SYSTEMS AND CAPABILITY

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Queensland Government
Department of Main Roads

STRUCTURES DIVISION/ NETWORK OPERATIONS AND ROAD SAFETY DIVISION

DESIGN AND SELECTION CRITERIA FOR ROAD/RAIL INTERFACE BARRIERS

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QR Network Queensland Government

DESIGN AND SELECTION CRITERIA FOR ROAD/RAIL INTERFACE BARRIERS

INTRODUCTION

An intrusion into the railway corridor by an errant vehicle, loss of cargo onto the rail track or debris resulting from the event can cause a major incident and lead to extensive disruptions to railway and road operations.

A major incident could cause:

- Significant loss of life to rail passengers and the occupant(s) of the road vehicle(s);
- Damage to vehicle(s) and train(s);
- Derailed train being hit by a train on adjacent tracks;
- Track blockage;
- Damage to infrastructure; and
- Delays due to the time taken for debris removal.

In light of the increasing potential of incidents in shared corridors, Queensland Main Roads and QR Network collaborated to produce this specification for designers to determine the appropriate road and bridge barrier where the road and the rail are in close proximity without having to go back to first principles each time.

The current standards for road and bridge barriers AS 3845 and AS 5100 assume the main risk of an errant vehicle is to the occupants of the vehicle. In addition to this, Queensland Main Roads "Road Planning and Design Manual" Chapter 8, currently provides guidance on the treatment of roadside hazards but does not take into account adjacent third parties, such as railways.

This document sets out requirements for road and bridge barriers where the road and rail corridors are in close proximity and includes a road/rail barrier selection matrix developed using a risk assessment methodology. It has been further supplemented with a systematic procedure for barrier selection in parallel road and rail corridors and a document on road barrier selection for bridges over rail corridors.

NOTE

This document has been jointly developed by QR Network and Transport and Main Roads (Network Operations and Road Safety Division and Structures Division); any alterations must be jointly endorsed by both Authorities.
This document shall be subject to a review in 5 years from initial date of issue.

ASSUMPTIONS

- The errant vehicle is assumed to have 1 or 2 occupant(s); and

- Trucks are assumed to be a 36 tonne tanker semi-trailer for road barriers and a 44 tonne tanker semi-trailer for bridge barriers in accordance with AS 3845 and AS5100 respectively.

EXCLUSIONS

- Level crossings;
- "High centre of gravity" vehicles such as double-decker cattle trucks (Where these vehicles form part of the traffic stream, then the height of barriers needs to be re-evaluated);
- Length of barrier required on bridge approaches;
- At-grade and elevated roads with tight horizontal radius curves where the speed environment transitions between high and low speed; and
- Barriers adjacent to construction sites.

REFERENCE DOCUMENTS

- AS 3845
- AS 5100
- Queensland Main Roads: Road Planning and Design Manual
- QR Network documents: MCE-SR-001; MCE-SR-006; MCE-SR-014
- Barlow, S., Pritchard, R., Theodoropoulos, A., Troutbeck, R., 2009, "Barriers between road and rail: barriers adjacent to rail explained", 7th Austroads Bridge Conference, Auckland, New Zealand.

ROAD/RAIL INTERFACE BARRIER SELECTION PROCESS

Suitable reinforced concrete barriers shall be provided between the road and railway corridor as outlined in the following sections. The possible future rail and road status shall be taken into consideration in the barrier selection process to accommodate future requirements.

Note: The road barrier is to be located on the road shoulder.

Step 1: Determine measured horizontal offset between road/rail interface

From the typical design cross-section, determine the measured horizontal offset (X_H) from the edge-line of the road to the closest railway infrastructure (either 3m from the centre-line of the nearest railway track or to the nearest significant QR Network building/structure). Refer to Appendix 1 which shows barrier placement for different road/rail interface scenarios.

Step 2: Apply slope adjustment factor to determine slope adjusted horizontal offset, X_S

The measured horizontal offset (X_H) is adjusted to take into account the slope of the embankment from the road corridor down to the rail corridor. No adjustment is necessary where the rail corridor is above the road corridor. For slopes between 1 to 4 and 1 to 2.5, the following equation is used to calculate the slope adjusted offset.

