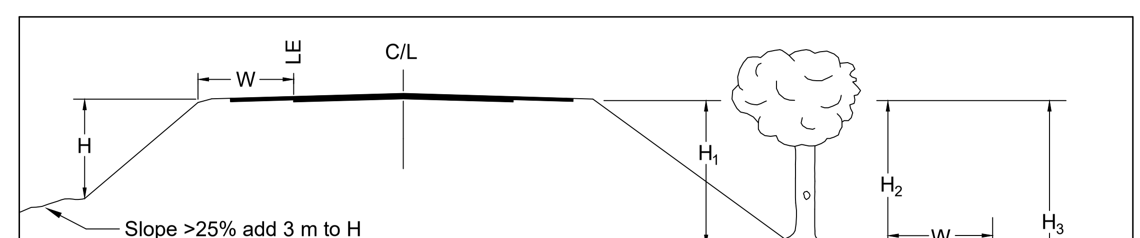
Design Speed 110 km/h			
Radius	e+f	e	f
1500	.064	.038	.025
1000	.095	.048	.047
800	.119	.053	.066
*600	.159	.060	.099
550	.173	.060	.113
500	.191	.060	.131
450	.212	.060	.152
380	.251	.060	.191
360	.265	.060	.205

* These curve radii are minimum values for new highway design.



Where d_1 < 0.3 m, effective height of fill is H_1
d_1 > 0.3 m, effective height of fill is H_1 + 8d_1 for still water
d_1 > 0.3 m, effective height of fill is H_1 + 10d_1 for running water

FIGURE 1



NOTE
1. Where trees or heavy brush grow on downslope, effective height of fill is H_1
2. Where W > 6 m, no guardrail required regardless of other factors.
3. Where $W_1 \geq 3$ m, effective height of fill is H_2
   $W_1 < 3$ m, effective height of fill is H_3
4. Where downslope from toe exceeds 25% (4:1), effective height of fill is H + 3 m

FIGURE 2

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610.03 CABLE BARRIER

610.03.01 Background

A cable barrier system consists of high tensioned galvanized steel wire ropes and support posts with anchors at both ends of the system. The wire rope is held in place by frangible support posts with a concrete foundation. The kinetic energy of the impacting vehicle is absorbed by the wire ropes which reduces impact acceleration to vehicle occupants.

Cable barrier minimizes view obstruction and improves stopping sight distance on highways compared to concrete or steel barriers.

Crash test results have shown that the typical wire rope deflection varies depending on post and anchor spacing. Lower deflection distances can be achieved by using tighter post and anchor spacing.

Refer to the BC MoTI *Recognized Products List* for currently acceptable cable barrier products for BC highways.

610.03.02 Basic Criteria

Similar to concrete and steel barriers, a 4-cable barrier system may be considered as a treatment option for median and roadside applications. However, a cable barrier may be the preferred option under the following situations:

1. On highway sections with curvilinear alignment to improve stopping sight distance.
2. On scenic routes to minimize view obstruction.
3. At locations where drifting snow creates a hazard.
4. On highway sections that are of sufficient length that the overall cost per metre to install it is less than the cost of other barrier options.

Cable barrier should NOT be considered as a Median Barrier when:

1. The distance behind the cable barrier available for cable deflection upon crashes is less than the minimum space specified in the manufacturer's design guideline.
2. The radius of horizontal curve of a road section is lower than the minimum radius specified in the manufacturer's design guideline.
3. The radius of curve of a vertical sag of a road section is lower than the minimum k-value specified in the manufacturer's design guideline.

Cable barrier should NOT be used as a Roadside Barrier where the soil or rock condition does not provide sufficient stability to hold the concrete foundation of the supporting posts in place under vehicle impact. Consult with the manufacturer for details.

Locations need to be evaluated carefully to determine if cable barrier is the appropriate barrier treatment. Contact the MoTI Principal Highway Safety Engineer if additional guidance is needed.

610.03.03 Application Guidelines and Restrictions

Cable barrier may be used as:

1. Median Barrier
2. Roadside Barrier

An engineering review is required when considering using cable barrier on highway segments with the following physical characteristics:

1. On highways with narrow median (i.e. where the cable deflection during a crash would encroach into the opposing traffic lane).
2. On the centre line of undivided highway sections.
3. On a horizontal alignment with a small radius of curve. Typical minimum value is 200 m. Contact the manufacturer for more detail.
4. On a sag vertical alignment with a small k-value.

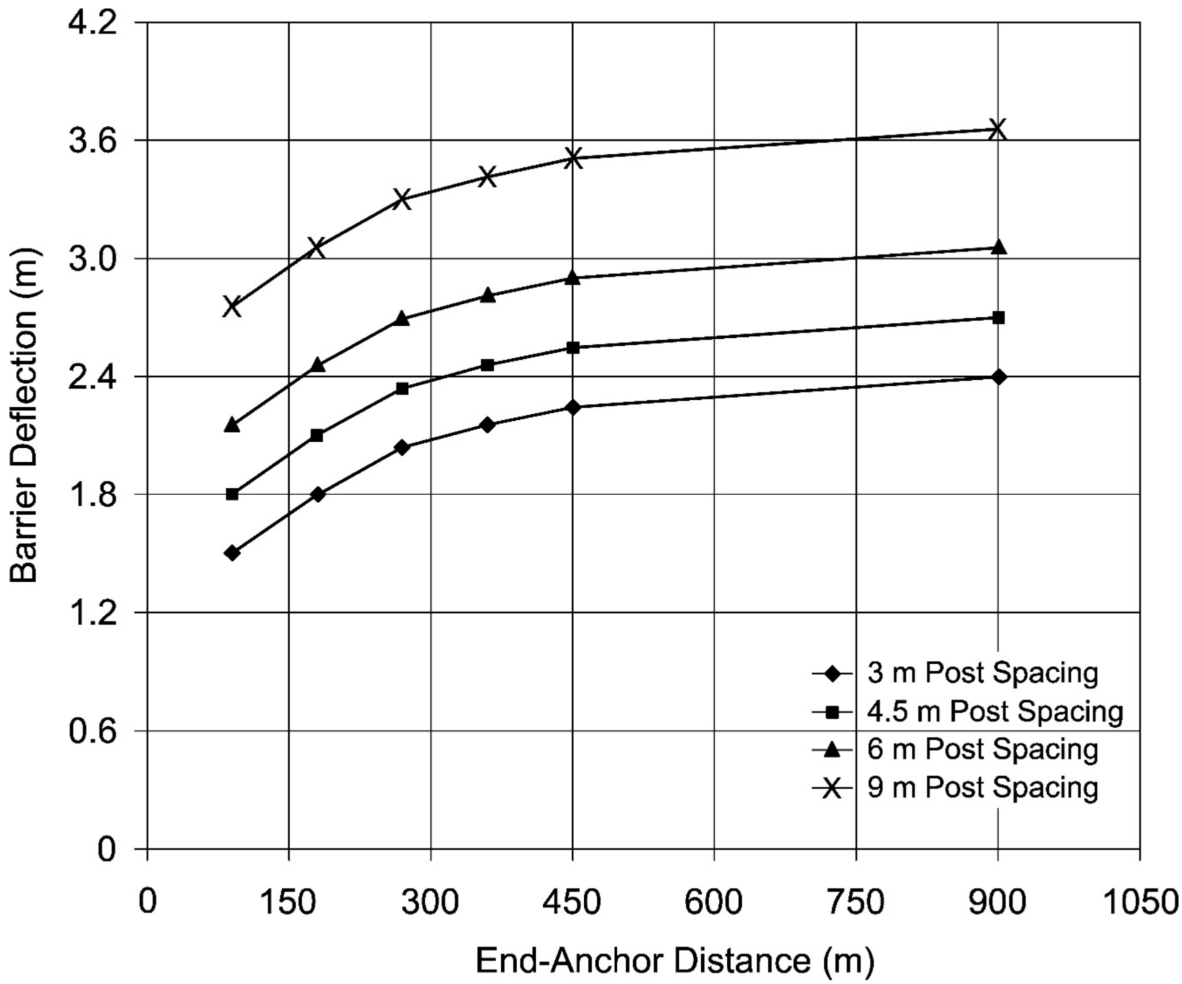
610.03.04 Design Guidelines

Cable barrier placement guidelines shall be in accordance with *NCHRP Report 711 - Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems*, Chapter 6, Section 6.3. For systems that do not meet NCHRP Report 711 placement guidelines, the Ministry will require FHWA acceptance of the product for the specific median profile and specific barrier system.

Cable deflection should be designed to prevent intrusion of opposing vehicles into the travel lane caused by the back-side impact to the cable system after crossing the median.

Design deflection distances noted by each manufacturer are based on the deflection that resulted from the MASH or NCHRP Report 350 test at 100 km/h, 25° impact angle with a pickup truck impacting a cable barrier with specific post and end-anchor spacing. In the field, deflections can be greater depending on the specific impact conditions that occur and the installation setup. Individual manufacturers should ensure that plots are available showing the effects of end-anchor and post spacing on barrier deflection. Figure 610.B is an example plot taken from NCHRP Report 711.

Figure 610.B Hypothetical Plot of Barrier Deflection vs. End-anchor and Post Spacings
(Adapted from NCHRP Report 711, Figure 6.5)



Cable barrier products have substantial differences in design, specification and method of installation. Consult with the manufacturer or vendor for design details and specifications (i.e. end-anchor spacing, post spacing, clearance from road shoulders, clearance from drop-off, barrier application on steep slope, concrete foundation design, flared end treatment, transition between different types of barriers, typical length of barrier, cable tensioning, etc.).

End anchors should be designed based upon an analysis of the soil where the cable barrier will be placed. Based on the soil data and climate information, static and dynamic geotechnical analyses or testing should be performed to determine the appropriate size for the end anchor.

Heavy accumulation of snow behind the cable barrier may bend the frangible supporting posts when it settles. An engineering review is required when considering using cable barrier in areas with heavy snow accumulation.

Cable barrier should NOT be connected directly to any other safety barrier or bridge parapet. However, the cable barrier can be interfaced with other types of barrier when installed in accordance with the details specified by the manufacturer and adequate performance is achieved.

The cable barrier shall be installed on socketed posts with concrete foundations adequate for existing soil and climate condition. The concrete post foundation shall be of sufficient size to ensure that it is not damaged or displaced when the post is knocked down under vehicle impact. Consult with the manufacturer or vendor for design details.

A sleeve shall be used in the socket of a concrete post foundation to facilitate removal of a damaged post. Consult with the manufacturer or vendor for design details.

For median cable barrier, retro-reflective delineators should be installed approximately every 12.5 m on top of the support post caps.

For roadside cable barrier, retro-reflective delineators should be installed approximately every 25 m on top of the support post caps.

An engineering review is required when considering the use of cable barrier in a manner that does not conform to the specifications in the manufacturer's design guideline. Contact the MoTI Principal Highway Safety Engineer if additional guidance is needed.

610.04 REFERENCES

(1) Report on the Performance of 460 mm P.C. Concrete Low Barriers and Proposed Installation Practices on Roads & Streets in British Columbia. Prepared by John (Jack) Lisman, P.Eng. – June 2006.

(2) NCHRP Report 711 - Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems. Transportation Research Board. 2012

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620 ROADSIDE SAFETY

620.01 INTRODUCTION

In highway design, the term Roadside Safety encompasses the area outside the travel portion of the roadway. This includes the shoulder, the side slopes, ditches and any fixed objects and water bodies that could present a serious hazard to the occupants of a vehicle leaving the roadway.

Within the limits of the project's scope and budget, the highway designer has some measure of control in shaping the roadside environment to reduce roadside hazards.

The following clarifies the British Columbia Ministry of Transportation & Infrastructure's (BC MoTI) design policy on the application of the most important design element of Roadside Safety which is called the Clear Zone.

This chapter supplements the Transportation Association of Canada's *Geometric Design Guide for Canadian Road*s which is the main reference manual used by the British Columbia Ministry of Transportation & Infrastructure.

620.02 FORGIVING ROADSIDE

The designer should strive to achieve the "*Forgiving Roadside*". The following quote, taken from Transportation Research Board Circular 435, outlines the essence of the design concept that incorporates Roadside Safety:

"*Basically, a forgiving roadside is one free of obstacles that could cause serious injuries to occupants of an errant vehicle. To the extent possible, a relatively flat, unobstructed roadside recovery area is desirable, and when these conditions cannot be provided, hazardous features in the recovery area should be made breakaway or shielded with an appropriate barrier.*"

620.03 CLEAR ZONE

The Clear Zone includes the total roadside border area, starting at the edge of the outer through lane. This area shall consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. The desired width is dependent upon the design traffic volume and speed and on the roadside geometry.

Note: Recovery zone is another term that is used interchangeably with clear zone.

620.04 DEFINITIONS

Average Annual Daily Traffic (AADT): Refer to the definition on page 3 of the glossary. The AADT for the design year should be used.

Back slope: Graded uphill slope up to the original ground and beyond the ditch in a cut. Sometimes written in one word as a "backslope" or referred to as a "cut slope".

Clear runout area: The area located beyond the toe of a non-recoverable slope that is free of fixed objects and available for an errant vehicle to come to a rest.

Clear zone distance: Distance in metres measured at ninety degrees from the outer through lane edge in the direction away from the traveled way. Within the boundaries outlined by the clear zone distance are usually the shoulder and a recoverable slope. In some situations, a non-recoverable slope and/or a clear runout area may also be located within the clear zone distance.

Critical fill slope: Any fill slope steeper than 3:1. An errant vehicle traversing a critical fill slope is at much greater risk to overturn than on slopes at 3:1 or flatter.

Cut slope: See "Back slope".

Design Clear zone distance: The target value used for a specific highway design when the design speed and the design volume are known. This value is obtained from Table 620.A.

Fill slope: See "Front slope".

Fixed objects: Refer to section 620.06 item # 2.

Front slope: Graded downhill slope beyond the outside edge of the shoulder down to the ditch in a cut or to the original ground on a fill. This is sometimes called a "fill slope" or a "foreslope".

Hazard: A critical slope, fixed object, or body of water which, when hit or reached by a vehicle, may either cause the vehicle to overturn and/or injure occupants of the vehicle.

Major Reconstruction: For the purposes of this chapter, "major reconstruction" includes projects on existing highways that involve grading works to improve capacity.

New Construction: For the purpose of this chapter - Construction of a new highway horizontal or vertical alignment.

Non-recoverable slope: A slope on which an errant vehicle will continue until it reaches the bottom, without having the ability to recover control. Fill slopes steeper than 4:1, but no steeper than 3:1, are considered non-recoverable.

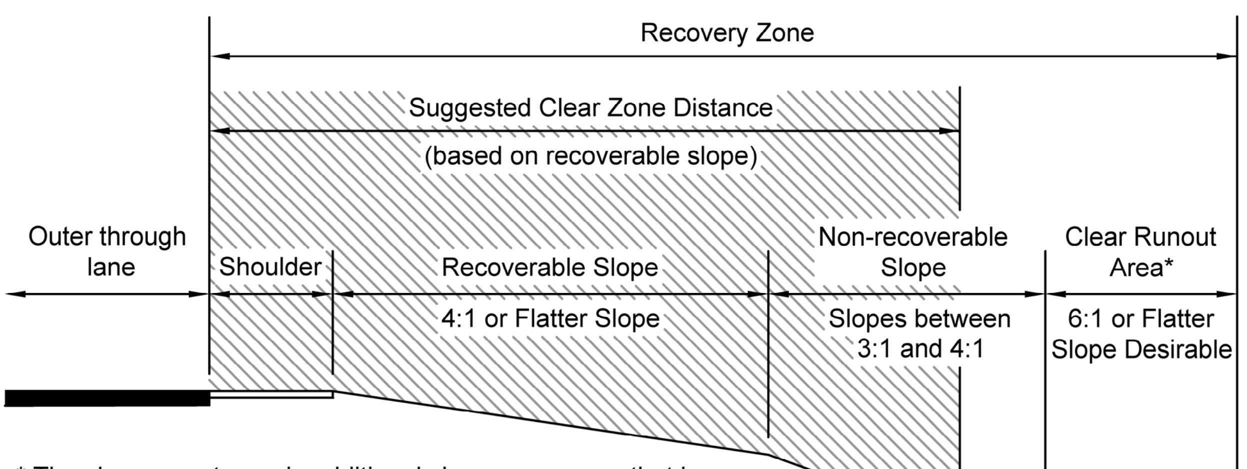
Recoverable slope: A slope on which the driver of an errant vehicle can regain control of the vehicle. Slopes that are 4:1 or flatter are considered recoverable.

Recovery zone: The target area used in highway design when a fill slope between 4:1 and 3:1 is used within the design clear zone distance.

Rehabilitation: Often called 3R for resurfacing, restoration, rehabilitation, is to restore the existing highway to its initial condition. The project may include some safety enhancements. The primary objective of projects falling under a 3R program is to extend the service life and improve safety of an existing highway.

Traveled way: That part of a roadway intended for vehicle traffic. This excludes shoulders, parking lanes, rest areas and bus bays.

Figure 620.A Components of the Clear Zone Design Element



* The clear runout area is additional clear zone space that is needed because a portion of the suggested clear zone (hatched area) falls on a non-recoverable slope. The width of the clear runout area is equal to that portion of the clear zone distance that is located on the non-recoverable slope.

Source: AASHTO *Roadside Design Guide*, 4th Edition, 2011

620.05 COMPONENTS OF CLEAR ZONE

Figure 620.A shows the components of the roadside Clear Zone. If the clear zone distance ends on a non-recoverable slope, a clear runout area is required. The desirable width of this area shall be equal to the portion of the clear zone distance overlapping the non-recoverable slope and typically should be a minimum of 3.0 m beyond the toe. Refer to Tables 620.A, B & C for Clear Zone distances. Also refer to note (**) in Table 620.A. The clear zone distance should preferably be located entirely within a recoverable slope thereby eliminating the need for a clear runout area.

