Civil Engineering Technical Requirement

CIVIL-SR-012

COLLISION PROTECTION OF SUPPORTING ELEMENTS ADJACENT TO RAILWAYS

This Technical Requirement is being revised.

Note: AS5100 has been revised since this Technical Requirement was last revised and some requirements in AS5100 that relate to this document have changed.

The user of this document shall read it with AS5100 and where there is a conflict the more onerous requirement shall be applied.

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A	22/12/2009		Complete Revision
B	30/09/2010		Rebranded with new disclaimer
C	30/05/2011		MCE replaced with CIVIL
C.1	05/02/2021	Cover only	Note added referencing changes to AS5100

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1.0 INTRODUCTION

This Technical Requirement details the criteria which must be met by external party designs for supporting components (piers, columns, walls) of structures (buildings, overbridges, footbridges) over or adjacent to railway property. Reference is made to the following additional Queensland Rail Technical Requirements which must also be satisfied:

- CIVIL-SR-001 Design of road overbridges,
- CIVIL-SR-002 Work in or about Queensland Rail property,
- CIVIL-SR-003 Work adjacent to overhead line equipment,
- CIVIL-SR-005 Design of buildings over or near railways, and
- CIVIL-SR-006 Design of footbridges.

Copies of these documents may be obtained from Queensland Rail.

All reference documents, e.g. Australian Standards, codes and Queensland Rail Technical Requirements, are to be the latest version.

Where this Technical Requirement prescribes a different degree of protection than any other standard, including Australian Standards, then this document will take precedence.

2.0 SCOPE

This Technical Requirement applies to the:

- design of new structures, and
- upgrading of existing structures

over or adjacent to railway property.

It covers design loads and collision protection methods to be used in the design of supporting elements of buildings, overbridges and footbridges.

The presence of piers between railway tracks is undesirable on safety grounds because of the increased risk of structure collapse from a derailment. There is a preference for structures to be a clear span between abutments.

Provision should be made for the foreseeable development of railway infrastructure, particularly regarding an increase in the number of tracks.

3.0 DESIGN CONSIDERATIONS

The design of the supporting elements of structures is to comply with:

- AS 5100 *Bridge Design* for collision protection and collision loads, and
- this Technical Requirement and associated Technical Requirements.

The collision loads from AS 5100 are to be modified in accordance with this Technical Requirement.

The design “collision loads” from derailed vehicles referred to in this document are not precise collision loads resulting from derailed rollingstock, but rather, are minimum loads intended to provide a design where the supporting elements have a degree of robustness in the event of a glancing blow from a derailed train. The design collision loads are less than the full collision impact from a loaded train at the maximum permitted speed. The design collision loads may be increased where deemed necessary by the designer.

Subject to approval by Queensland Rail, collision loads and the point of contact (from AS 5100.2 or this document) may be modified:

- if justified by a risk assessment and if other controls are in place, or
- where it can be shown that the loads or point of contact are not appropriate, e.g. where the support has a wide base or where the support is located on ground sloping away from the track.

The design is to consider:

- the collision load and point of contact,
- all permanent loads,
- the applied traffic loads,
- the effect of the collision load on the immediately, adjacent, structural member in the superstructure above the relevant supports, and
- the effect of the collision load on the foundations immediately below the relevant supports.

The design of the supports is not to include any assistance by propping action from other structural

elements that may be demolished as the result of a collision.

4.0 STRUCTURES CATEGORIES FOR DESIGN

Collision design loads and suitable collision protection measures are to be provided based on the:

- **CLASS** of superstructure to be protected,
- **ZONE** or proximity of the support to the tracks, and the
- **SPEED CATEGORY** environment of the track.

4.1 Class of Structure

Structures built above or adjacent to railway tracks are classified as Class A, B or C Structures according to their use.

Class A Structures

These structures are:

- permanently or semi-permanently occupied, e.g. commercial offices, retail premises, residential developments,
- temporary gathering places for large numbers of people e.g. theatres, cinemas, train station ticket offices, or
- multiple story structures which are only subject to short-term occupancy e.g. multi-story carparks and warehouses.

Collapse of this type of structure would almost certainly lead to multiple deaths of people occupying the structure.

Class B Structures

These structures are:

- sporadically or infrequently occupied, e.g. lifts, waiting areas, footbridges, roadways, road overbridges,.
- single story structures not providing long-term occupancy, e.g. parking areas, single-story warehouses.

Collapse of this type of structure would almost certainly lead to a single death or multiple injuries of people occupying the structure.

Class C Structures

These structures are:

- not occupied, except for maintenance activities, but are capable of crushing the roof of rollingstock in the event of collapse because of their weight and / or height above rail, i.e. coal loadouts, conveyors to coal loadouts, some overhead pipelines.