Slope adjusted horizontal offset $X_S = (X_H \times F_S)$

Where:
X_H = measured horizontal offset
F_S = slope adjustment factor (refer to Table 1)

For embankments with compound slopes, each section with a different slope is calculated individually and each slope adjusted offset is added to obtain the overall slope adjusted offset, X_S, such that:

Slope adjusted horizontal offset $X_S = \sum (X_{Hi} \times F_{Si})$

Embankment Slope (V to H)	F_S
Horizontal/Flat	1.00
Less than 1 to 4	1.00
1 to 4	0.38
1 to 3.5	0.29
1 to 3	0.17
1 to 2.5 or steeper	0.00

Table 1. Slope Adjustment Factors

Example
If a railway was located at the base of a 1 to 3 embankment, and the offset between the railway infrastructure and the hinge point at the top of the embankment was 4.0m, and the distance from the edge-line of the road to the hinge point of the slope was 2.5m (refer to Figure 1.) then:

$$X_S = \sum (X_{Hi} \times F_{Si})$$
$$= (X_{H1} \times F_{S1}) + (X_{H2} \times F_{S2})$$
$$= (2.5 \times 1.00) + (4.0 \times 0.17) = 3.18m$$

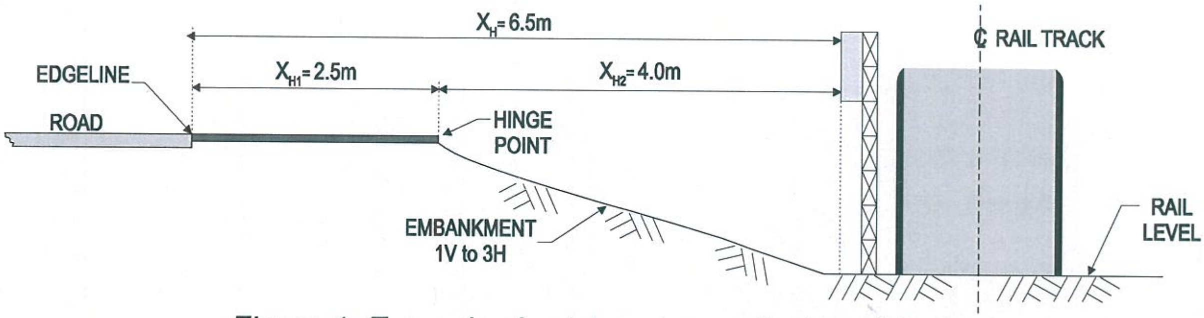


Figure 1. Example: Applying slope adjustment factor

Notes
1. For slopes flatter than 1 to 4, the slope adjustment factor (F_{Si}) should be taken as 1.00. That is, $X_S = X_H$
2. For slopes steeper than 1 to 2.5, slope adjustment factor (F_{Si}) should be taken as 0.00. In this instance, the slope adjusted offset distance (X_S) will become the measured distance from the road edge-line to the top of embankment hinge point.
3. At the locations where the railway is above the level of the road, $X_S = X_H$.

Step 3: Apply horizontal road curve adjustment factor
If the design radius of the road is equal to or less than 2000m, a horizontal curve adjustment factor, F_C, is applied to the slope adjusted horizontal offset determined in the previous step, X_S, to calculate the design offset, X_D, therefore:

The design offset, $X_D = (X_S \times F_C)$

Where:
X_S = slope adjusted offset
F_C = horizontal curve adjustment factor (refer to Table 2)
$X_D = X_H$ where the road is on a straight alignment or the radius is greater than 2000m.

Horizontal curve radii (m)	**Horizontal Road Curve Adjustment Factor (F_c)**						
100	0.56	0.50	0.43	0.37	0.31	0.26	0.21
150	0.66	0.60	0.54	0.47	0.41	0.34	0.29
200	0.72	0.67	0.61	0.54	0.48	0.41	0.35
250	0.76	0.71	0.66	0.60	0.53	0.47	0.40
300	0.80	0.75	0.70	0.64	0.58	0.51	0.45
400		0.80	0.75	0.70	0.65	0.58	0.52
500			0.79	0.75	0.69	0.64	0.57
600				0.78	0.73	0.68	0.62
700				0.81	0.76	0.71	0.65
800					0.78	0.74	0.68
900						0.76	0.71
1000						0.78	0.73
1200						0.81	0.76
2000							0.84
Design Speed Environment (km/h)	**60**	**70**	**80**	**90**	**100**	**110**	**120**

Table 2. Horizontal road curve adjustment factors

Note:
1. The design speed environment is 10km/h above the posted speed limit of the road on the approach to the horizontal curve.