620.06 ROADSIDE DESIGN METHODS FOR NEW CONSTRUCTION AND MAJOR RECONSTRUCTION

For the purpose of this chapter, new construction and major reconstruction are defined in section 620.04. The designer should refer to the Roadside Safety chapter of the TAC *Geometric Design Guide for Canadian Roads* for factors influencing the Clear Zone Design Domain and examples of calculations on shaping the side slopes for the area enclosed within the recovery zone.

This section clarifies BC MoTI's policy on the treatment of hazards and mitigation methods within the recovery zone.

The first step is to identify the suggested clear zone distance as a function of the project design speed and the estimated design year volume for a selected slope. In the area enclosed within the clear zone distance, there are three general categories of hazards that the designer should remove or mitigate: side slopes, fixed objects and bodies of water.

The designer must evaluate the potential risks presented by these hazards and proceed with any of these options in descending order of desirability based on an optimum net present value analysis:

i) Design the side slopes according to the Clear Zone Guidelines;

ii) Remove any hazard within the recovery zone;

iii) Shield the hazard with safety barrier or crash cushion;

iv) Use break-away devices or posts;

v) Take no action if all of the above actions are not cost effective (usually only considered on lower volume roads that are less than 750 AADT and/or low speed facilities with posted speeds of less than 60 km/h). However, in such a case, the obstacle should be properly delineated.

Shoulder Rumble Strips are not a substitute for clear zone design. Therefore, they cannot be used as a reason to justify a reduction of the clear zone distance.

1) Highway Cross-section Slopes

A. Fill or Front Slopes

The designer should preferably design fill slopes of between 10:1 and 6:1. The minimum fill slope is 4:1. Fill slopes steeper than 4:1 are non-recoverable and require special attention from the designer to provide specific measures in the design to mitigate the hazard presented by such slope.

B. Cut or Back Slopes

Cut slopes of 3:1 and flatter that are free of fixed objects are usually less severe a hazard than a traffic barrier. In the case of a rock cut, it should either be outside the clear zone or shielded by a roadside barrier.

The designer should conduct an individual analysis for each rock cut or group of rock cuts and document the reasons justifying the roadside safety design decision.

C. Transverse Slopes and Culvert Ends

Roadway features that introduce a transverse slope or exposed face within the clear recovery zone must either be shielded or designed to be traversable. These roadway features typically include:

driveways, turnarounds in depressed median and earth berms.

Traversable transverse slope treatments are applied for slopes facing oncoming traffic on divided highways and on both sides for undivided highways. The designer should refer to the latest edition of the TAC *Geometric Design Guide for Canadian Roads* for detailed design parameters to be used for transverse slopes and culvert end treatments within the clear zone.

2) Fixed Objects

The following are typical examples of fixed objects that require special analysis by the designer for roadside safety mitigation treatment:

- Non-breakaway posts and light standards (note: all posts should be analysed including tall electrical power line posts as well as simple posts that support signs or mail boxes. Fire hydrants that are made of cast iron which will easily fracture on impact are considered as breakaway. Any other part of the base of a fire hydrant that is not frangible must not protrude more than 100 mm above ground);

- Any hazard that falls within the Zone of Intrusion. Refer to TAC Geometric Design Guide 2017 Edition Section 7.6.2.6.

- Trees which have a potential of growing to a diameter that exceeds 100 mm measured 150 mm above ground level;

- Any fixed object protruding more than 100 mm above ground. This includes but is not limited to boulders, curbs, culverts and pipe ends.

- Fencing should preferably be located outside the clear recovery zone or be designed and installed in a manner that will make it yield on impact without producing debris that could penetrate the errant vehicle and injure occupants. Refer to section 660 for guidelines to provide fencing for pedestrians and cyclists.

620.07 COST-EFFECTIVENESS METHODOLOGY

Utilizing a cost-effectiveness approach will allow the Ministry to optimize the allocation of its resources to achieve better safety for the traveling public throughout the overall Provincial roadway system.

Further discussion on the explicit analysis of roadside safety features may be found in the TAC *Geometric Design Guide for Canadian Roads*, section 7.2.

The AASHTO *Roadside Design Guide* describes a cost-effectiveness methodology called Roadside Safety Analysis Program (RSAP). Copies of the NCHRP Report 492 Engineer's Manual, RSAP User's Manual and the RSAP program can be downloaded free from the TRB Web site at: http://www.trb.org/TRB/Publications/Publications.asp

620.08 PREAMBLE ON CLEAR ZONE DISTANCES

The Clear Zone Distances in Tables 620.A and 620.B in the following pages, are from AASHTO and TAC documents (see section 620.14 REFERENCES). The reduced Clear Zone distances in Table 620.C were adopted by BC MoTI in 1995 based on a benefit-cost analysis

As stated in the AASHTO *Roadside Design Guide*:

> These tables "*only provide a general approximation of the needed clear zone distance*". They are "*based on limited empirical data that was extrapolated to provide information for a wide range of conditions, design speeds, rural versus urban locations, and practicality.*

Table 620.A Suggested (¥) Design Clear Zone Distances (see note 1) in metres For New Construction and Reconstruction Projects on Rural Highways (¥¥)

Design Speed (km/h)	Design Year AADT (see note 2)	Front Slopes (Fill)			Back Slopes (Cut)		
		6:1 or flatter	5:1 to 4:1	3:1	3:1	5:1 to 4:1	6:1 or flatter
< 70	200 <AADT< 750 (see note 3)	2.0 – 3.0	2.0 – 3.0	**	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0
	750 - 1500	3.0 – 3.5	3.5 – 4.5	**	3.0 – 3.5	3.0 – 3.5	3.0 – 3.5
	1501 - 6000	3.5 – 4.5	4.5 – 5.0	**	3.5 – 4.5	3.5 – 4.5	3.5 – 4.5
	> 6000	4.5 – 5.0	5.0 – 5.5	**	4.5 – 5.0	4.5 – 5.0	4.5 – 5.0
70 - 80	200 <AADT< 750 (see note 3)	3.0 – 3.5	3.5 – 4.5	**	2.5 – 3.0	2.5 – 3.0	3.0 – 3.5
	750 - 1500	4.5 – 5.0	5.0 – 6.0	**	3.0 – 3.5	3.5 – 4.5	4.5 – 5.0
	1501 - 6000	5.0 – 5.5	6.0 – 8.0	**	3.5 – 4.5	4.5 – 5.0	5.0 – 5.5
	> 6000	6.0 – 6.5	7.5 – 8.5	**	4.5 – 5.0	5.5 – 6.0	6.0 – 6.5
90	200 <AADT< 750 (see note 3)	3.5 – 4.5	4.5 – 5.5	**	2.5 – 3.0	3.0 – 3.5	3.0 – 3.5
	750 - 1500	5.0 – 5.5	6.0 – 7.5	**	3.0 – 3.5	4.5 – 5.0	5.0 – 5.5
	1501 - 6000	6.0 – 6.5	7.5 – 9.0	**	4.5 – 5.0	5.0 – 5.5	6.0 – 6.5
	> 6000	6.5 – 7.5	8.0 – 10.0*	**	5.0 – 5.5	6.0 – 6.5	6.5 – 7.5
100	200 <AADT< 750 (see note 3)	5.0 – 5.5	6.0 – 7.5	**	3.0 – 3.5	3.3 – 4.5	4.5 – 5.0
	750 - 1500	6.0 – 7.5	8.0 – 10.0*	**	3.5 – 4.5	5.0 – 5.5	6.0 – 6.5
	1501 - 6000	8.0 – 9.0	10.0 – 12.0*	**	4.5 – 5.5	5.5 – 6.5	7.5 – 8.0
	> 6000	9.0 – 10.0*	11.0 – 13.5*	**	6.0 – 6.5	7.5 – 8.0	8.0 – 8.5
≥ 110	200 <AADT< 750 (see note 3)	5.5 – 6.0	6.0 – 8.0	**	3.0 – 3.5	4.5 – 5.0	4.5 – 5.0
	750 - 1500	7.5 – 8.0	8.5 – 11.0*	**	3.5 – 5.0	5.5 – 6.0	6.0 – 6.5
	1501 - 6000	8.5 – 10.0*	10.5 – 13.0*	**	5.0 – 6.0	6.5 – 7.5	8.0 – 8.5
	> 6000	9.0 – 10.5*	11.5 – 14.0*	**	6.5 – 7.5	8.0 – 9.0	8.5 – 9.0

(¥) The designer may use lesser values than the suggested distances in this table only if these lesser values are justified using a cost-effectiveness analysis as outlined in section 620.07. The Design Clear Zone Inventory form in Figure 620.C should be filled-in by the designer and included in the design folder.

(¥¥) Rural highways are typically open ditch. Urban highways typically have curb and gutter with enclosed drainage. Refer to section 620.13 for a discussion of Clear Zone applied to an urban environment.

(*) Clear zones may be limited to 9.0 metres for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

(**) Since recovery is less likely on the unshielded, traversable 3:1 slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety need and collision history. Also, the distance between the edge of the through travel lane and the beginning of the 3:1 slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the foreslope parameters which may enter into determining a maximum desirable recovery area are illustrated in Figure 620.A.

Notes:

1. All distances are measured from the outer edge of the through traveled lane. Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zone shown in Table 620.A.
2. For clear zones, the "Design Year AADT" will be total AADT for both directions of travel for the design year. This applies to both divided and undivided highways.
3. For AADT≤200, the front slope is 2:1 or flatter, the back slope is 1.5:1 or flatter. Refer to section 510.08 of the Low-volume Roads chapter for the setback to fixed objects. .
4. The values in the table apply to tangent sections of highway. Refer to Table 620.B for adjustment factors on horizontal curves.
5. Refer to Fig. 620.B and the TAC *Geometric Design Guide for Canadian Roads* or AASHTO *Roadside Design Guide* for worked examples of calculations.

Table 620.B Horizontal Curve Adjustment Factors for Clear Zone Distances (K_{cz})

Radius (m)	Design Speed (km/h)					
	60	70	80	90	100	110
900	1.1	1.1	1.1	1.2	1.2	1.2
700	1.1	1.1	1.2	1.2	1.2	1.3
600	1.1	1.2	1.2	1.2	1.3	1.4
500	1.1	1.2	1.2	1.3	1.3	1.4
450	1.2	1.2	1.3	1.3	1.4	1.5
400	1.2	1.2	1.3	1.3	1.4	
350	1.2	1.2	1.3	1.4	1.5	
300	1.2	1.3	1.4	1.5	1.5	
250	1.3	1.3	1.4	1.5		
200	1.3	1.4	1.5			
150	1.4	1.5				
100	1.5					

Notes:

1. Adjustments apply to the outside of a horizontal curve only.
2. No adjustment is warranted for curves that have a radius exceeding 900 metres.
3. The applicable clear zone distance on a horizontal curve is given by the following formula:
   $CZ_c = (K_{cz})(CZ_t)$
   where: CZ_c = clear zone distance on the outside of a curve in metres.
   K_{cz} = curve adjustment factor from Table 620.B.
   CZ_t = clear zone distance used on a tangent section as per Table 620.A.
   Rounding of the calculated Clear Zone distance is to the next higher 0.5 metre increment.
4. Use straight-line interpolation to calculate the adjustment factor for a curve radius other than those listed in the table.
5. The transition from CZ_t on tangent to CZ_c in the curve is done by gradually increasing the Clear Zone over the length of the spiral.
6. Also refer to the TAC *Geometric Design Guide for Canadian Roads* for worked examples of calculations.

620.09 DEPRESSED MEDIAN TREATMENT

The British Columbia Ministry of Transportation & Infrastructure has been using a minimum standard depressed median width of 13 metres. This width is the minimum width on four lane divided highways that will allow for adding lanes on the inside to achieve the standard 5.6-metre-wide narrow median (two 2.5 m wide inside shoulders and a 0.6 m wide standard concrete median barrier) on a six-lane divided highway.

The 13 metre depressed median is a minimum dimension. In some cases, such as on horizontal curves that have a radius between the minimum for the design speed and minimum plus 15%, the designer should consider a wider median. The desirable median width in such a case is the calculated clear recovery area multiplied by 1.5. On current highways that were built with a median width less than 1.5 times the calculated clear recovery zone distance, the designer should review the collision history to estimate the potential risk of head-on collisions at various locations and most particularly on curves. Typical mitigating measures recommended for locations with high potential of cross-over collisions are: 1) to widen the median or, as it is often more convenient, 2) to install on the edge of the shoulder on the outside of the curve, or at another appropriate place within the wide median, a flexible barrier (such as high-tension cable barrier) or rigid concrete roadside barrier.

Guidelines for the narrow median treatment are provided in section 630.

620.10 GUIDELINES FOR REHABILITATION TYPE PROJECTS

1) Context

Highways that are constructed to meet recognized design criteria and follow the guidelines provided in section 620.06 for new construction and major reconstruction provide measurable advantages for the motoring public. However, available finances do not always permit the reconstruction or rehabilitation of existing highways to a higher level. These projects are often initiated for reasons other than geometric design deficiencies (e.g., pavement deterioration), and they often must be designed within restrictive right-of-way, financial limitations, and environmental constraints. As a result, the design criteria and guidelines for rehabilitation and reconstruction are often not attainable without major adverse impacts.

For these reasons, it may be applicable to adopt clear zone values on existing highways that are, in many cases, lower than the values for new construction or major reconstruction. The guidelines in this section are therefore intended to find the balance among many competing and conflicting objectives. These include supporting the objective of improving BC's existing highways, minimizing the impact of construction on existing highways, and improving the greatest number of highway kilometres within the available funds. The intent of these guidelines is to assist the implementation of cost-effective construction that may reduce the number and severity of run-off-the-road collisions, typically by identifying locations where the greatest safety benefit can be realized.

2) Application

Highway improvement projects fall into one of four types: new construction; reconstruction; resurfacing, restoration, rehabilitation, often referred to as 3R; and maintenance.

Guidelines for the first two types, new construction and reconstruction, are provided separately in section 620.06. The guidelines provided here in section 620.10 are most applicable to 3R type projects where, for reasons outlined in section 620.10(1), the guidelines for new construction/reconstruction are not cost-effective.

3R projects involve rehabilitation, restoration and resurfacing and primarily work on an existing roadway surface and/or subsurface. The purpose includes extending the service life of the roadway and enhancing the safety of the highway. To accomplish this objective, the focus should be on the most cost-effective safety improvements to improve safety where major reconstruction is not cost–effective.

3) Definitions

The following definitions apply to British Columbia 3R type projects:

Rehabilitation – The traffic service improvement and safety needs may be of equal importance to the need to improve the riding quality. Projects may involve intersection reconstruction, pavement widening, pavement replacement, shoulder widening, flattening foreslopes, drainage improvements and improvement of isolated grades, curves or sight distance by reconstruction. Some additional right-of-way may be necessary.

Restoration – This category is primarily for the major resurfacing or overlays of a nominal 100 mm or more which improve the strength and extend the life of the existing pavement. In addition, some pavement widening, short sections of pavement reconstruction, shoulder widening, flattening foreslopes on high fills and intersection reconstruction may be involved. Consideration may be given to improving isolated grades, curves, or sight distance by construction or traffic control measures. In some cases, minor ROW acquisitions or easements may be required.

Resurfacing – Pavement resurfacing or overlays of less than a nominal 100 mm fall within this category. Other types of work such as pavement patching or short areas of reconstruction, joint replacement or repair, and shouldering may be included as part of the resurfacing project. Usually no additional right-of-way is required.

In general, 3R improvements are made within the existing right-of-way and typically involve minimal changes to alignment or grade and no increase to capacity for the through lanes.

These guidelines are for 3R type projects as described above, and are intended to enhance roadway safety by helping to identify problem areas so that the adverse impact of run-off-the-road incidents can be reduced in a cost-effective way. These guidelines are not intended for projects where the purpose and scope is intended to replace or expand the facility, in which case guidelines for major reconstruction should be applied.

4) General Guidance for Rehabilitation Type Projects

The guidelines for geometric improvements on existing highways are located in tab 13 of this manual. The following describes how to apply the "Corridor Ambient Geometric Design Element Guidelines" as defined in the context of clear zone principles.

The majority of existing highways were constructed before the application of clear zone as a standard. Accordingly, clear zone is not explicitly considered part of the ambient condition. The principal safety consideration in the ambient condition is the setback to utility poles and similar obstacles.

In terms of Ministry projects, recommended guidelines for pole locations are provided in Section 1120 of this manual. For open shoulder projects utilities should be located outside the clear zone, as per the appropriate design cross-section (and preferably within 2 m of the edge of the right-of-way) or protected by an approved barrier. However, section 1120.03 notes that the Ambient Guidelines policy replaces clear zone guidelines with Utility Setback language to ensure uniformity within the specific corridor under review.

On 3R projects, unless collision history, public complaint or site inspections indicate there is a safety hazard, it may not be cost effective to fully comply with the typical clear zone requirements suggested for new construction/reconstruction. In addition, on many highways, the run-off-the-road collision rate may be too low to justify the cost of providing hazard free zones, as per section 620.06, throughout the length of the highway. Accordingly, it may be appropriate to adopt clear zone values that are selective and generally "fit" conditions within the existing right-of-way and the character of the road.