Collapse of this type of structure would probably lead to a single death or multiple injuries of people occupying the rollingstock.

Lightweight structures close to the track are excluded from this category, as collapse of this type of structure would have a low risk of a single death caused by crushing of the roof of rollingstock, e.g. signal gantries, advertising signs, overhead traction wiring masts.

Additional Considerations

Notwithstanding the above descriptions, a structure may be allocated a higher classification if it is considered by Queensland Rail that there is an increased risk to personal safety based on additional risk factors including:

- number of people occupying the structure,
- number of people travelling in trains,
- high frequency of trains,
- type of train using the line (passenger or freight),
- presence of points and crossings in the vicinity of the structure, and
- curvature of the track or structural configuration of the structure.

4.2 Zone of Structure

Each Class A, B and C structure is further classified according to its distance from the nearest track centre-line as follows:

- **ZONE 1:** support is less than 3 m from track centre-line
- **ZONE 2:** support is more than 3 m and less than 5 m from track centre-line
- **ZONE 3:** support is more than 5 m and less than 10 m from track centre-line
- **ZONE 4:** support is more than 10 m and up to 20 m from track centre-line
- **ZONE 5:** support is behind the terminating end of tracks

4.3 Speed Category

Each Class of structure in each Zone is attributed a speed category as follows:

- **SPEED CATEGORY 1:** 51 km/hr to 160 km/hr (assumed to be passenger trains)
- **SPEED CATEGORY 2:** 21 km/hr to 50 km/hr (assumed to be passenger trains)
- **SPEED CATEGORY 3:** Less than 20 km/hr (assumed to be freight trains)

5.0 DESIGN COLLISION LOADS FOR SUPPORTING ELEMENTS

Notwithstanding the requirements of this document, all supports must be able to carry the permanent and applied loads from the superstructure with half of their cross-section rendered ineffective at the collision point.

Supporting elements adjacent to railways are to be avoided. If it is not possible to avoid having supporting elements adjacent to the track, structures are to be designed with an alternative load path in accordance with AS 5100.2, allowing for 60% live load. Structures without provision for redundancy are to be designed to resist collision loads as described in AS 5100.2, except as modified below.

5.1 Class A Structures

Collision protection is to be provided for Class A structures as follows:

5.1.1 Zone 1

Speed Categories 1, 2 and 3

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- To be avoided if possible
- The support is to be designed as a continuous wall with minimum dimensions of:

  L:W ≥ 4:1,
  W ≥ 0.8 m and
  L ≥ H/2

  where L = length of support
  W = width of support
  H = height of support
- Designed to withstand equivalent collision loads of 10,000 kN parallel to the track and 3,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

5.1.2 Zone 2

Speed Category 1

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- The support is to be designed as a continuous wall or as a non-continuous wall made up of individual wall-type sections.
- The wall is to have the minimum dimensions of:

  L:W ≥ 4:1,
  W ≥ 0.8 m and
  L ≥ H/2

  where L = length of support
  W = width of support
  H = height of support
- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- Where the support is constructed from individual wall-type sections, an alternative load path is to be provided in the event that the support is struck. The superstructure is to be designed with sufficient redundancy to

- be capable of supporting the dead load plus 60% of the live load with one or more of the wall-type sections removed. The number of sections to be removed is to be determined by risk analysis and accepted by Queensland Rail.
- If supports are located on platforms (with 20 m minimum length of platform protection), supports do not have to be designed as walls, but may be designed as columns with applied forces or redundancy as described above.

Speed Category 2

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- The support should be designed as a continuous wall. However, if this is not possible for technical reasons, individual columns may be used if either a deflection wall or 20 m minimum length of platform is provided in front of the first column and all other columns that are located in an area where there is a high risk of derailment.
- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 2,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- The deflection wall is to be designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.

Speed Category 3

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- The deflection wall is to be designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.

5.1.3 Zone 3

Speed Category 1

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

Speed Category 2

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand

equivalent collision loads of 1,500 kN parallel to the track and 1,000 kN perpendicular to the track applied at 2 m above top of rail.
- The deflection wall is to be designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.

Speed Category 3

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail.
- The deflection wall is to be designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.

5.1.4 Zone 4

Speed Categories 1, 2 & 3

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 750 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail.
- The deflection wall is to be designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.

5.1.5 Zone 5

Speed Categories 1, 2 and 3

Suitable buffer stops are to be provided to prevent trains colliding with structures beyond the end of the track. As a minimum, buffer stops are to prevent a low speed collision with the structure.