Example
Continuing from the previous example, consider that the road also has a 600m horizontal curve, a posted speed of 100km/h and hence a design speed of 110km/h. If X_S = 3.18m, the horizontal curve radius on the road is 600 m and the design speed is 110 km/h, then to calculate the design offset:

$X_D = (X_S \times F_C)$.
$= (3.18 \times 0.68) = 2.16m$

Example summary
$X_D = \sum (X_{Hi} \times F_{Si}) F_C$
Where:
$X_H = 6.5m = X_D$ *if no slope or curve adjustment is required*
$X_S = 3.18m = X_D$*, if only the slope adjustment is required*
$X_D = 2.16m$*, if both the slope and curve adjustment factors are required.*

The barrier is to be located on the road shoulder.

Step 4: Determine rail status

The railway status should be classified as shown in Table 3.

Rail status	Description
MPE	Main-line electrified (high passenger train frequency), i.e. the suburban network
MC & DG	Main country passenger and goods lines (eg. NCL) & light trafficked dangerous goods lines (i.e. explosive or highly flammable)
SP	Secondary passenger and/or goods lines. 1-5 trains / 24 hours
L	Light country lines < 7 trains per week
C	Coal/mineral lines

Table 3. Rail Status

Step 5: Determine road status

The design speed and road classification should be used to determine the road status. Refer to Table 4.

Road status	Description	Design Speed (km/h)	Upper limit AADT (veh/day)
1A	Arterial & dual carriageway	110	130,000
1B	Arterial & dual carriageway	80	90,000
1C	Arterial & dual carriageway	60	65,000
2A	Arterial, connection roads and rural highways	110	65,000
2B	Arterial, connection roads and rural highways	80	40,000
2C	Urban road	70	10,000
3	Residential Street	60	1,000

Note: The road speeds shown above, represent the design speed.

Table 4. Road Status

Step 6: Select/design road barrier

To select an appropriate road barrier, where a barrier is TL5 (height 1.1m) or TL4; refer to Main Roads document "Road Safety Barriers and End Treatments, assessed as compliant with AS 3845" (www.mainroads.qld.gov.au). Where the required barrier is TL5 (height 1.5m) or TL6, the barrier should be designed for the loads described in Table 5. Refer to road safety barrier "first principles" design procedure for road bridge barriers in the next section.

Barrier Performance Level	Height (m)	Effective height H_e (m)	Transverse Load (kN)	Vehicle Contact Length (m)***
TL4	0.8	Refer to MR document: "Road Safety Barriers and End Treatments, assessed as compliant with AS 3845" (available on QMR website.)		
TL4	1.1			
TL5	1.1			
TL5	1.5	1.40	500	2.4 (AS 5100.2 Table A2)
TL6	1.5	1.40	750	2.4 (AS 5100.2 Table A2)
TL6*	1.5	1.40	1000	2.5 (AS 5100.2 Table A2)
TL6**	2.0**	1.40	1000	2.5 (AS 5100.2 Table A2)

Notes to table 6a:
* 44 t articulated truck
** 2.0 m height for fire protection
*** Length of barrier that vehicle load is distributed over.

Table 5. Road barrier design criteria

Note: for TL5 barrier (height 1.5m) and TL6 barriers (heights 1.5, 2m) there are no proprietary barriers available in Australia. Advice on their design can be sought from the Road Authority.

Step 7: Determine the road barrier test level and height.
Use Table 6 "road/rail interface barrier selection" to select the appropriate barrier type and design height, using the rail and road status, and design offset, X_D.