For many projects, existing parallel slopes will generally remain the same, unless there is evidence of a problem at the site. This is in line with the application of the ambient conditions policy, outlined in tab 13, where the design principle is to maintain the ambient condition for the rehabilitation of a section of the corridor. Thus, the elements of the rehabilitated section will essentially be the same as those of the ambient condition set for the corridor. Since most of the existing BC highways were constructed before the application of clear zone as a standard, this may mean that in many cases the roadside design does not fully comply with typical clear zone requirements. If no operational or safety problems are identified, and the roadway has been performing well, this may be acceptable. However, where cost-effective improvements can be made to the roadside area, they should be considered. Where any variation from the ambient condition is justified (for example for reasons as noted in the policy document located in tab 13), consideration should be given to improving the roadside geometry where this is cost-effective. In addition, where the existing right-of-way permits significant slope flattening or where grading within the right-of-way is necessary, the designer should consider flattening parallel earth slopes, particularly on the outside of horizontal curves. Also, transverse slopes at driveways and accesses shall be re-graded and protected as described in chapter 700 of this manual.

Where it may not be cost-effective or feasible to comply fully with the clear zone distances suggested in Table 620.A, application of a "reduced" clear zone value for 3R type projects may be both prudent and appropriate. Section 620.10(5) below provides some minimum clear zone guidance where the simple application of the ambient conditions utility setbacks alone may not be appropriate.

5) Clear Zone Guidance

Where the application of the “full” clear zone requirements is not appropriate or cost-effective, a “reduced” clear zone application is proposed. In these cases, the designer may consider using the suggested clear zone distances as per Table 620.C. The distances in Table 620.C represent a reduction of clear zone distances from Table 620.A by as much as 40% with a minimum distance of 2 metres. These distances should be examined for the flattening of slopes and removal of obstructions. Where right-of-way is not restricted, front slopes should be 4:1 or flatter and back slopes 3:1 or flatter, but slopes may vary in relationship to prevailing conditions throughout the project and/or adjacent highway sections.

The designer should examine the possibilities to expand the roadway clear zone on the outside of relatively sharp horizontal curves to address the increased potential of vehicles running off the roadway at curves. Typically, this would normally be considered where collision histories indicate a need, or a site-specific investigation shows a definite collision potential which could be significantly lessened by increasing the clear zone width, and such increases are cost-effective.

Table 620.C Suggested(¥) Minimum Design Clear Zone Distances in metres For Rehabilitation Type Projects on Rural Highways(¥¥)

Design Year AADT	Minimum Clear Zone Width (m) For Front Slopes 4:1 or flatter				
	Design Speed (km/h)				
	≤ 60	70 - 80	90	100	≥ 110
< 750	2.0	2.7	3.3	4.5	5.0
750 - 1500	2.7	3.5	4.5	6.0	6.5
1501 - 6000	3.0	4.5	5.5	7.0	8.0
> 6000	3.3	5.0	6.0	8.0	8.5

(¥) The designer may use lesser values than the suggested distances in this table only if these lesser values are justified using a cost-effectiveness analysis as outlined in section 620.07. The Design Clear Zone Inventory form in Figure 620.D should be filled-in by the designer and included in the design folder.

(¥¥) Rural highways are typically open ditch. Urban highways typically have curb and gutter with enclosed drainage.

Notes:

1. All distances are measured from the outer edge of the through traveled lane. Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zone shown in Table 620.C.
2. For clear zones, the “Design Year AADT” will be total AADT for both directions of travel for the design year. This applies to both divided and undivided highways.
3. The values in the table apply to tangent sections of highway. Refer to Table 620.B for adjustment factors on horizontal curves.

6) Roadside Hazards

In general, any obstructions within the suggested clear zone should be reviewed for removal, relocation, the use of breakaway supports, the provision of a barrier, or do nothing based on cost-effectiveness and safety considerations (refer to section 620.06). This is especially relevant where "reduced" clear zone widths as described in previous section 5) are being considered. Reference should be made to the following section 7) for general guidance regarding various types of roadside hazards and specific considerations. Particular attention should be made to certain roadside hazards, such as poles, roadside barrier ends and trees, which are usually more threatening to vehicle occupants than others because of their positioning and structure, particularly in high speed environments. There is a general consensus that the minimum width for a clear zone to effectively reduce severe injury is 3 m.

Evaluation and selection of alternative treatments to mitigate hazardous roadside locations should be carried out using a cost-effectiveness methodology such as RSAP, discussed previously in section 620.07.

7) Identification of Problem Areas

Collision records, inspections of collision site, interviews with local officials involved in road safety such as local RCMP traffic detachment, Highway District Area Manager and citizen's safety committee and other sources of data can act as a useful guide in pinpointing areas within the project that have identifiable safety problems related to clear zone width and where available resources can be most effectively directed.

In terms of identifying high roadside collision locations, the designer should review the crash history for the last 3 to 5 years (e.g. Collision Information System data) with respect to frequency, rate, location, type and severity to identify any probable safety deficiencies. Sources of available data include collision report forms (e.g. BC's MV 6020 Accident Report Form), BC collision databases (e.g. ICBC's Traffic Accident System and MoTI's CIS), municipal collision databases, and ICBC claims data. However, the user needs to be aware of some of the problems and limitations of the data, including reduced reporting levels, inconsistent reduction in reporting levels, reliability of the data (especially for self-reported incidents), accuracy of the collision data (at the scene/during data entry), timeliness of the collision data, and jurisdictional constraints. High roadside collision locations are considered to be those which exhibit higher potential for collisions than an established norm, for example where a collision frequency or rate exceeds a threshold value. A widely used statistical technique is to calculate a critical collision rate for the location, which represents a threshold value above which the occurrence of collisions may be attributed to site specific characteristics rather than random fluctuations in collision occurrence. Comparison of the calculated collision rate and the critical collision rate for similar facilities enables a "collision-prone" location to be identified. The CIS database itself can also be queried to identify collision prone locations and sections. The process of collision analysis is part of the procedural guidelines for determining ambient conditions under the BC policy, and enables safety or operational related problem areas to be identified.

In evaluating the collision history, the designer should look for possible concentrations of collisions that may justify construction of wider clear zones, similar to those required for new construction/reconstruction, over a short section of the project. If only a few isolated hazards exist within the desirable clear zone and if these hazards can be removed or relocated at a low cost, the plan should provide for removal or relocation. Normally, acquisition of right of way just to obtain the desirable clear zone is not cost effective.

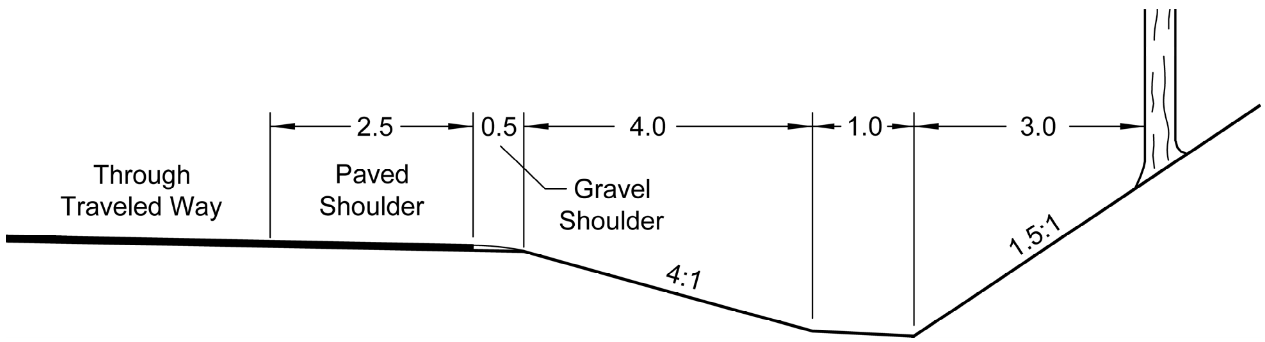
620.11 WORKED EXAMPLES

The TAC *Geometric Design Guide's* preferred channel cross section is rarely achieved on BC highways. Refer to Typical Sections in section 440.

Figure 620.B is an example that represents the most common ditch cut situation on rural BC highways. For examples of other clear zone situations, refer to the TAC *Geometric Design Guide* and the AASHTO *Roadside Design Guide*.

Figure 620.B Example of Clear Zone Concept for Ditch Cut

Design ADT: 5000
Speed: 100 km/h
Suggested clear-zone distance for 4:1 foreslope: 10 to 12 m (from Table 620.A); use 9 m max. for practicality
Suggested clear-zone distance for 1.5:1 backslope: 4.5 to 5.5 m (from Table 620.A)



Discussion - When the suggested clear zone exceeds the available recovery area for the foreslope and ditch bottom, the backslope may be considered as additional available recovery area. The suggested clear zone for the foreslope is 9 m which extends past the slope break onto the backslope. Since the backslope (cut) has a suggested clear-zone of 4.5 to 5.5 m, which is less than the foreslope, the larger of the two values should be used. In addition, fixed objects should not be located near the center of the channel where the vehicle is likely to funnel.

Because the tree is located beyond the suggested clear zone, removal is not required. Removal should be considered if this one obstacle is the only fixed object this close to the through traveled way along a significant length.

Drainage channels should be located at or beyond the suggested clear zone. However, backslopes steeper than 3:1 are typically located closer to the roadway. If these slopes are relatively smooth and unobstructed, they present little safety problem to an errant motorist. If the backslope consists of a rough rock cut or outcropping, shielding may be warranted.

620.12 SUGGESTED WORKSHEETS FOR DOCUMENTING CLEAR ZONE TREATMENTS

Figure 620.C Design Clear Zone Inventory – New Construction & Reconstruction

Note: This sheet is recommended for <u>all</u> sections of the design project including those locations where clear zone is met.

BC Ministry of Transportation & Infrastructure			**Design Clear Zone Inventory**	
Location km to km	Distance from the traveled way (m)		Meet Guidelines [1] (Yes or No)	Summary of reasons for not meeting the suggested guidelines and description of corrective actions taken. [2]
	Left	Right		

(1) Distances meet or exceed suggested guidelines in Tables 620.A & B.

(2) Include references to appropriate documents in the design folder that contain detailed analyses and calculations.

Figure 620.D Design Criteria Sheet for Roadside Design Review – Rehabilitation Projects

Note: This sheet is recommended for all sections of the design project including those locations where clear zone is met.

BC Ministry of Transportation & Infrastructure	**Roadside Hazard Treatments Inventory**
List locations where the off-road collision history and/or an examination of potential roadside obstacles indicate the need for a review of the roadside geometry for cost effective safety improvement measures.	
Location km to km (1)	Summary of reasons for not meeting the suggested clear zone distances in Tables 620.B & C and description of corrective actions taken. (3)
Location km to km (2)	Locations where clear zone distances as per Tables 620.B & C are met. Indicate the achieved recovery zone distances. (3)

(1) Distances do not meet or exceed suggested guidelines in Tables 620.A and B.
(2) Locations where clear zone distances as per Tables 620.B & C are met.
(3) Include references to appropriate documents in the design folder that contain detailed analyses and calculations.

620.13 ROADSIDE SAFETY IN AN URBAN ENVIRONMENT

For the purpose of this section, an urban highway section must be posted at 60 km/h or less and is defined as having at least one of the following traffic environments:

- Reduced speed zone in the vicinity of a residential or commercial subdivision;
- Highway section with curb-and-gutter or a sidewalk;
- The average spacing is less than 150 metres for driveways and 500 metres for intersections.

The Clear Zone in an urban environment with restricted right-of-way is:

- 4.0 m from the edge of the traveled lane in open ditch situations;
- The greater of the following clearances: 2.0 from the face of the curb in closed drainage situations or 0.3 m beyond the sidewalk.

The Clear Zone in an urban environment where right-of-way is not restricted is to be evaluated similar to a suburban or transition area as described below.

Sections of highway that are posted at 70 km/h are typically in suburban or transition areas. In these cases, the designer should do a risk review considering local traffic conditions before deciding to apply the rural or urban clear zone guidelines. In these cases, the designer should consider guidelines that are contained in the TAC *Geometric Design Guide,* 2017 Edition, section 7.7 - Roadside Design in Urban Environments and the AASHTO *Roadside Design Guide*, 4th Edition 2011, chapter 10 - Roadside Safety in Urban or Restricted Environments.

620.14 REFERENCES

References used specifically for this chapter:

The following reports commissioned by BC MoTI were used to produce chapter 600 – Safety Elements:

- CH2MHILL, *Review of Roadside Hazard Mitigation Practices used by North American Road Agencies and Professional Transportation Organisations*. May, 2005

General References:

- AASHTO, *Roadside Design Guide*, 4th Edition, 2011.
- Transportation Association of Canada, *Geometric Design Guide for Canadian Roads*, 2017 Edition.
- Transportation Association of Canada, *Canadian Guide to 3R/4R*. August 2001.

630
MEDIAN TREATMENT

630.01 GENERAL

The primary use of median separation is to eliminate the risk of head-on collisions and to control access.

The standard median treatments are:

- no median separation (undivided road)
- narrow flush median with or without barrier
- depressed median with traversable slopes

630.02 GUIDELINES

Use the following guidelines and Figure 630.B when selecting a median treatment:

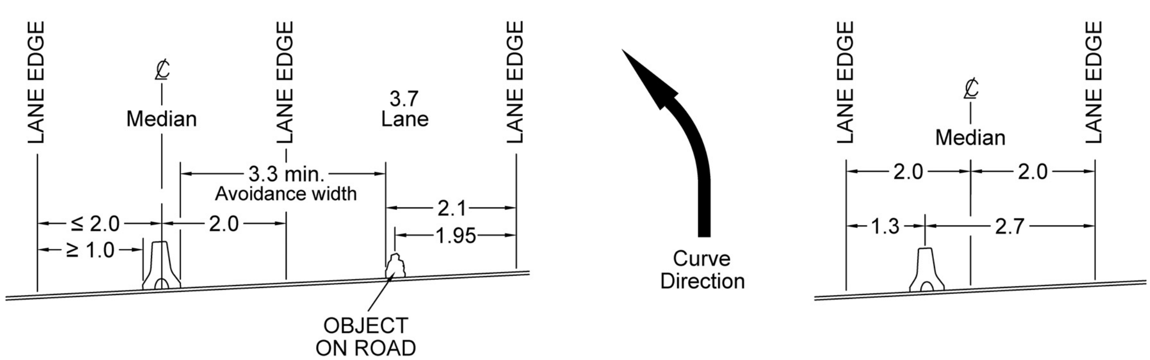
1. Median Barrier is not normally used, and a median separation is optional, on low speed multilane highways (posted speed less than 70 km/h).
2. For 4-lane rural arterials with less than 10,000 AADT[1] (two-way traffic), median barrier is not required unless indicated by collision history.
3. For 4-lane rural arterials with between 10,000 and 20,000 AADT[1], median barrier is not required unless indicated by collision history. However, the 2.6 m median without barrier should be used as a staged development, anticipating the future placement of barrier.
4. For rural arterials with 20,000 AADT[1] or greater, either the median barrier with narrow flush median, or the 13 metre wide depressed median should be used.
5. When barrier is to be installed on an existing facility which has less than the standard 2.6 m median, widening to 2.6 m is required to provide one metre of shy distance from the lane edge to the barrier.

   However, installation of median barrier on narrower medians may be approved by the Principal Highway Safety Engineer in special circumstances if safety, geometry, maintenance, and costs are adequately addressed.
6. Where sight distance may be restricted by tight curvature in conjunction with median barrier, the preferred treatment is to flatten the curves or use depressed median. However, these treatments may not be cost-effective when constructing in built up or mountainous areas.

   A modified median has been chosen to provide some additional sight distance and allow the driver some extra width to swerve safely around an object that partially obstructs the inside lane. See Figure 630.A.

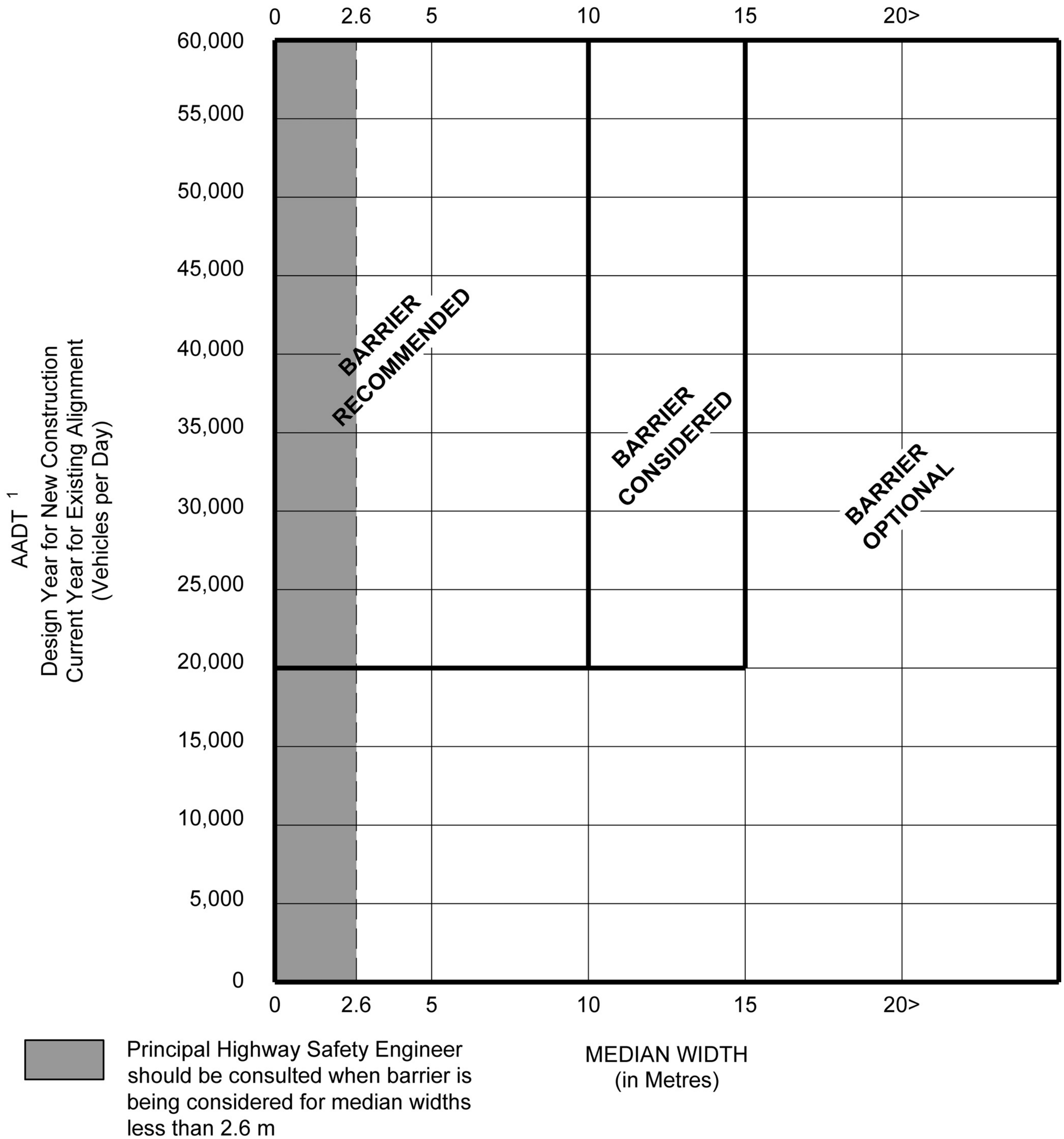
   The modified treatment has a symmetrical 4 m median separation; in very tight situations, you may consider installing the barrier on the side without sight restriction with 1.3 m separation from lane edge to centerline of barrier.