Road /Rail corridor characteristics	1A-MPE	1B-MPE 2A-MPE	1C-MPE 1A-MC 1A-C 2B-MPE	1B-MC 2A-MC	1C-MC 2B-MC 1A-SP 2A-SP 2A-C 1B-C 2C-MPE	2C-MC 1B-SP 2B-SP 2B-C 1A-L 2A-L 1C-SP	2C-SP 2C-C 1B-L 3-MPE	1C-L 2B-L 2C-L 3-MC	3-SP 3-C 3-L
Design Offset, X_D (m)									
≤4	TL6 2.0	TL6 1.5	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL4 1.1	TL4 1.1	TL4 1.1
5	TL6 2.0	TL6 1.5	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL4 1.1	TL4 1.1	TL4 0.8
6	TL6 2.0	TL6 1.5	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL4 1.1	TL4 0.8	
7	TL6 1.5	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.5	TL4 1.1	TL4 0.8		
8	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL4 1.1			
9	TL5 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL5 1.1	TL4 0.8			
10	TL5 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL5 1.1				
11	TL5 1.5	TL5 1.5	TL5 1.1	TL5 1.1	TL4 1.1				
12	TL5 1.5	TL5 1.1	TL5 1.1	TL5 1.1	TL4 1.1				
13	TL5 1.1	TL5 1.1	TL5 1.1	TL5 1.1	TL4 1.1				
14	TL5 1.1	TL5 1.1	TL5 1.1	TL4 1.1	TL4 0.8				
15	TL5 1.1	TL5 1.1	TL4 1.1	TL4 1.1					
16	TL5 1.1	TL5 1.1	TL4 1.1	TL4 1.1					
17	TL5 1.1	TL5 1.1	TL4 1.1	TL4 0.8					
18	TL5 1.1	TL4 1.1	TL4 1.1	TL4 0.8					
19	TL4 1.1	TL4 1.1	TL4 0.8						
20	TL4 1.1	TL4 1.1	TL4 0.8						
21	TL4 1.1	TL4 1.1							
22	TL4 1.1	TL4 1.1							
23	TL4 1.1	TL4 0.8							
24	TL4 1.1	TL4 0.8							
25	TL4 0.8								
26	TL4 0.8								
27	TL4 0.8								
28									
29									
30									
31									
32									
33									
34									
35									

Note: Light Green shaded area denotes that a barrier may be required where directed by the Road and/or Rail authority as determined by a risk assessment.

Table 6. Road / Rail interface barrier selection

Step 8: Increase barrier height for electrification, and/or anti-throw screen (if required)
Additional height may be required for electrification, anti-throw, anti-glare screens and/or fire protection. This is determined on a case by case basis.

ANTI THROW and ELECTRIFICATION SCREENS FOR ROAD BARRIERS
Anti throw screens shall be provided on the side of the road or path nearest to the railway, where the horizontal distance from the road edge, fence line or traffic barrier to the nearest track centre line is less than 6m. The anti throw screen shall be 2.4m high, if see-through and 2.0m high, if not see-through.

Electrification screens shall be provided on the side of the road or path nearest to the railway, where the minimum horizontal distance from the road/path, fence line or traffic barrier is less than 3m horizontally (in any direction), from overhead line equipment or wiring. The minimum required height (measured from the highest point of the adjacent pavement) for the electrification screen is 1.8m.

Subject to Rail Authority approval, anti glare screens may be suitable as anti throw or electrification screens. Also, the screens may be incorporated in the height of the crash barrier, subject to Rail Authority approval. Refer to Appendix 2 at the end of this document, and QR Network documents, MCE-SR-006, MCE-SR-001, for additional information.

BRIDGES OVER RAILWAY CORRIDOR

Suitable reinforced concrete barriers shall be provided over the full width of the railway corridor on both sides of road bridges over railways and on bridge approaches (the length of the approach barrier is to be determined by a risk assessment). The Rail Authority may allow the barrier to partially span the railway corridor, based on the current and future frequency of rail traffic and other railway activity in the railway corridor.

The possible future rail and road status shall be taken into consideration in the barrier selection process and the bridge designed accordingly to also accommodate future barrier requirements.

ROAD BRIDGE OVERPASS/RAIL INTERFACE BARRIER SELECTION AND DESIGN

Step 1: Determine rail status
The railway status shall be classified as shown in Table 3.

Step 2: Determine road bridge overpass status
The design speed (i.e. the posted speed plus 10km/h) and road classification should be used to determine the road status. Refer to Table 4.

Step 3: Determine the bridge barrier test level and height.
Use Table 7 to select the appropriate bridge barrier type and height, using the rail and road status.

Road Status	Bridge Barrier Height (m) and Barrier Performance Level to AS 5100				
1A	2.0 (Special)	1.5 (Special)	1.5 (Medium)	1.1 (Medium)	1.5 (Special)
1B	1.5 (Special)	1.5 (Medium)	1.1 (Medium)	1.1 (Regular)	1.5 (Medium)
1C	1.5 (Special)	1.5 (Medium)	1.1 (Medium)	1.1 (Regular)	1.5 (Medium)
2A	1.5 (Special)	1.5 (Medium)	1.5 (Medium)	1.1 (Medium)	1.5 (Medium)
2B	1.5 (Special)	1.5 (Medium)	1.1 (Medium)	1.1 (Regular)	1.1 (Medium)
2C	1.5 (Medium)	1.1 (Medium)	1.1 (Regular)	1.1 (Regular)	1.1 (Medium)
3	1.1 (Regular)	1.1 (Regular)	1.1 (Regular)	1.1 (Regular)	1.1 (Regular)
Rail Status	**MPE**	**MC & DG**	**SP**	**L**	**C**

Note:
[1.1 (Regular)] denotes the barrier is 1100mm high, measured from the edge of the adjacent road lane pavement level with a barrier performance level "Regular".

Table 5. Road bridge over railway barrier selection

Step 4: Select bridge barrier criteria
Design bridge barrier for loads described in Table 8 and refer to barrier design procedure.

Bridge barrier performance Level	Barrier height (m)	Effective height H_e of transverse load (m)**	Transverse Load (kN)	Vehicle Contact Length (m)***
Regular	1.1	1.05	250	1.1 (AS 5100.2 Table 11.2.2)
Medium	1.1	1.05	500	2.4 (AS 5100.2 Table A1)
Medium	1.5	1.45	500	2.4 (AS 5100.2 Table A1)
Special	1.5	1.45	750	2.4 (AS 5100.2 Table A2)
Special*	1.5	1.45	1000	2.5 (AS 5100.2 Table A2)
Special*	2.0	1.95	1000	2.5 (AS 5100.2 Table A2)

Notes to table:
* 44 t articulated truck
** Length of barrier that vehicle load is applied over.
*** Refer to AS 3845 Figure 3.5 "Dimensions"

Table 6. Bridge barrier design criteria

Step 5: Analyze the barrier structure.
The analysis can be undertaken by either of the proposed methods:

(a) simple design model
(b) complex computer model (approval by the Road Authority and Rail Authority is required prior to use)

Refer also to AS 3845, Appendix C, clause 3.4 "Analysis of stresses in rigid barriers".

<u>Simple Design Method</u>
The analysis can be undertaken by assuming the distribution of the transverse load at 45^{o} to the horizontal from the point of application of the load to the deck. Refer to Figure 2 below.

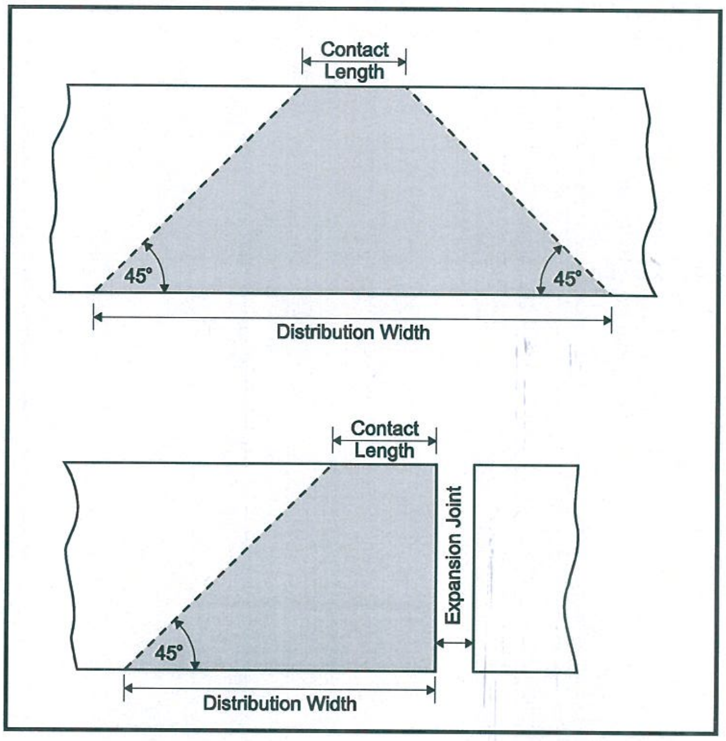


Figure 2. Distribution of load

The design method shall consider the actual distribution of loads that produce the most adverse ultimate bending moment (M*), ultimate shear force (V*) and ultimate torsion force (T*) effects. End effects such as expansion joints shall be considered to determine the effective distribution length. Also, additional analysis of the connection between the barrier and the bridge superstructure is required.