Figure 630.A Modified Median



[1] Contact Regional or Headquarters Planning for the SADT to AADT conversion factors for your projects.

Figure 630.B Guidelines for Median Barrier Placement



[1] Contact Regional or Headquarters Planning for the SADT to AADT conversion factors for your projects.

640
HIGHWAY SAFETY DRAWINGS

640.01 DIMENSIONS OF ROADSIDE BARRIER APPROACH AND OPPOSING FLARES ON RURAL HIGHWAYS

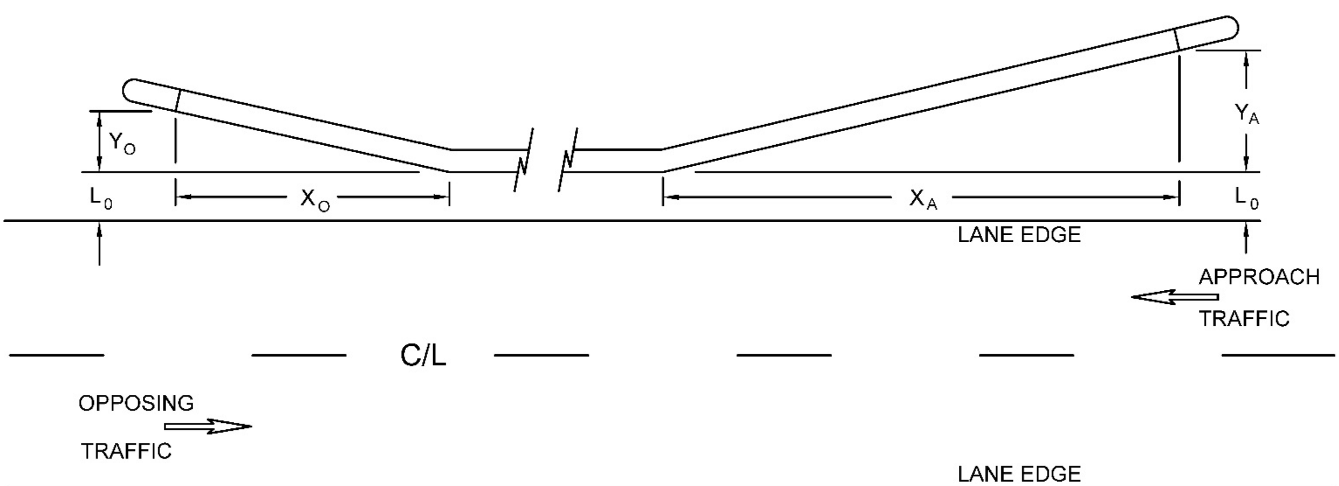
Many of the figures in this section are based on old drawings created by the Highway Safety Engineering (HSE) Section. This section gives the dimensions of roadside barrier approach and opposing flares that are applied to the HSE drawings.

Where the drawings were converted from manual to CAD drawings, some graphic re-arranging has occurred, as well as some additions to the tables for speeds up to 120 km/h.

The flare layout dimensions have also been revised in accordance with the 2011 AASHTO *Roadside Design Guide*. The X and Y dimensions are calculated based on:

- Runout Length for ADT > 10,000,
- Shoulder Width of 1.3 m,
- Hazard Offset set at 9 m for practicality and
- Flare Rate for rigid barrier at or beyond shy line

Figure 640.A Roadside Barrier Approach and Opposing Flares



L_0 = Normal Paved Shoulder without Barrier; minimum width = 1.3 m (except on LVR)

The offset Y_A is dependent of the speed and volume; the length of need X_A is speed dependent only.

(Refer to Tables 640.A and 640.B for Y_A and X_A dimensions.)

Table 640.A Barrier Approach Flare Dimensions on Rural Highways For New Construction and Major Reconstruction Projects

Barrier Approach Flare Longitudinal dimension X_A & Lateral offset Y_A (metres)																	
		Design Speed (km/h)															
Design ADT	Assumed L_0[1]	<60		60		70		80		90		100		110		120	
		X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A
≤ 200	0.0 [3]	See Note 3		See Note 3		See Note 3		See Note 3		See Note 3		Not Applicable		Not Applicable		Not Applicable	
201 - 750	1.3 [2]	20.0	1.7	27.5	1.7	35.0	2.2	40.0	2.2	45.0	2.8	50.0	2.7	60.0	3.0	67.5	3.0
751 - 1500	1.5 [2]	20.0	2.0	27.5	2.0	35.0	2.9	40.0	2.8	45.0	2.8	50.0	2.7	60.0	3.0	67.5	3.0
1501 - 6000	2.0 [2]	20.0	2.5	27.5	2.5	35.0	2.9	40.0	2.8	45.0	2.8	50.0	2.7	60.0	3.0	67.5	3.0
>6000	2.5 [2]	20.0	2.5	27.5	2.5	35.0	2.9	40.0	2.8	45.0	2.8	50.0	2.7	60.0	3.0	67.5	3.0
No. of CRB Units [7]		8		11		14		16		18		20		24		27	
Taper Ratio		Varies [5]		Varies [5]		12:1 [6]		14:1 [6]		16:1 [6]		18:1 [6]		20:1 [6]		22:1 [6]	

Notes:

1. L_0 = Normal Paved Shoulder width without safety barrier. The pavement is to be widened by 600 mm beyond the L_0 width to accommodate the barrier.
2. These are the assumed distances between parallel barrier sections and the edge of the travel lane. For cells in the table that are located above and to the left of the heavy line, if the actual L_0 is less than the table value, the "Y_A" should be increased so that the total L_0+Y_A is the same as in the table. In this case, the number of CRB units in the taper is also increased to maintain the same taper ratio. Correspondingly, if the actual L_0 happens to exceed the assumed value of L_0 in the table, the value of "Y_A" may be decreased by the same amount without reducing the number of CRB units. When the shoulder to the right of the traffic lane is less than 1.9 m, the width of shoulder should be increased so that the offset to the barrier face section parallel to the lane edge is at least 1.3 m for highways with an ADT > 200.
3. Refer to Section 510.09 of the Low-volume Roads chapter.
4. Y_A offsets are measured from the face of the parallel length of barrier, not the lane edge line (refer to Figure 640.A). For example, on an 80 km/h design with 2.0 m shoulders and a design ADT of 3,500, the shoulder is widened by 600 mm to accommodate the width of the barrier over the length of the barrier so that the offset to the barrier is still 2.0 m; the Y_A is added to the 2.0 m to provide a total offset of 4.8 m between the lane line and the beginning of the standard terminal section on the end of the approach flare.
5. Above and to the left of the heavy line, the L_0 + Y_A value is equal to the higher value for Clear Zone distance listed in Table 620.A for front slopes 6:1 or flatter. In these cases, the taper ratios vary depending on the ADT and speed.
6. Below and to the right of the heavy line, Y_A offsets are based on the maximum flare rates (which are speed dependent) shown in the 2011 AASHTO *Roadside Design Guide*, Table 5-9, Flare Rate for Barrier at or Beyond Shy Line, Column A (rigid barrier). Clear Zone has no bearing on these Y_A distances.
7. The number of CRB units shown in the table are for layouts in accordance with Figure 640.C and may be increased but should not be reduced.
8. The lateral offset dimension of the approach flare Y_A must not be less than the lateral offset dimension of the opposing flare Y_O.

Table 640.B Barrier Approach Flare Dimensions on Rural Highways For Rehabilitation Projects

Barrier Approach Flare Longitudinal dimension X_A & Lateral offset Y_A (metres)																	
		Design Speed (km/h)															
Design ADT	Assumed L_0[1]	<60		60		70		80		90		100		110		120	
		X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A	X_A	Y_A
≤ 200	0.0 [3]	See Note 3		See Note 3		See Note 3		See Note 3		See Note 3		Not Applicable		Not Applicable		Not Applicable	
201 - 750	1.3 [2]	20.0	0.8	27.5	0.8	35.0	1.4	40.0	1.4	45.0	2.0	50.0	2.7	60.0	3.0	67.5	3.0
751 - 1500	1.5 [2]	20.0	1.2	27.5	1.2	35.0	2.0	40.0	2.0	45.0	2.8	50.0	2.7	60.0	3.0	67.5	3.0
1501 - 6000	2.0 [2]	20.0	1.2	27.5	1.2	35.0	2.5	40.0	2.5	45.0	2.8	50.0	2.7	60.0	3.0	67.5	3.0
>6000	2.5 [2]	20.0	1.2	27.5	1.2	35.0	2.5	40.0	2.5	45.0	2.8	50.0	2.7	60.0	3.0	67.5	3.0
No. of CRB Units [7]		8		11		14		16		18		20		24		27	
Taper Ratio		Varies [5]		Varies [5]		Varies [5]		Varies [5]		16:1 [6]		18:1 [6]		20:1 [6]		22:1 [6]	

Notes:

1. L_0 = Normal Paved Shoulder width without safety barrier. The pavement is to be widened by 600 mm beyond the L_0 width to accommodate the barrier.
2. These are the assumed distances between parallel barrier sections and the edge of the travel lane. For cells in the table that are located above and to the left of the heavy line, if the actual L_0 is less than the table value, the "Y_A" should be increased so that the total L_0+Y_A is the same as in the table. In this case, the number of CRB units in the taper is also increased to maintain the same taper ratio. Correspondingly, if the actual L_0 happens to exceed the assumed value of L_0 in the table, the value of "Y_A" may be decreased by the same amount without reducing the number of barriers. When the shoulder to the right of the traffic lane is less than 1.9 m, the width of shoulder should be increased so that the offset to the barrier face section parallel to the lane edge is at least 1.3 m for highways with an ADT > 200.
3. Refer to Section 510.09 of the Low-volume Roads chapter.
4. Y_A offsets are measured from the face of the parallel length of barrier, not the lane edge line (refer to Figure 640.A). For example, on an 80 km/h design with 2.0 m shoulders and a design ADT of 3,500, the shoulder is widened by 600 mm to accommodate the width of the barrier over the length of the barrier so that the offset to the barrier is still 2.0 m; the Y_A is added to the 2.0 m to provide a total offset of 4.5 m of width between the lane line and the beginning of the standard terminal section on the end of the approach flare.
5. Above and to the left of the heavy line, the $L_0 + Y_A$ value is generally based on the Clear Zone distance listed in Table 620.C. In these cases, the taper ratios vary depending on the ADT and speed.
6. Below and to the right of the heavy line, Y_A offsets are based on maximum flare rates (which are speed dependent) shown in the 2011 AASHTO *Roadside Design Guide*, Table 5-9, Flare Rate for Barrier at or Beyond Shy Line, Column A (rigid barrier). Clear Zone has no bearing on these Y_A distances.
7. The number of CRB units shown in the table are for layouts in accordance with Figure 640.C and may be increased but should not be reduced.
8. The lateral offset dimension of the approach flare Y_A must not be less than the lateral offset dimension of the opposing flare Y_O.

640.02 OPPOSING FLARE

640.02.01 For Highways with ADT ≤ 200

Because of the narrowness of Low-volume Roads that have an ADT ≤ 200, there is no difference in the design of approach and opposing flares. Although Clear Zone is not a design parameter for Low-volume roads, good safety practice requires consideration of dimensions for barrier offsets. As there is no minimum 1.3 m offset to the face of barrier for these roads, the flare requirements as shown in Table 510.N of the Low-volume Roads chapter are recommended.

640.02.02 For Highways with ADT>200

The offset, from the centreline of the roadway, for the opposing guardrail end, must be equal to or greater than that of the approach end offset, as measured from the lane edge (see Figure 640.B).

The minimum offset of the opposing end from the near lane edge, for two lane highways, without auxiliary lanes shall be 1.3 m or the normal paved shoulder, whichever is greater. The minimum for two lane highways with truck lanes shall be 1.3 m. The minimum for four lane undivided highways without auxiliary lanes shall be 1.3 m or the normal paved shoulder, whichever is greater. The minimum for 4-lane highways with auxiliary lanes shall be 1.0 m. All offsets are measured from the lane edge marking to the toe of the barrier.

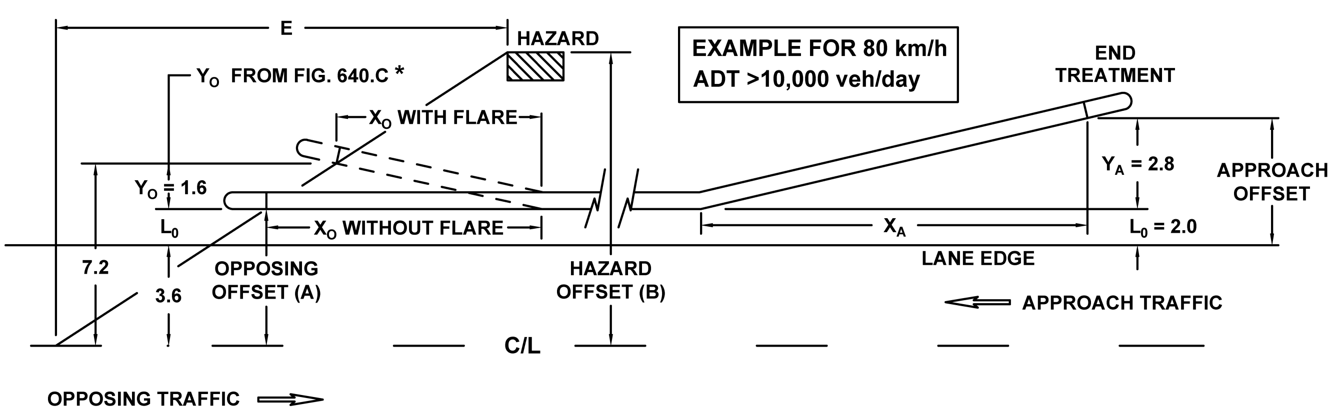
640.02.03 Caveat

The previous procedure of using opposing flares for all 2-lane highways represented a standard that needed no further consideration for the likelihood of passing vehicles encroaching on the opposing direction flare. While the new treatment provides construction savings, its use needs to be tempered by the provision of passing opportunities. The designer needs to review for the potential of passing occurring in the vicinity of the reduced or eliminated opposing flare.

Because of exposure of opposing traffic to the end treatment, when passing on a 2-lane highway, care should be taken to ensure that either normal opposing flares are used or that the barrier is extended to a location on the inside of a curve or into a no passing zone.

If the barrier would normally end on the outside of a curve, the length of barrier should be extended through the curve and ended on tangent or on the inside of a curve.