Special analysis case - Bridge to Road Barrier where barrier is anchored by piles/footing
There may be a requirement, such as where a bridge crosses a railway on a "skew" angle, where a barrier needs to be continued from a bridge to a road. In these instances, depending on the barrier performance level, barriers on the road may need to be supported on piles or a footing so that they meet the same requirements as the bridge barrier. This should be undertaken from first principles using a recognised design method approved by both the Road and Rail Authorities.

Step 6: Reinforcement design
Design of reinforcing steel shall be in accordance with AS 5100.5 "Concrete".

Step 7: Transition design
Bridge barriers either need to have a barrier end treatment or a transition between the bridge barrier and the road barrier. Refer to Appendix 3 "Road bridge over rail" which shows the extent of barrier required over railway corridor. In addition to this barrier, a risk assessment is required to determine the length of barrier required on the bridge approaches.

The transition barrier shall be either:

- A barrier conforming to Queensland Main Roads standard drawings; or
- A barrier designed from first principles using a recognised design method approved by both the Road and Rail Authorities.

The design process is similar to the bridge barrier design for the analysis and the reinforcement design. A transition in stiffness may also be required between barrier types and where the height between the barriers varies, the height should be transitioned with a 1 in 10 taper, refer to Appendix 3. (This can be used to obtain the minimum length of the transition.) The most adverse M*, V* and T* effects shall be determined. Load cases should show the transverse loading effects with the required effective height, transverse load and vehicle contact length. A load case is applied separately to each end of the transition segment.

Step 8: Increase barrier height for electrification, and/or anti-throw screen and/or fire protection (if required.)
In addition to the barrier height required to structurally contain/re-direct a vehicle, the height of the barrier may need to be increased due to electrification, anti-throw and/or fire protection requirements. This may be created through the additional of metal screens or by increasing the height of the concrete barrier (refer to Appendix 2). Note: the additional barrier height is not to be modeled in the above analysis, as it is not required for vehicle redirection. The minimum reinforcement required in the additional barrier height shall be the same as the reinforcement used in the lower section of the barrier. The maximum spacing of the horizontal bars shall not exceed 200mm.

BARRIER DESIGN CONSIDERATIONS

AS 5100.1 Table 10.4 shows the controlling strength of the test vehicles, associated barrier performance levels and NCHRP report 350 Test Levels (TL). The test levels range from TL2/low performance barrier to TL6/special performance barrier. A 36 tonne articulated tanker has been nominated as the controlling vehicle. (Refer to AS 5100.1 Table B3 and AS 5100.2 Table A2 and to NCHRP Report 350)

Barriers shall be designed to contain any part of the nominated design vehicle, its load and/or debris resulting from the collision and remnants of any secondary collisions, within the road corridor. The design shall take into consideration:

- Strength of the barrier to stop the vehicle or its load penetrating the barrier.
- Barrier height to minimise the risk of the vehicle or its load being propelled over the barrier.
- Containment of debris from any secondary vehicle collisions within the road corridor.
- Limiting the impact of any fire within the road corridor from adversely impacting on railway operations.
- Fire in either corridor can impact both the railway and road corridors from excessive smoke, and can damage infrastructure or in larger fires, power to the railway may be required to be switched off due to safety issues.

Typically, barriers are to be located within the road corridor adjacent to the road shoulder unless directed otherwise by the Road and Rail Authorities. Where the railway is located above the road, a single slope barrier may be incorporated into the base of the embankment or retaining wall to redirect a vehicle and shield the embankment/retaining wall.

For regular, medium and special barriers, concrete barriers are preferred. Afflux considerations in urban areas normally exclude concrete parapets. Where the road is subject to flooding, and an afflux will have an adverse effect on road users and adjacent property owners, steel or other barrier types, as directed by the Road and Rail Authorities, shall be considered.