Figure 640.B Roadside Barrier with No Opposing Flare



L_0 = Normal Paved Shoulder without barrier; minimum width = 1.3 m

Although Y_O is reduced to zero where there is no opposing flare, the length of need (X_O) is speed dependent and must be extended to shield the hazard. As an example for 80 km/h:

X_O = Length of barrier without flare
$X_O = E (1 - A/B)$
$X_O = 70 (1 - 5.6/9)$
$X_O = 26.4$

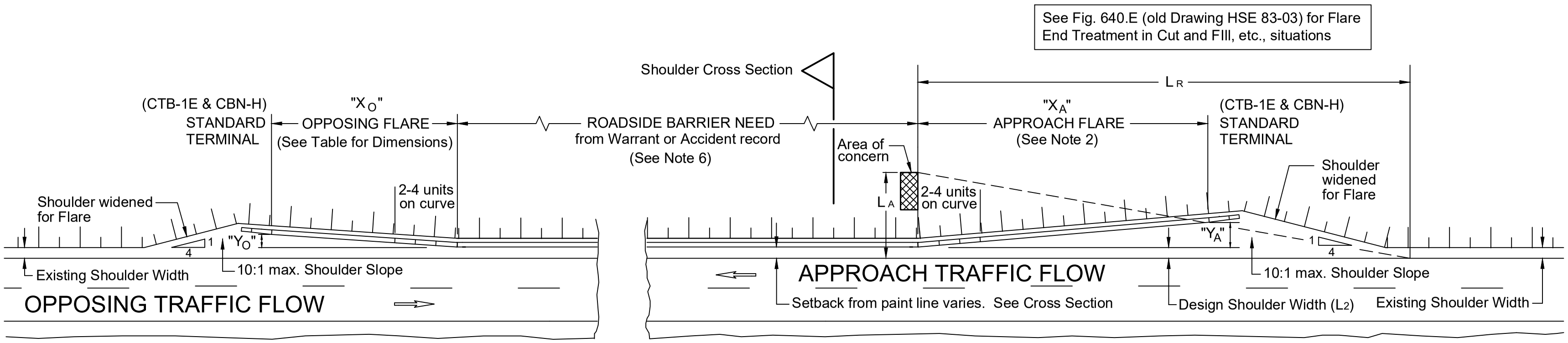
where: A = distance from centreline to face of barrier
B = the lesser of
- **distance from centreline to back of hazard; or**
- **clear zone width (maximum 9.0 m)**

E = encroachment distance (see TAC Table 7.6.6, use ADT >10,000)

*** The opposing flare layout dimensions in Fig. 640.C are based on the highest ADT in TAC Table 7.6.6 and a 1.3 m minimum shoulder width.**

Figure 640.C Standard Layout of Flares and Terminals for Concrete Roadside Barriers

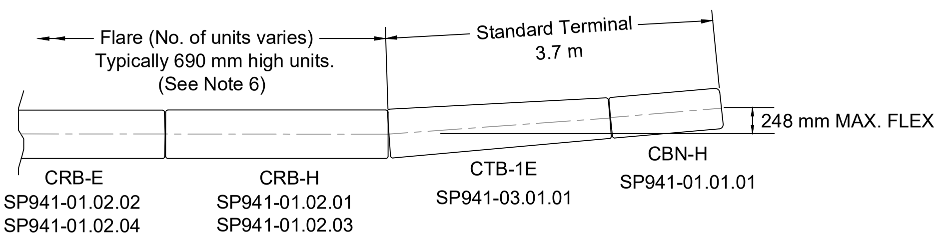
N.T.S. (old HSE 82-07A)



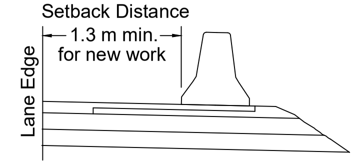
LAYOUT PLAN of PRECAST CONCRETE BARRIER FLARES

(For Assembly Elevations, see Drawing HSE 82-11 in BC MoT "Guardrail Placement Guidelines")

LAYOUT DIMENSIONS			
Travel Speed	OPPOSING FLARE		
km/h	X_O	Y_O	No. of Units
120	37.5	1.7	15
110	32.5	1.6	13
100	27.5	1.5	11
90	25.0	1.5	10
80	22.5	1.6	9
70	20.0	1.6	8
60	15.0	1.5	6
50	12.5	1.5	5



DETAILS OF STANDARD TERMINAL



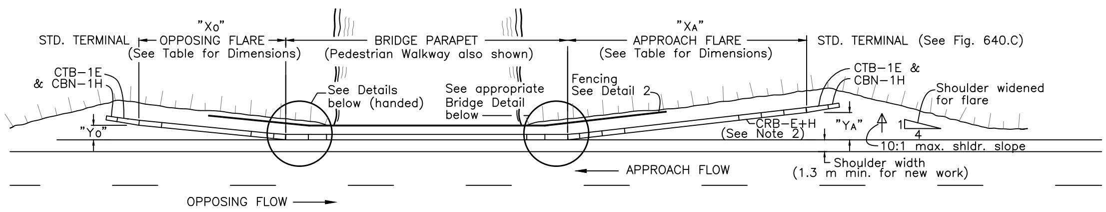
SHOULDER CROSS SECTION
(See Figure 440.F)

NOTES :

1. All dimensions in metres unless otherwise noted.
2. See Tables 640.A and 640.B for Approach Flare Layout Dimensions.
3. Table of layout dimensions is derived from 2011 AASHTO "Roadside Design Guide" based on L_R (Runout Length) for ADT > 10000, L_2 (Shoulder Width) = 1.3 m, L_A (Lateral Extent of the Area of Concern) = 9 m, and Table 5-9 Flare Rate for rigid barrier system.
4. Both Approach and Opposing Flares are required for Roadside Barrier on all undivided highways. Opposing Flare may not be required on a divided highway with Median Barrier in place or at locations that meet the criteria outlined in Section 640.02.
5. Number of units shown in table may be increased but should not be reduced.
6. Roadside barrier will usually be 690 mm high (CRB). In special cases, 810 mm high units (CMB) may be used. In this event, transition units (CTB-2) will be needed to link the CMB to the CRB.

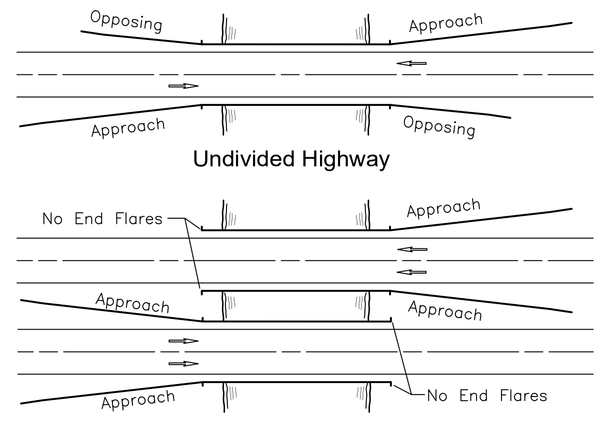
Figure 640.D Standard Layout of Flares for Concrete Roadside Barriers at Bridge Ends

N.T.S. (old HSE 83-01B)



LAYOUT PLAN OF P.C. CONC. BARRIER FLARES AT BRIDGES

See Fig. 640.E for treatments of Bridge Approaches at Rock Cuts, Gorges, etc., where additional barrier is needed.



APPLICATION OF FLARE BARRIER TREATMENTS

OPPOSING FLARE

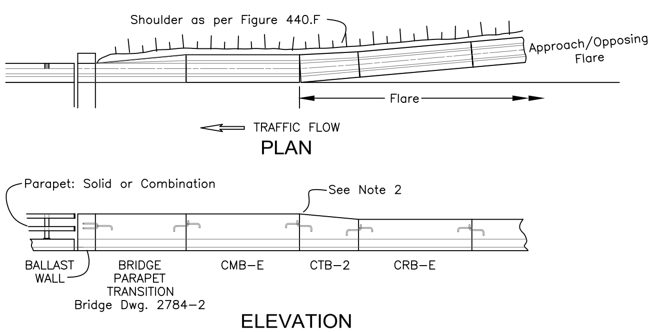
Travel Speed (km/h)	See Note 3 X_O (metres)	Y_O (metres)	Bridge Transition & CMB-E	No. of Units in Flare (See Note 6) CTB-2	CRB-E	CRB-H
120	41.3	1.8	(1 each)	1	8	8
110	36.3	1.8	(1 each)	1	7	7
100	31.3	1.7	(1 each)	1	6	6
90	26.3	1.6	(1 each)	1	5	5
80	26.2	1.8	(1 each)	1	5	5
70	21.2	1.7	(1 each)	1	4	4
60	16.2	1.6	(1 each)	1	3	3
50	16.2	2.0	(1 each)	1	3	3

APPROACH FLARE

Travel Speed (km/h)	X_A (metres)	Y_A (metres)	Bridge Transition & CMB-E	No. of Units in Flare (See Note 6) CTB-2	CRB-E	CRB-H
120	71.2	3.2	(1 each)	1	14	14
110	61.2	3.0	(1 each)	1	12	12
100	51.2	2.8	(1 each)	1	10	10
90	46.2	2.8	(1 each)	1	9	9
80	41.2	2.9	(1 each)	1	8	8
70	36.2	3.0	(1 each)	1	7	7
60	31.2	3.1	(1 each)	1	6	6
50	21.1	2.6	(1 each)	1	4	4

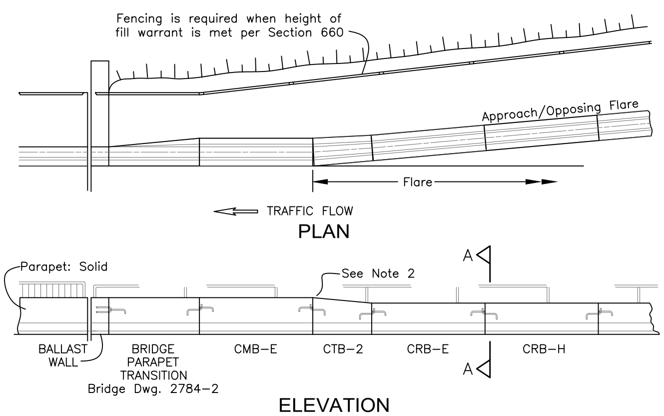
NOTES :

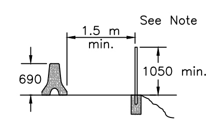
1. All dimensions in mm unless otherwise noted.
2. Units in flare will normally be CRB (690 mm). Very high bridges and fill heights may require more 810 mm high CMB-E & H units between CTB-2 and Bridge Parapet Transition Unit.
3. Refer to Section 640.02 for discussion on opposing barrier installed without a flare.
4. Read with Bridge Contract, BC Supplement to TAC, and Highway Safety Drawings.
5. Refer to the BC Supplement to Canadian Highway Bridge Design Code for appropriate widths. Pedestrian height fence shown, but 1.4 m cyclist height may be needed.
6. Bridge end flare configurations require an even number of CRB units to achieve the required hook and eye connections at the CTB-2 transition barrier units.



DETAIL 1

FLARE FROM CONCRETE BRIDGE PARAPET





SECTION A-A

DETAIL 2

FLARE FROM CONCRETE BRIDGE PARAPET WITH PEDESTRIAN WALKWAY

Figure 640.E Roadside Barrier Layouts at Cut & Fill, and Curves

N.T.S. (old HSE 83-03)

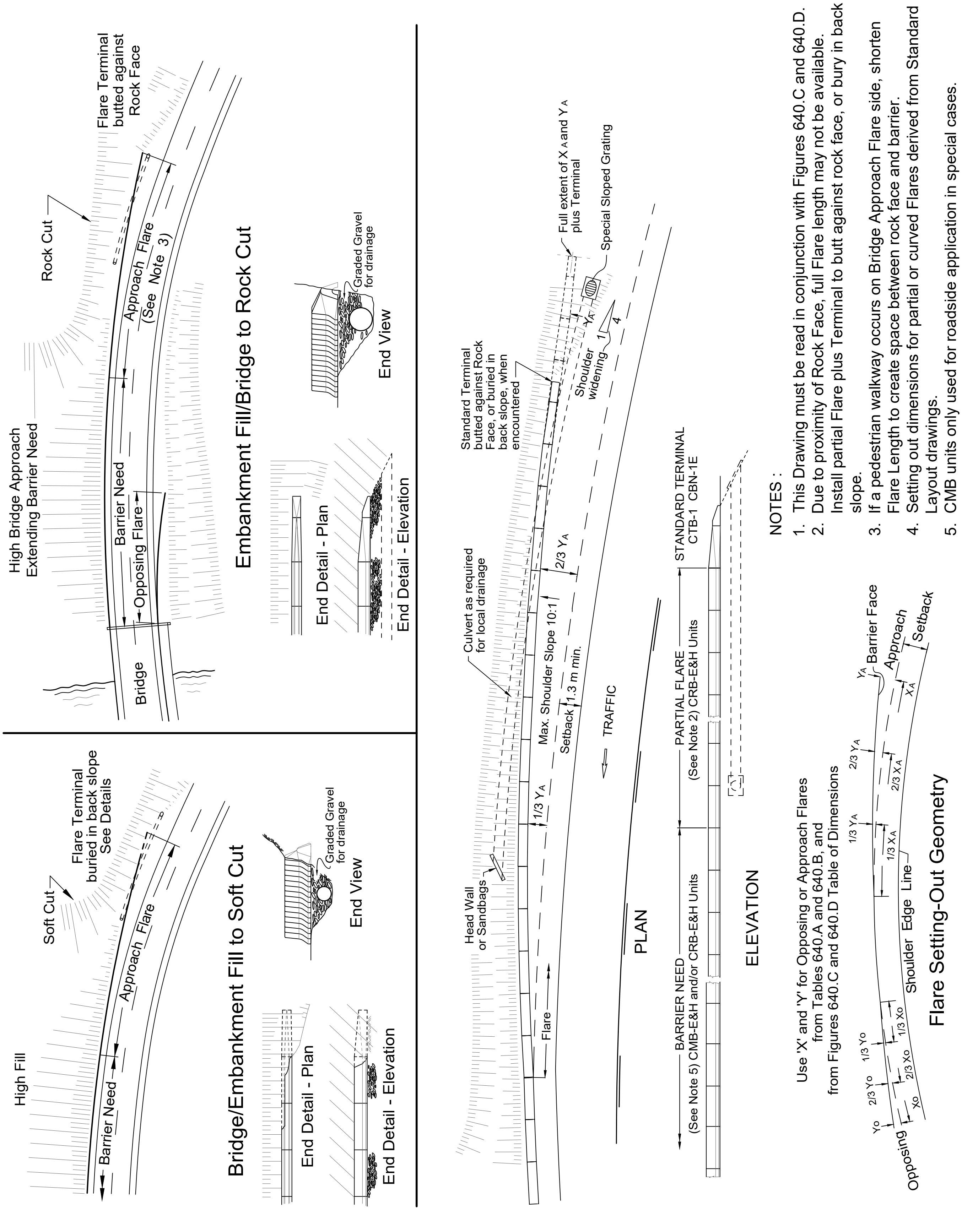
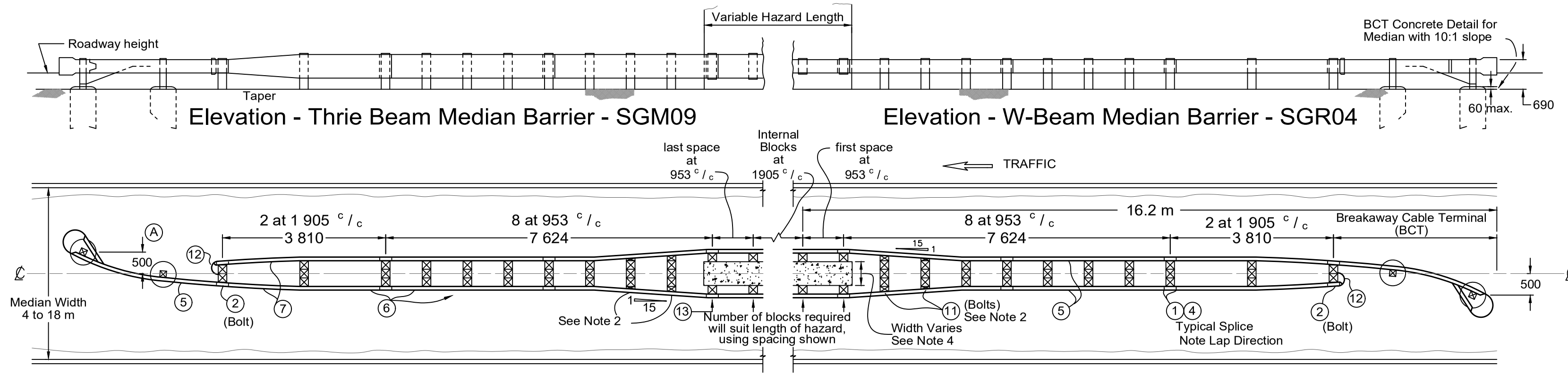
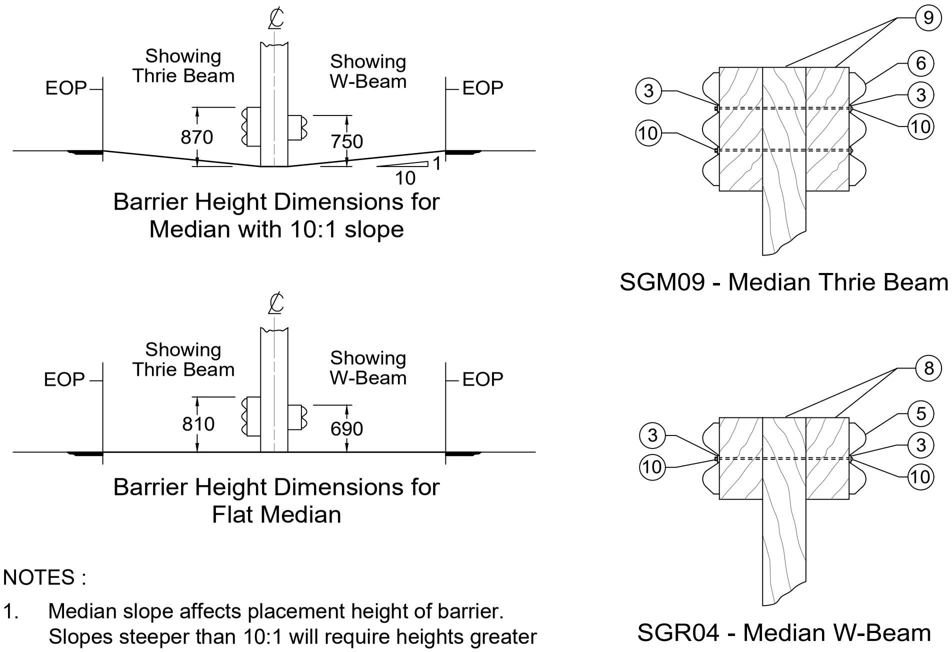
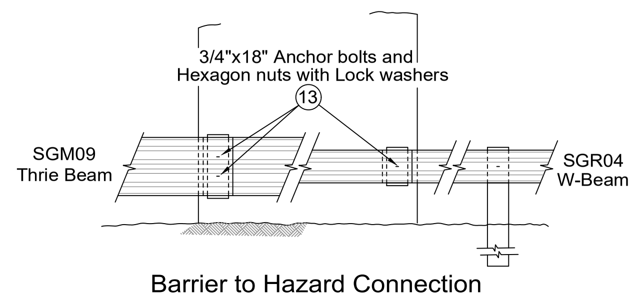


Figure 640.F SGR04/SGM09 Median Hazard Treatment in 4-18 m Undepressed Medians

N.T.S. (old HSE 83-13A)







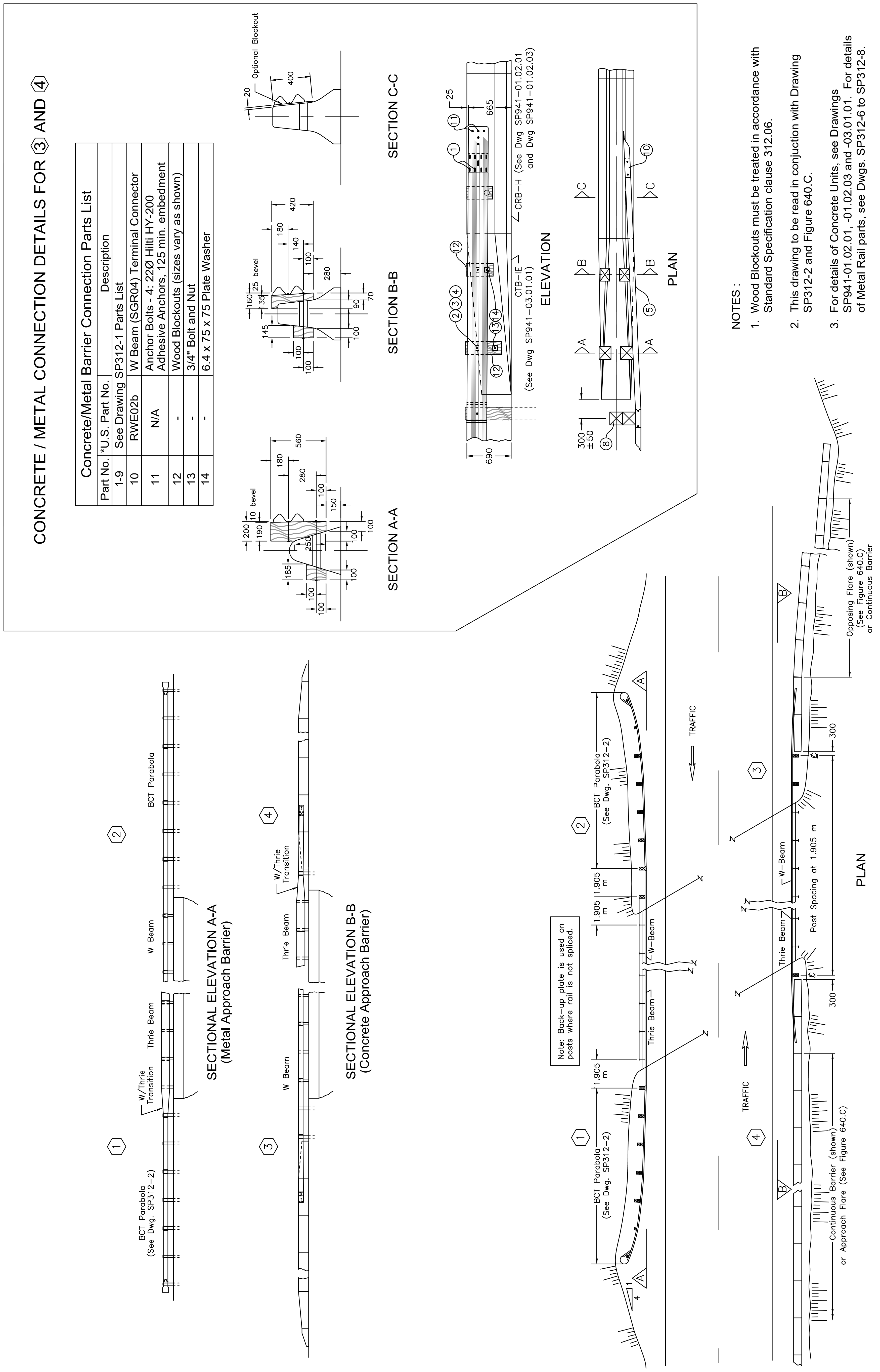
METAL GUARDRAIL PARTS LIST		
Part No.	* U.S. Part No.	Description
1-4	See Drawing SP312-1 for listing and info (*) notes	
Ⓐ 5	RWM02a [4 at 3'-1 1/2" = 12'-6"]	SGR04 W Beam
Ⓐ 6	RTM02a [4 at 3'-1 1/2" = 12'-6"]	SGM09 Thrie Beam
7-9	See Drawing SP312-1 for listing and info (*) notes	
10	FBB-05 [640 mm long]	16 mm Button Head Bolt and Recess Nut
11	FBB-05 [suit length to site]	” (See Note 2)
12	RWE03a	W Beam End Section (Rounded)
13	(local parts)	3/4" x 18" (457 mm) Anchor Bolts and Hexagon nuts with Lock washers

NOTES :

1. Median slope affects placement height of barrier. Slopes steeper than 10:1 will require heights greater than shown. Contact the Principal Highway Safety Engineer.
2. Flares of 15:1 match vehicle speeds. Adjust block-out dimensions to suit this requirement and width of hazard by adding shaped pieces. Bolt lengths to suit.
3. See Drawing SP312-1 for Metal Barrier (SGR04 and SGM09) details. See Drawing SP312-2 for BCT details.
4. This arrangement for max. hazard widths of 670 mm. For wider, contact the Principal Highway Safety Engineer.
5. Ⓐ Median may require some grading to smooth irregularities and prepare site for beam installation.
6. When shielding vertical bridge columns or vertical abutment walls, the designer shall take into consideration the Zone of Intrusion (refer to TAC section 7.6.2.6).

Figure 640.G Approach Barrier Layouts for Bridges with W-Beam and Thrie Beam Barrier

N.T.S. (old HSE 84-03)



Concrete/Metal Barrier Connection Parts List

Part No.	*U.S. Part No.	Description
1-9	See Drawing	SP312-1 Parts List
10	RWE02b	W Beam (SGR04) Terminal Connector
11	N/A	Anchor Bolts - 4: 22Ø Hilti HY-200 Adhesive Anchors, 125 min. embedment
12	-	Wood Blockouts (sizes vary as shown)
13	-	3/4" Bolt and Nut
14	-	6.4 x 75 x 75 Plate Washer

NOTES :

1. Wood Blockouts must be treated in accordance with Standard Specification clause 312.06.
2. This drawing to be read in conjuction with Drawing SP312-2 and Figure 640.C.
3. For details of Concrete Units, see Drawings SP941-01.02.01, -01.02.03 and -03.01.01. For details of Metal Rail parts, see Dwgs. SP312-6 to SP312-8.

650
RUMBLE STRIPS

650.01 SHOULDER RUMBLE STRIPS

650.01.01 Considerations

Shoulder Rumble Strips (SRS) should be considered on rural highways in the following cases:

1. New rural highway sections;
2. When re-paving, rehabilitating or reconstructing existing rural highway sections, which include the shoulders;
3. Other rural Highway Sections that are not part of a project but that would benefit from the installation of SRS in terms of decreasing the number of single vehicle off-road crashes. Funding and other resources for these stand-alone SRS projects are subject to availability and should be considered in the larger context of all safety initiatives.

SRS should not be used in urban areas. Good indications of urban highway sections are:

1. Speed Zone of 70 km/h or less in the vicinity of a settlement;
2. Highway section with curb and gutter or a sidewalk;
3. The average driveway spacing is less than 150 metres and intersection spacing is less than 500 metres.

The minimum shoulder depth of pavement required is 50 mm. SRS are not to be installed if pavement deterioration or cracking is evident. (NOTE: There is no concern with the outer edges of the SRS and the first lift of asphalt being at the same vertical location.)

All projects that involve SRS should be submitted for ICBC Cost-Sharing evaluation.

650.01.02 Application Guidelines

The Layout for Milled-in SRS is shown in Figure 650.A.

SRS should be installed on shoulders, in both directions, for rural two lane and four lane undivided highways.

On rural four lane divided arterials, expressways and freeways (RAD, RED & RFD), the SRS should be installed on both the outside and the median shoulders.

SRS should be installed, in both directions, on the median of rural highways with painted flush medians that are at least 2.0 m wide. This includes locations with existing median barrier if there is sufficient room for the milling machine to install the SRS. For widths less than 2.0 m, refer to Section 650.03 - Centreline Rumble Strips.

Shoulders that are to have SRS installed should be a minimum of 0.5 m wide where there is no cycling traffic on the shoulder. Shoulders with SRS that have cycling traffic should be at least 1.5 metres wide.

650.01.03 Alternatives to SRS

Should other audible delineation devices be approved, the use of such approved devices, which minimize the reduction of usable smooth paved shoulder, should be considered on the same cost-effective basis as SRS.

650.01.04 SRS Installation

Figure 650.A shows the Patterned SRS installation for outside shoulder locations. Discussion with cycling advocates suggests that regular gaps should be provided to facilitate movement to/from the shoulder. The patterned SRS should be installed in a repeating cycle consisting of approximately 15 m of rumble strips followed by approximately 3.5 m of gap.

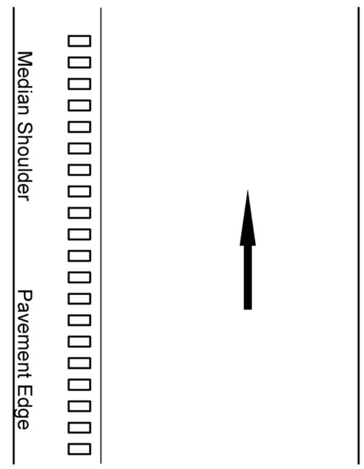
Figure 650.A shows the Continuous SRS installation for median shoulder locations and painted flush medians.

650.01.05 SRS Interruptions

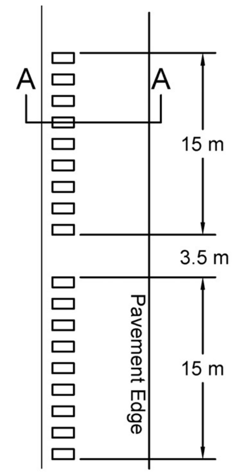
SRS are to be interrupted prior to driveways, intersections, ramps, shoulder constraints and wherever it is needed and required to allow cyclists to merge to the left of the SRS, as shown in Figures 650.B, 650.C and 650.D.

Shoulder rumble strips shall not be installed on bridge decks, overpasses or other concrete surface structures.

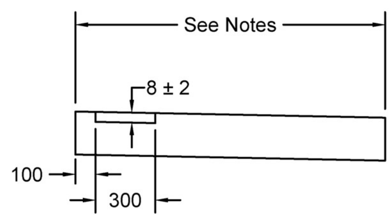
Figure 650.A Milled Shoulder Rumble Strips



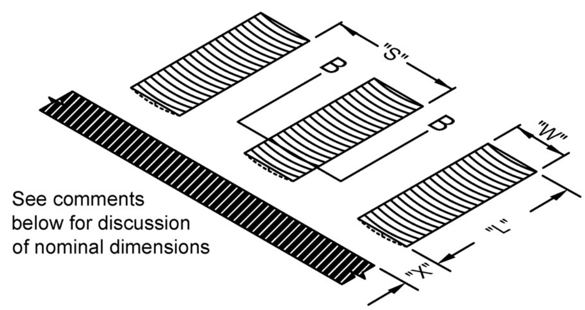
Continuous SRS

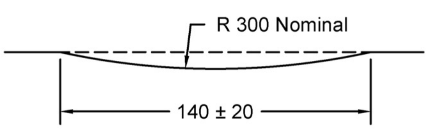


Patterned SRS



Section A-A





Section B-B

Offset "X" from the edge of the lane paintline is 100 mm ± 10 mm. This may be reduced to 0 mm to maintain cycling width.

Length of Rumble Strip "L" is 300 mm ± 10 mm.

Width "W" is nominally 140 mm ± 20 mm, based on the tolerance of the cut depth (8 mm ± 2).

Spacing "S" between strips is 300 mm.

NOTES:

1. Milled-in SRS are to placed on existing/new paved shoulders on:
   - 2-Lane highways with minimum 1.5 m shoulders
   - Multi-Lane undivided highways with minimum 1.5 m shoulders
   - Multi-Lane divided highways with minimum 0.5 m shoulders inside and 1.5 m outside.
2. The minimum shoulder depth of pavement required is 50 mm. SRS are not to be installed if pavement deterioration or cracking is evident.
3. Milled-in SRS are to placed on existing/new paved centre medians with a minimum 2.0 m painted width. This includes locations with existing median barrier if there is sufficient room for the milling machine to install the SRS. For widths less than 2.0 m, see Figure 650.F.
4. Patterned SRS installation is for outside shoulder locations. Continuous SRS installation is for median shoulder locations and painted flush medians.
5. Milled-in SRS may be placed where outside shoulders are less than 1.5 m if there is no cycling traffic on the shoulder.
6. Milled-in SRS are not to be placed through urban areas or in the presence of turning lanes.
7. Milled-in SRS are to be discontinued across private accesses and public road intersections. Refer to Figures 650.B and 650.C.
8. Milled-in SRS are to be discontinued in advance of all bridges and where minimum dimensions do not exist because of Roadside Barrier, Drainage Curb, Fencing, Rock Face, etc. Refer to Figure 650.D.
9. Shoulder rumble strips shall not be installed on bridge decks, overpass structures, or other concrete surfaced structures.

Figure 650.B SRS Interruptions at Intersections and Driveways

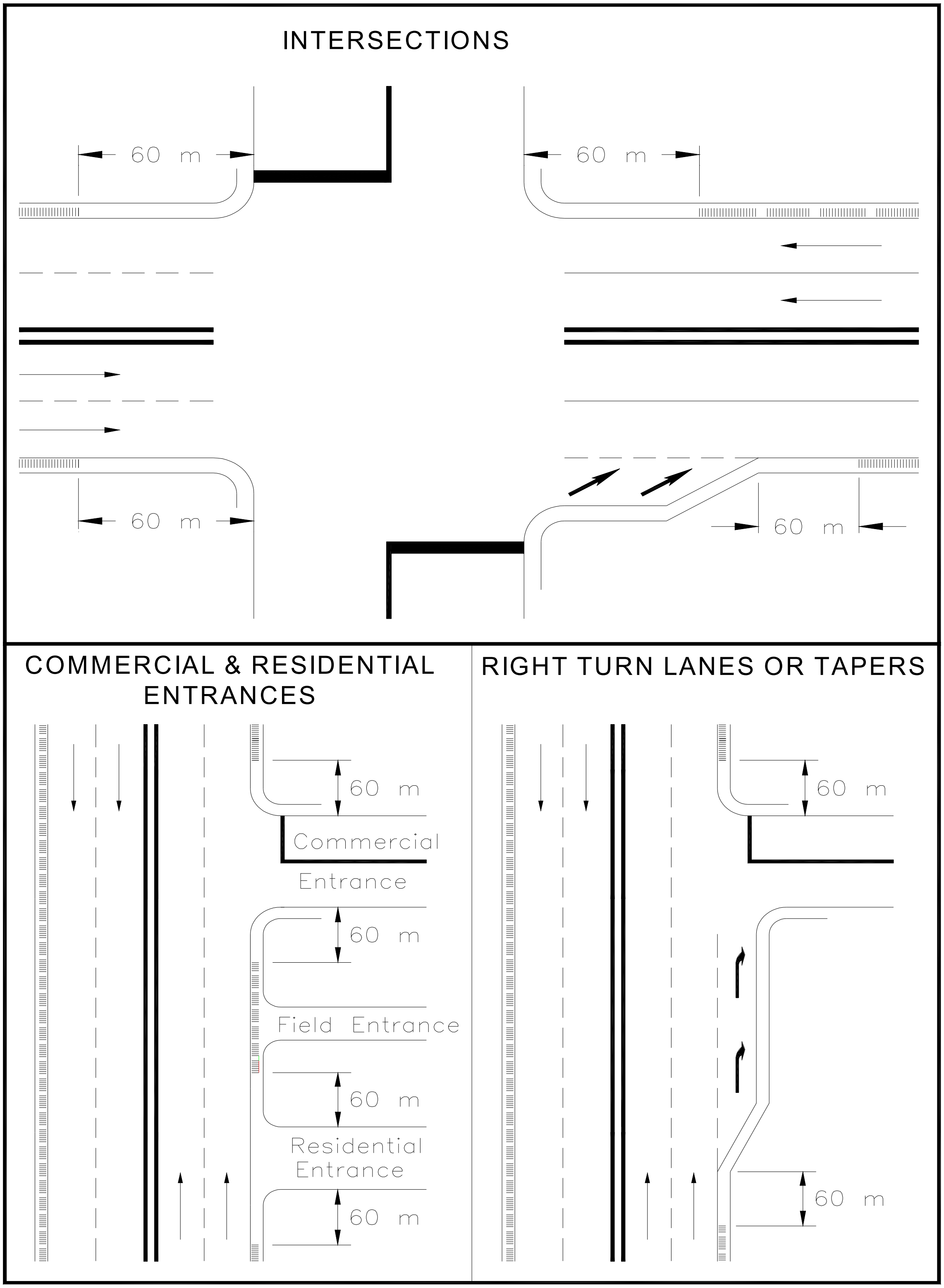
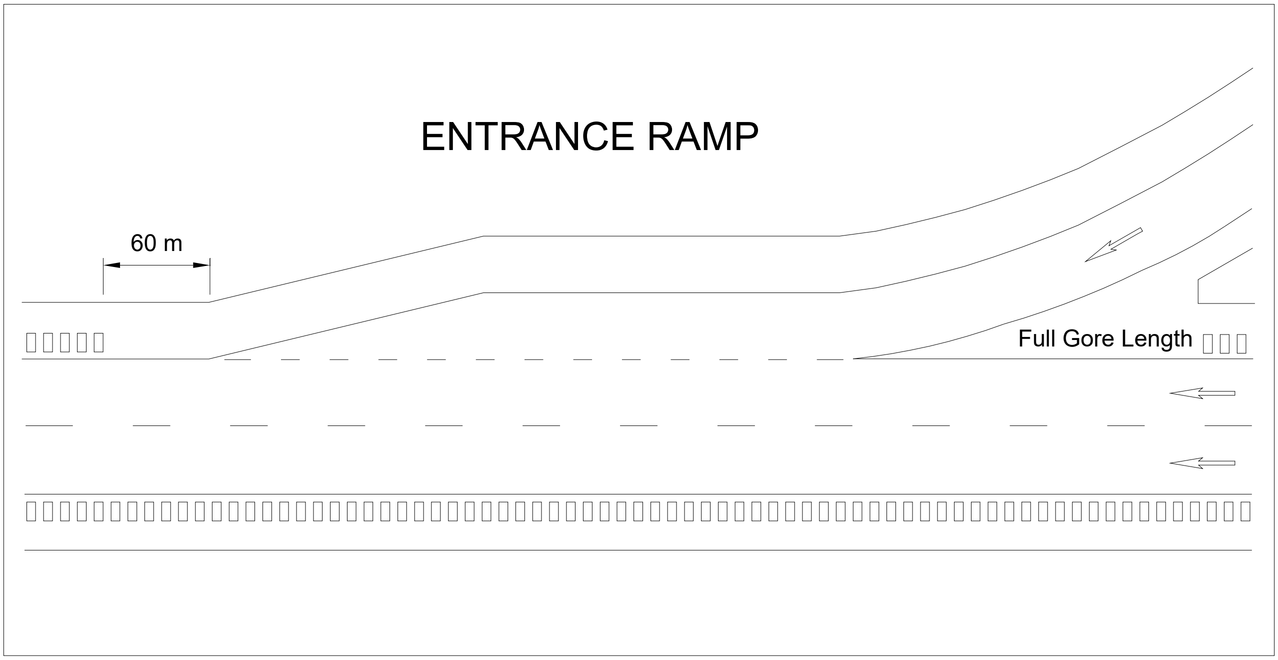