ANTI THROW and ELECTRIFICATION SCREENS ON BRIDGE OVERPASSES

Anti-throw screens

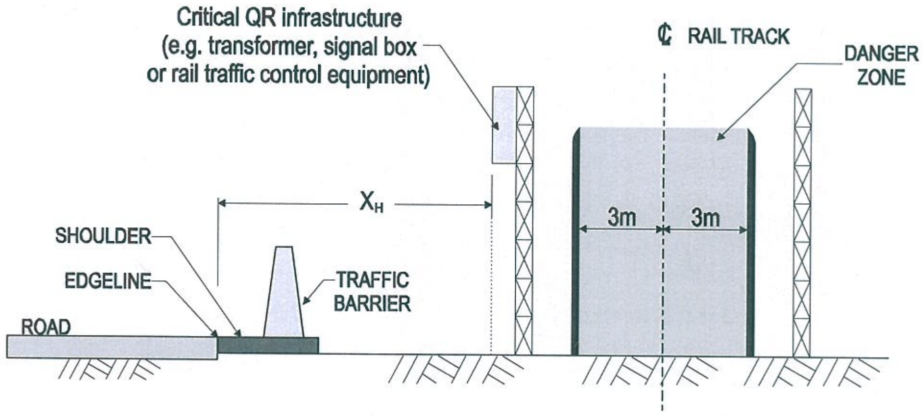
Anti throw screens are required on all road bridges, bike path and foot bridges over a railway corridor. The screen shall be provided over the total width of the corridor unless the Rail Authority has given approval in writing to reduce the length. This approval is based on rail traffic frequency and the extent of other railway activity under the bridge. The minimum extent of the screen on bridges shall be 3m (horizontally) either side of the track centre line, on both sides of the bridge. The height requirement for an anti throw screen is 2.4m, if see-through and 2.0m if not see-through.

Electrification screens

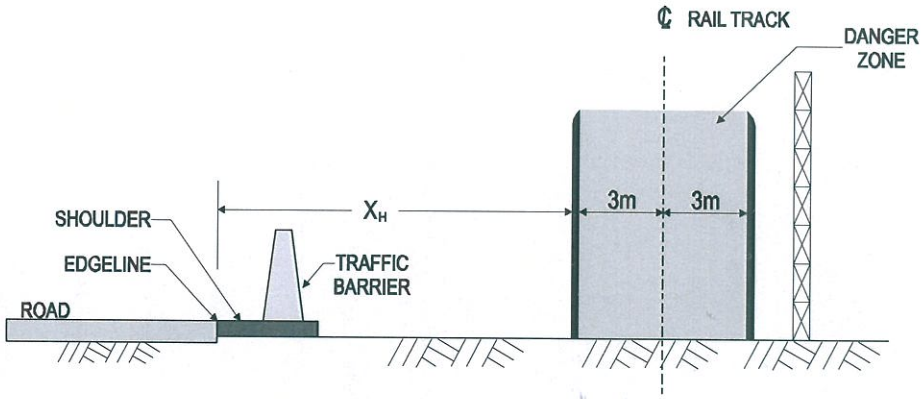
Electrification screens are required where the railway corridor is electrified. The screen shall be provided over the total width of the corridor unless the Rail Authority has given approval in writing for a reduced screen length to be provided. This approval is based on rail traffic frequency and extent of other railway activity under the bridge. The minimum extent of the screen on bridges shall be 3m (horizontally) either side of the track centre line, or overhead line equipment. The minimum required height of the electrification screen is 1.8m.

Anti-throw screens and electrification screens

The other main difference between the two screens is the minimum allowable size of the screen openings. The height is measured from the highest point of the adjacent pavement level. The screens may be incorporated in the height of the crash barrier, subject to Rail Authority approval. Refer to Appendix 2, and QR Network documents, MCE- SR – 006 and MCE – SR – 001, for additional information.



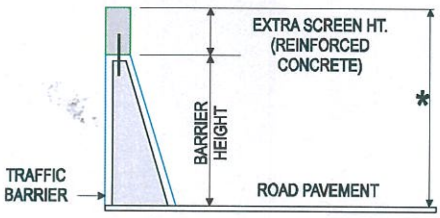
HORIZONTAL / FLAT
(Option A)



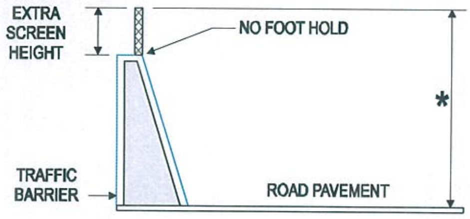
HORIZONTAL / FLAT
(Option B)

NOTE
BARRIERS ARE TO BE LOCATED ON THE ROAD SHOULDER.