Figure 650.C SRS Interruptions at Exit and Entrance Ramps



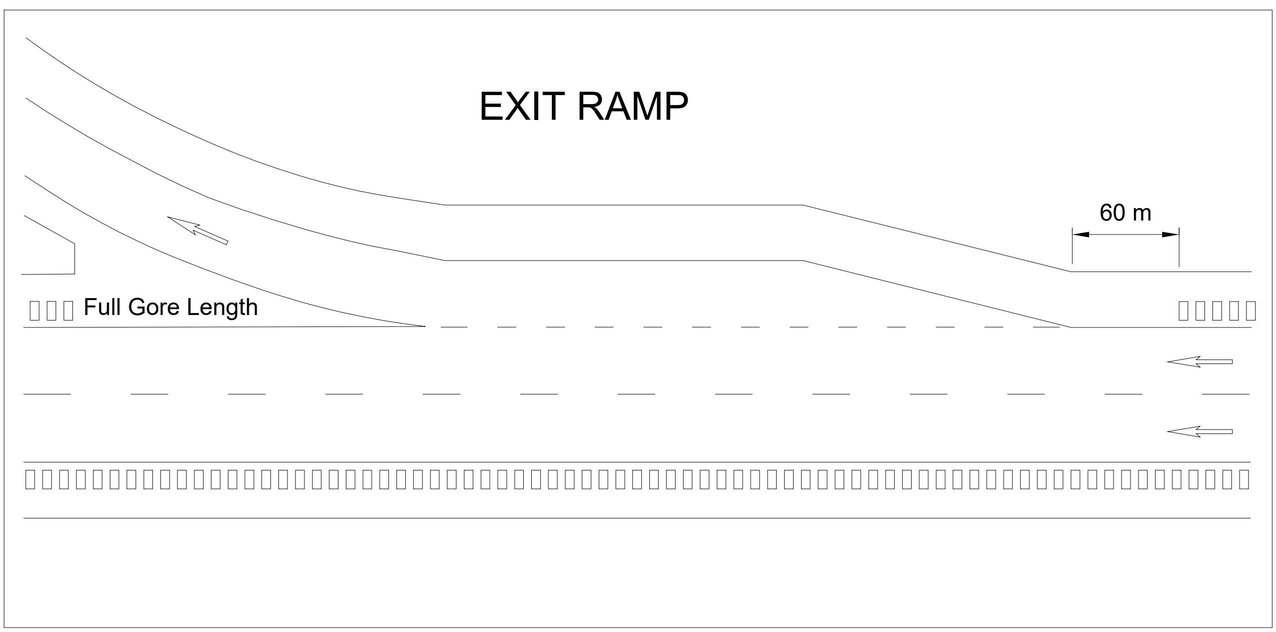
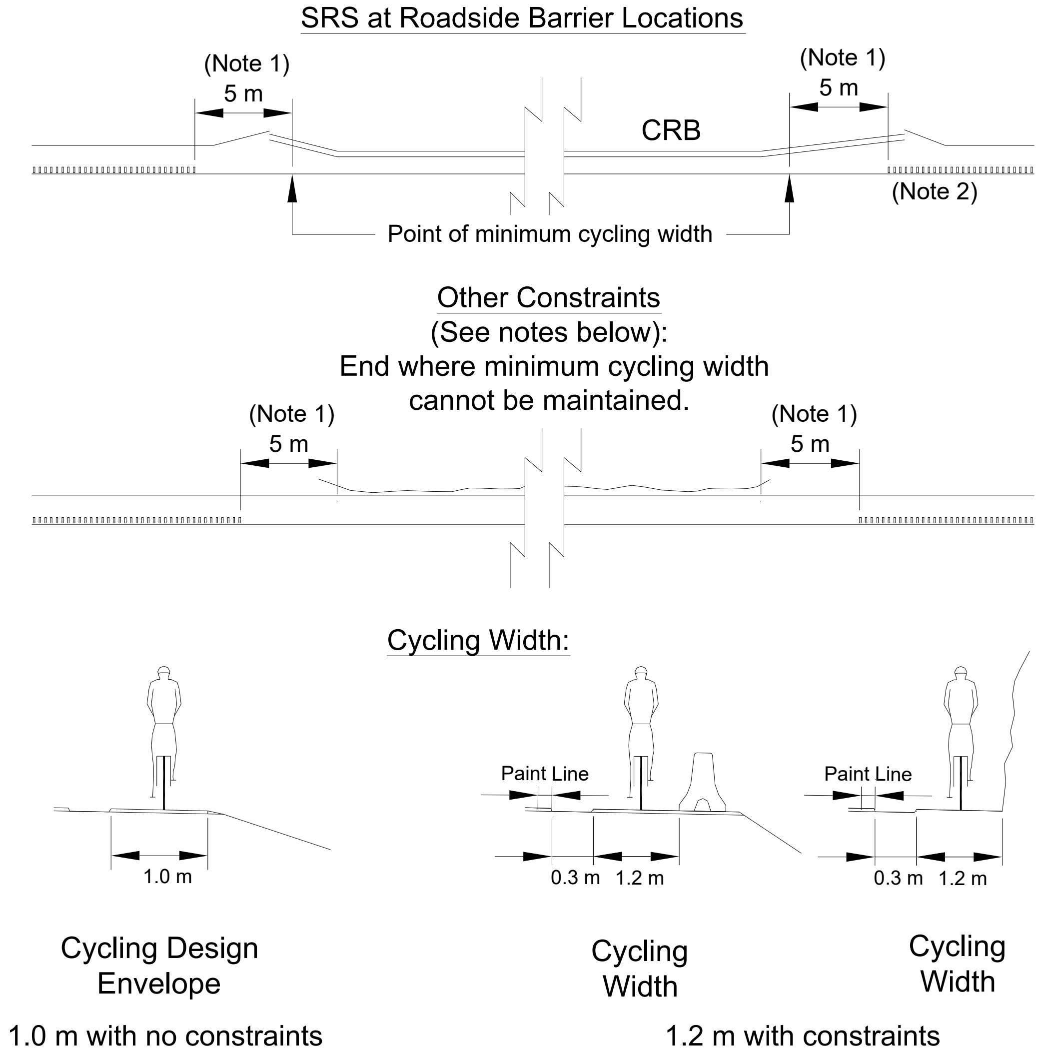


Figure 650.D SRS Interruptions at Shoulder Constraints



NOTES:

1. The minimum acceptable cycling width with a longitudinal obstruction is 1.2 m. The SRS should be discontinued 5 m before and restarted 5 m after where this width to longitudinal constraints cannot be maintained.
2. If there is adequate cycling width adjacent to a barrier, the SRS should not be discontinued.
3. SRS shall not be installed on bridge decks, overpasses or other concrete surfaces.

650.02 CENTRELINE RUMBLE STRIPS

650.02.01 Background

Centreline Rumble Strips (CRS) are used as a means to reduce the frequency of centreline crossover crashes due to poor visibility related to weather, driver fatigue, inattention, error and/or impairment.

650.02.02 Considerations

CRS should be considered on undivided, rural two-lane, three-lane, or four-lane highways in no passing zones (i.e. a double solid painted centreline) in the following cases:

1. New undivided, rural two-lane, three-lane, or four-lane highway sections;
2. When re-paving, rehabilitating or reconstructing existing undivided, rural two-lane, three-lane, or four-lane highway sections;
3. Other undivided, rural two-lane, three-lane, or four-lane highway sections that are not part of a project but would benefit from the installation of CRS in terms of decreasing the number of crossover centreline crashes. Funding and other resources for these stand-alone CRS projects are subject to availability and should be considered in the larger context of all safety initiatives.

CRS may also be considered on undivided, rural two-lane, three-lane, or four-lane highways in passing zones where there is a history of centreline crossover crashes.

CRS should not be used in urban areas. Good indications of urban highway sections are:

1. Speed Zone of 70 km/h or less in the vicinity of a settlement;
2. Highway section with curb and gutter or a sidewalk;
3. The average driveway spacing is less than 150 metres and intersection spacing is less than 500 metres.

The minimum centreline depth of pavement required is 50 mm. CRS are not to be installed if pavement deterioration or cracking is evident. Pavement should be in sufficiently good condition to accept the milling process without ravelling or deteriorating, otherwise the pavement should be upgraded prior to milling centreline rumble strips.

CRS are not to be installed if pavement is to be overlaid within 3 years.

Milling of CRS should be coordinated with traffic line painting operations to avoid milling newly applied traffic lines and to ensure that new yellow centrelines are installed within a short period of time after completion of the milling of the centreline rumble strips.

All projects that involve CRS should be submitted for ICBC Cost-Sharing evaluation.

650.02.03 Application Guidelines

The layout for Milled-in CRS is shown in Figure 650.F.

CRS should be installed on the centreline for undivided, rural two-lane, three-lane, or four-lane highways in no passing zones.

CRS are also permitted to be used on the centreline in passing zones with the approval of the Principal Highway Safety Engineer.

For application of CRS on lane widths less than 3.4 m, an engineering review is required.

On rural two-lane, three-lane, or four-lane undivided highways, CRS should be installed in the following manner:

a) In no passing zones, 300 mm CRS installed over the double solid painted centreline.

b) In no passing zones, CRS installation shall begin at the start of the double solid painted centreline.

c) In passing zones, 300 mm CRS installed over the single dashed painted centreline line or the single-solid/single-dashed painted centreline.

On highways with a painted flush median, CRS should be installed in the following manner:

a) For painted flush median < 2.0 m – apply CRS in the centre of the painted median;

b) For painted flush median ≥ 2.0 m – refer to Section 650.01 and follow application guidelines for continuous Shoulder Rumble Strips.

650.02.04 CRS Interruptions

CRS are to be interrupted prior to intersections, as shown in Figure 650.F.

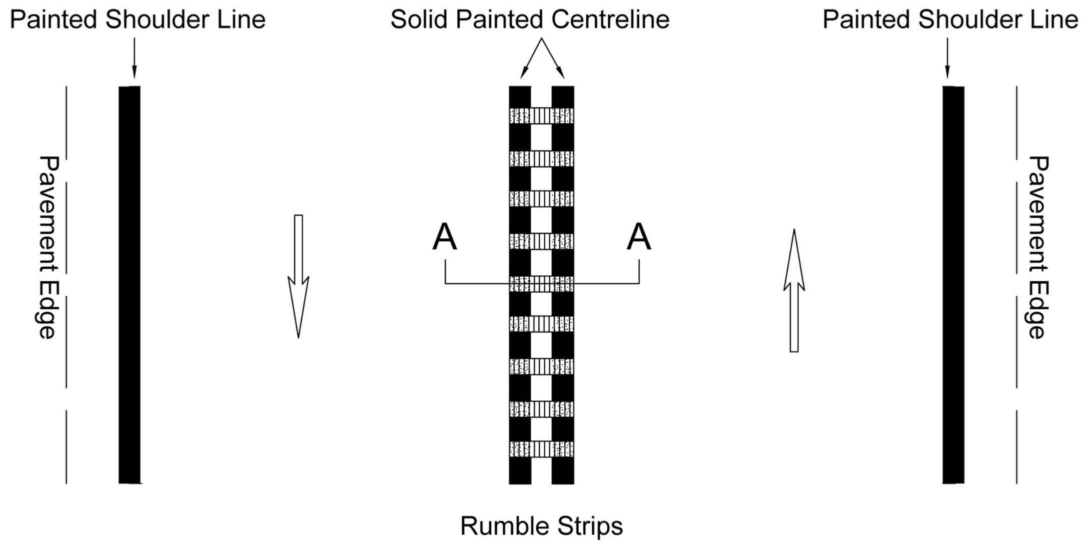
CRS are to be interrupted prior to commercial and residential entrances, as shown in Figure 650.G.

CRS shall not be installed on bridge decks, overpasses or other concrete surface structures, as shown in Figure 650.G.

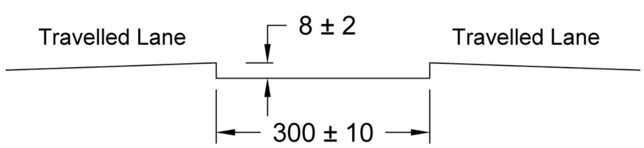
CRS should be discontinued within 200 m of a residential or urban area.

The minimum length of any individual section of CRS shall be 160 m.

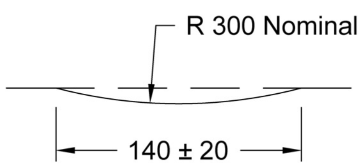
Figure 650.E Milled Centreline Rumble Strips



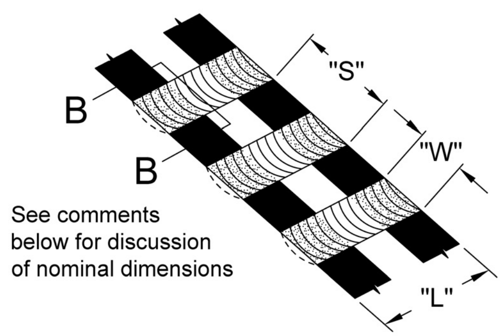
NOTE: ALL MEASUREMENTS SHOWN IN MILLIMETRES.



Section A-A



Section B-B



General Isometric View

Length of Rumble Strip "L" is 300 mm ± 10 mm.

Width "W" is nominally 140 mm ± 20 mm, based on the tolerance of the cut depth (8 mm ± 2 mm).

Spacing "S" between strips is 300 mm.

Lateral tolerance is ± 10 mm left or right of the outside edge of the paintlines.

NOTES:

1. Milled-in CRS are to be placed on new and existing paved 2-Lane, 3-Lane, or 4-Lane undivided rural highways in No Passing Zones. With Principal Highway Safety Engineer approval, they may also be placed in Passing Zones.

2. Milled-in CRS are not to be placed through urban areas.

3. Milled-in CRS are to be discontinued across private accesses and public road intersections. Refer to Figure 650.G.

4. CRS are to be discontinued in advance of all bridges. Refer to Figure 650.G.

5. For new pavement, milling shall only be done after line spotting but prior to the installation of new centreline pavement markings.

Figure 650.F CRS Interruptions at Intersections

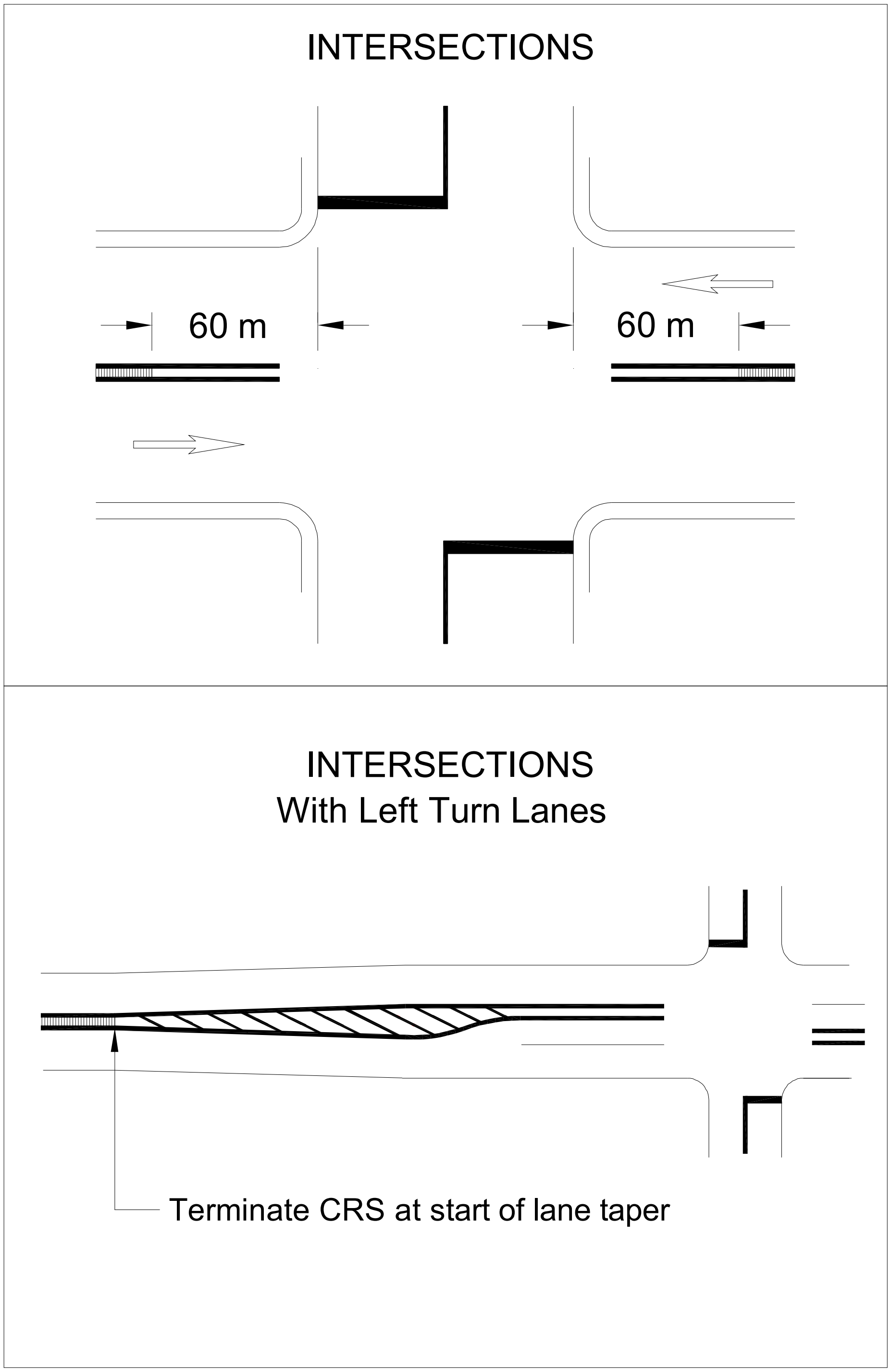
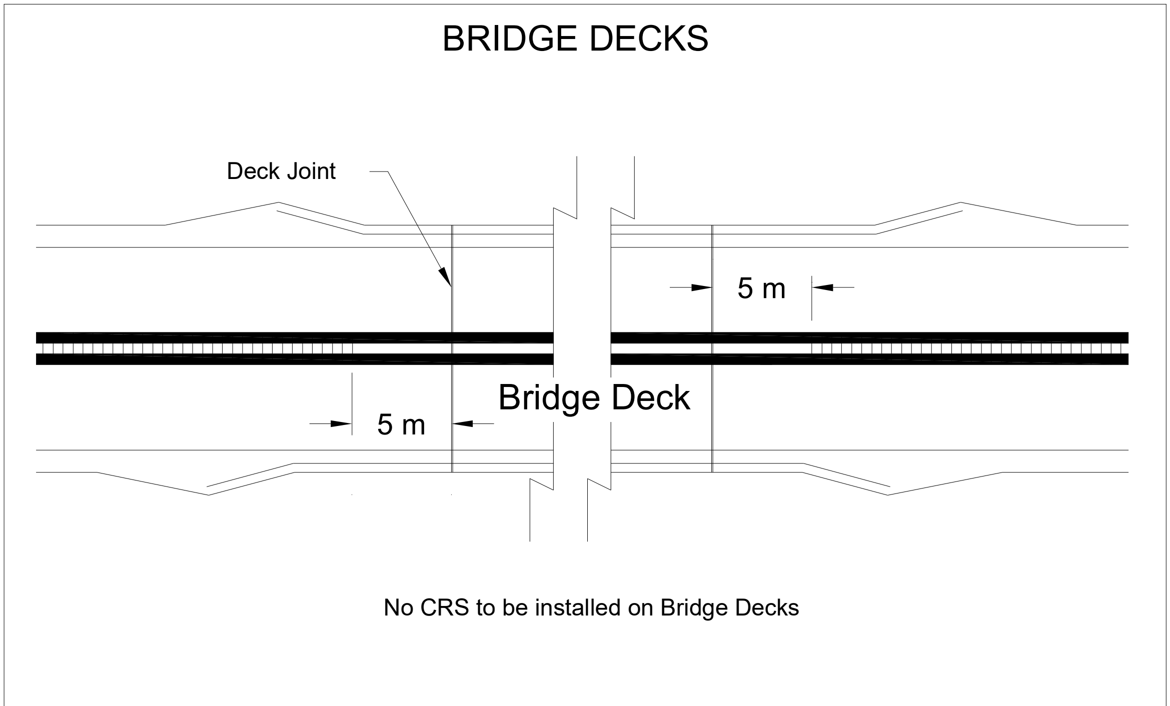
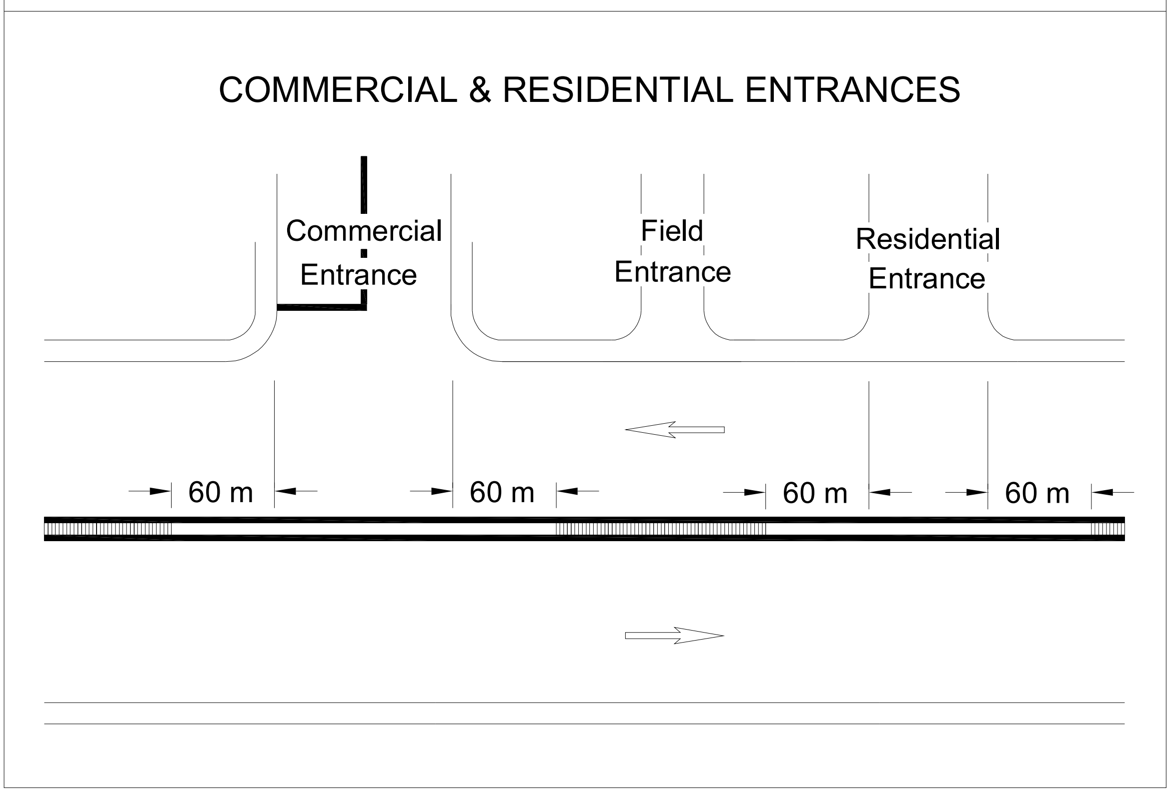


Figure 650.G CRS Interruptions at Bridge Decks and Accesses





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660
FENCING FOR PEDESTRIANS AND CYCLISTS

660.01 BACKGROUND

The Ministry of Transportation & Infrastructure (MoTI) has adopted a policy for the consideration of pedestrians and cyclists for works within the highway right-of-way.

The primary objective of the policy is to ensure that adequate care is provided for the safety of pedestrians and cyclists when planning, designing and project managing works within the highway right-of-way.

660.02 APPLICATION DOMAIN

These guidelines are for all construction work, other than pavement re-surfacing work, within the right-of-way of highways under MoTI jurisdiction, whether it is carried out by the Ministry, a utility provider, a developer, a private property owner, or under a partnership agreement.

660.03 DEFINITION

The following section describes physical roadside environments within the right-of-way which could be hazardous to pedestrians and cyclists. An assessment of the need for fencing requires an evaluation of the both the nature of the hazard and the frequency of its exposure to pedestrians and cyclists. The frequency of exposure is a function of the location of the hazard and the volume of pedestrian and bicycle traffic nearby.

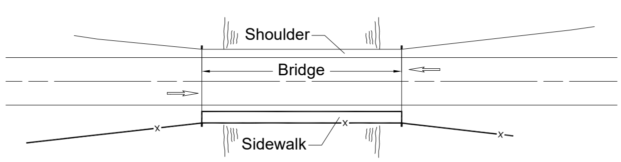
There are no definitive guidelines to determine what constitute significant numbers of pedestrians and bicycles. The designer should consult with a regional Traffic Operations Engineer to determine whether and where there is significant pedestrian and bicycle traffic in the vicinity of the highway construction project.

660.04 APPLICATION AND INSTALLATION INSTRUCTIONS

The fence should be placed as far away as practicable from the traffic lanes or on top of a guardrail. The following figures and guidelines show and describe situations that can be construed as hazards requiring the installation of pedestrian or bicycle fencing.

Situation A

Figure 660.A Fencing on a Bridge



Description

Figure 660.A shows a bridge with a sidewalk and shoulder bikeway.

Guidelines

- Use the Standard Steel Sidewalk Fence (Bridge Dwg. 2891 - 1) along the edge of the sidewalk on the side of the water, ditch or gully.
- Use the Standard Steel Bicycle Fence (Bridge Dwg. 2891 - 2) when a significant number of cyclists use the sidewalk or if there is no sidewalk and a significant volume of cyclists use the bridge.
- Extend fence past the bridge abutments only if required as per Table 660.A and as shown in Figures 660.B and 660.C.

Situation B

Figure 660.B Fencing on a Fill Slope

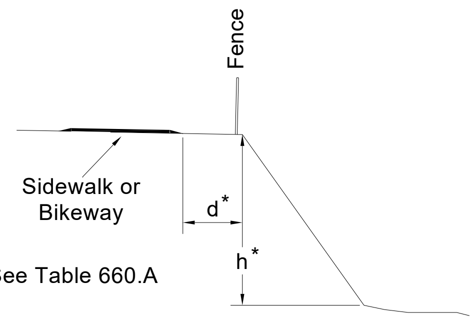
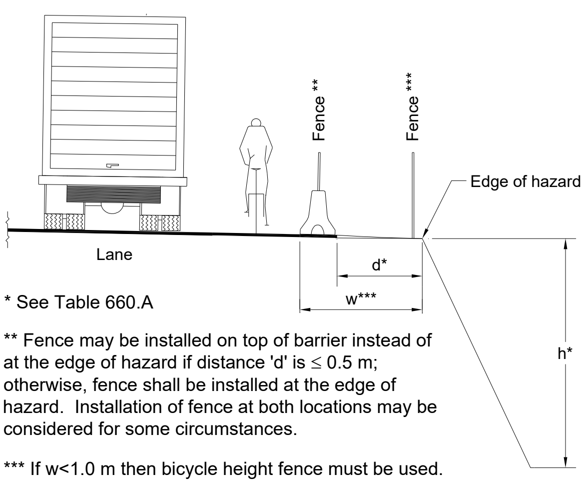


Figure 660.C Fencing Near a Steep Drop



Description

A constructed fill slope or original ground steeper than 1.5:1, a vertical drop or a structure such as a retaining wall or culvert within the right-of-way. This does not apply to most slopes adjacent to highway ditches which are 1.5:1 or flatter. Fencing is used when these hazards are:

- close to a sidewalk, bikeway, or trail, as illustrated in Figures 660.B and 660.C, known to be frequently used by pedestrians or cyclists (refer to preceding section 660.03), or
- close to a roadway; and
- for both of the above cases, when the height of the hazard meets the warrant in Table 660.A.

In these cases, the fence is required only when the sidewalk, bikeway, trail or edge of roadway pavement is located on the high side of the slope, drop or structure.

Table 660.A Hazard Warrant for Installing Fence

Distance from the outside edge of sidewalk, bikeway, trail or pavement: d (m)	Height of drop h (m)
d < 1.0	≥ 0.5
1.0 ≤ d < 2.0	≥ 1.0
2.0 ≤ d < 3.0	≥ 2.0
d ≥ 3.0	≥ 3.0

Guidelines

Use one of the following protections between the public and the hazard; according to the situation:

- the Sidewalk Fence (drawing SP741-07.01 in the Ministry "Standard Specifications for Highway Construction") at the edge of a sidewalk or trail on the high side of the hazard;

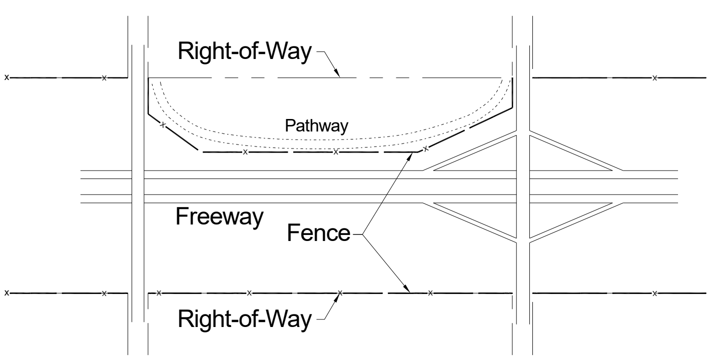
Guidelines (continued for Situation B)

- the Bicyclist Sidewalk Fence (SP741-07.02) at the edge of a bikeway (or sidewalk or trail used by cyclists) on the high side of the hazard;
- the concrete roadside barrier with rails and posts fastened on top of the barrier to make it conform in height to the sidewalk fence or the bicycle fence;
- fencing as per the current Ministry "Standard Specifications for Highway Construction" - Type B, Standard Wire Fabric Fence or Type D, Chain Link Fence. In this case, the fence should be installed in a location which would prevent pedestrian and cyclist access to the hazard. This is preferably, but not necessarily always, right against the top of the hazard. In some cases, fencing along the right-of-way or the property line should be sufficient. For trails, fencing may be installed where it is most convenient between the trail and the hazard. Within the clear zone, use a fence that has frangible posts. If chain link fence is used, it shall be designed with a top tension wire.

Important note: In locations where fencing is required which are near a primary school or playground, or on a route used by children of primary school age or younger -- the vertical bars on the fence shall be spaced to a maximum of 150 mm for a height of at least 685 mm above the ground or sidewalk surface. For bikeways, the height required for the vertical bars spaced at 150 mm or less should be at least 985 mm.

Situation C

Figure 660.D Fencing Along a Pathway Inside Right-of-Way



Description

Along Freeways and Expressways as illustrated in Figure 660.D.

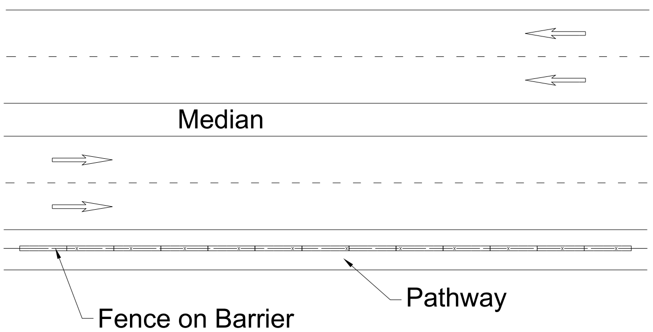
For urban and suburban freeways and expressways abutting residential subdivisions, commercial or industrial land, there is a need to separate the general population from the high speed traffic.

Guidelines

Use fencing as per the current Ministry "Standard Specifications for Highway Construction" - Type B, Standard Wire Fabric Fence or Type D, Chain Link Fence along roadway stretches between interchanges and intersections. Fencing is installed along the right-of-way or, in cases where there is a pathway within the right-of-way, the fence should be between the pedestrian or bicycle pathway and the roadway, as far as practicable from the edge of the roadway. Within the clear zone, use a fence that has frangible posts. If chain link fence is used, it shall be designed with a top tension wire.

Situation D

Figure 660.E Fencing Along a High Volume Highway



Description

On roadways and bridges with a bicycle path or sidewalk where the AADT > 35,000 or SADT > 40,000 and a posted speed ≥ 70 km/h as shown in Figure 660.E.

Guidelines

Use fencing when the separation between the edges of the outside travel lane and the bike path or sidewalk is less than 2.1 metres (including the shoulder width). (Note: If the outside roadway travel lane is wider than 3.6 metres, this offset requirement between the bike path or sidewalk and the lane may be decreased by the same amount that the roadway lane is in excess of 3.6 metres.)

Use fencing when and where it is necessary to deter pedestrians from crossing the roadway.

Use the standard Concrete Roadside Barrier (CRB SP941-01.02.01/02) on the side of the roadway, between the roadway and the sidewalk or bike path. Rails and posts should be installed on top of the barrier to make it conform to the sidewalk fence height for a sidewalk. The bicycle fence height is used when a significant number of cyclists use the sidewalk or if the CRB is adjacent to a bike path. If the pathway next to a barrier is used by cyclists and pedestrians, the minimum width from the edge of barrier to the outside edge of pavement should be:

- 2.5 m for one-way bicycle traffic
- 3.5 m for two-way bicycle traffic