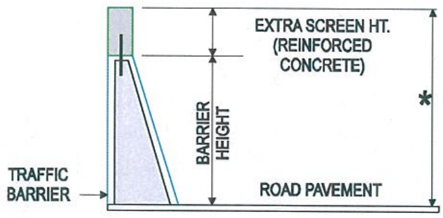
Appendix 1



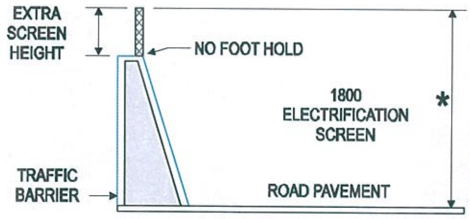
* TYPICAL ANTI-THROW SCREEN
2.4m IF SCREEN IS SEE THROUGH
2.0m IF SCREEN IS NOT SEE THROUGH



TYPICAL BARRIER SECTION (NON ELECTRIFIED RAILWAY)



* TYPICAL ANTI-THROW SCREEN
2.4m IF SCREEN IS SEE THROUGH
2.0m IF SCREEN IS NOT SEE THROUGH



TYPICAL BARRIER SECTION (ELECTRIFIED RAILWAY)

NOTES

1. **GENERAL**

   - FOR BARRIERS ON ROAD OVER RAIL AND WHERE THE ELECTRIFICATION WIRING OR WIRING EQUIPMENT IS <3m HORIZONTALLY FROM SCREEN FOR ROAD/RAIL SEPARATION BARRIERS.
   - EXTRA SCREEN HEIGHT TO BE FIRMLY SECURED TO TRAFFIC BARRIER.

2. **TYPICAL ANTI THROW SCREEN**

   SEE-THROUGH
   LOUVRE MESH
   WELDED WIRE MESH
   PERFORATED STEEL SHEETING
   MAX OPENING IS 25mm x 25mm

   NON SEE-THROUGH
   REINFORCED CONCRETE
   GALVANISED STEEL PLATE

3. **TYPICAL ELECTRIFICATION SCREEN**

   * PERFORATED STEEL SHEETING
   * CRIM SAFE WIRE MESH
   * LOUVRE MESH
   * APPROVED GLASS PANE

   TYPE OF SCREEN TO BE SUBJECT TO RAIL AUTHORITY APPROVAL

4. **FOR ANTI-THROW AND ELECTRIFICATION SCREENS**

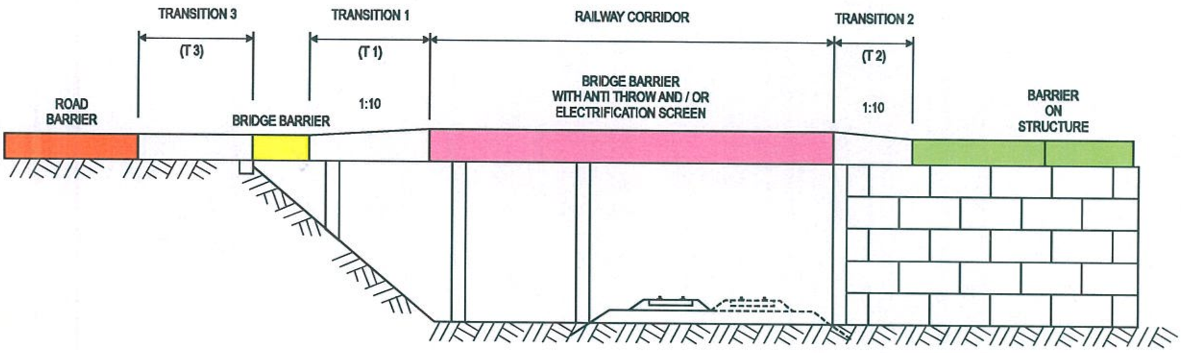
   ALSO REFER TO QR NETWORK TECHNICAL SPECIFICATIONS
   MCE-SR-001, MCE-SR-006 & MCE-SR-015 (ELECTRIFICATION SCREEN SELECTION)

5. **ANTI GLARE SCREEN**

   A SUITABLE ANTI HEADLIGHT GLARE SCREEN MAY ALSO BE INCORPORATED IN THE ROAD/RAIL INTERFACE BARRIER WHERE REQUIRED.

ANTI THROW AND ELECTRIFICATION SCREENS

Appendix 2



TYPICAL BRIDGE SECTION

NOTE

T1 = TRANSITION IN HEIGHT 1(v) TO 10(h)

T2 = TRANSITION IN HEIGHT 1(v) TO 10(h) AND IN STIFFNESS

T3 = TRANSITION IN STIFFNESS

BARRIER TRANSITIONS

ROAD BRIDGE OVER RAILWAY CORRIDOR

Appendix 3