Unless additional suitable control measures are provided to prevent collision, supporting elements behind buffer stops are to be designed for the same collision load requirements as described above for Zones 1, 2, 3 or 4 for main-line speed. For example, a support located 4 m behind a buffer stop with a main-line speed of 40 km/hr is to be designed to the same requirements as for Zone 2, Speed Category 2.

5.2 Class B Structures

Collision protection is to be provided for Class B structures as follows.

5.2.1 Zone 1

Speed Category 1

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- To be avoided if possible
- Where redundancy is not provided, the support is to be designed as a continuous wall with minimum dimensions of:

  L:W ≥ 4:1,
  W ≥ 0.6 m and
  L ≥ H/2

  where L = length of support
  W = width of support
  H = height of support
- Designed to withstand equivalent collision loads of 5,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

5.2.2 Zone 2

Speed Category 1

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

Speed Category 2

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 2,000 kN parallel to the track and 1,000 kN perpendicular to the track applied at 2 m above top of rail.
- The deflection wall is to be designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.

Speed Category 3

Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 1,000 kN perpendicular to the track applied at 2 m above top of rail.
- Where the superstructure has a supported area of < 50 m^2, e.g. a mid-section footbridge,

supports are to be designed to withstand equivalent collision loads of either:

- 2,000 kN applied both parallel and perpendicular to the track at 1.2 m above top of rail or
- 500 kN applied both parallel and perpendicular to the track at 3 m above top of rail.

whichever produces the more adverse effect.

5.2.3 Zone 3

Speed Category 1
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

Speed Category 2
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 1,000 kN perpendicular to the track applied at 2 m above top of rail.
- The deflection wall is to be designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.

Speed Category 3
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail.
- Where the superstructure has a supported area of < 50 m^2, e.g. a mid-section footbridge, supports are to be designed to withstand equivalent collision loads of either:
  - 2,000 kN applied both parallel and perpendicular to the track at 1.2 m above top of rail or
  - 500 kN applied both parallel and perpendicular to the track at 3 m above top of rail.

  whichever produces the more adverse effect.

5.2.4 Zone 4

Speed Category 1
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

Speed Categories 2 and 3
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- Where supports are protected by a deflection wall or 20 m minimum length of platform, supports are to be designed to withstand equivalent collision loads of 750 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail.
- Where the superstructure has a supported area of < 50 m^2, e.g. a mid-section footbridge, supports are to be designed to withstand equivalent collision loads of either:
  - 2,000 kN applied both parallel and perpendicular to the track at 1.2 m above top of rail or
  - 500 kN applied both parallel and perpendicular to the track at 3 m above top of rail.

  whichever produces the more adverse effect.

5.2.5 Zone 5

Speed Categories 1, 2 and 3
Suitable buffer stops are to be provided to prevent trains colliding with structures beyond the end of the track. As a minimum, buffer stops are to prevent a low speed collision with the structure.

Unless additional suitable control measures are provided to prevent collision, supporting elements behind buffer stops are to be designed for the same collision load requirements as described above for Zones 1, 2, 3 or 4 for the main-line speed. For example, a support located 4 m behind a buffer stop with a possible main-line speed of 40 km/hr is to be designed to the same requirements as for Zone 2, Speed Category 2.

5.3 Class C Structures

Collision protection is to be provided for Class C structures as follows.

5.3.1 Zone 1

Speed Category 1
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:

- To be avoided if possible

- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

Speed Category 2
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:
- To be avoided if possible
- Where railway traffic is only freight, supports are to be designed to withstand equivalent collision loads of 2,000 kN parallel to the track and 1,000 kN perpendicular to the track applied at 2 m above top of rail.

Speed Category 3
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exception:
- Where railway traffic is only freight, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail.

5.3.2 Zone 2

Speed Category 1
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:
- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

Speed Category 2
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exception:
- Where railway traffic is only freight, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail

Speed Category 3
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exception:
- Where railway traffic is only freight, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail.

5.3.3 Zone 3

Speed Category 1
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:
- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction in collision loads is allowed if the support is located on a station platform.

Speed Category 2
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exception:
- Where railway traffic is only freight, supports are to be designed to withstand equivalent collision loads of 1,500 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail.

Speed Category 3
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exception:
- Where railway traffic is only freight, supports are to be designed to withstand equivalent collision loads of 1,000 kN parallel to the track and 500 kN perpendicular to the track applied at 2 m above top of rail.

5.3.4 Zone 4

Speed Category 1
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exceptions:
- Designed to withstand equivalent collision loads of 3,000 kN parallel to the track and 1,500 kN perpendicular to the track applied at 2 m above top of rail.
- No reduction is to be allowed in collision loads if the support is located on a station platform.

Speed Category 2
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exception:
- Where railway traffic is only freight, supports are to be designed to withstand equivalent collision loads of 1,000 kN parallel to the track and 750 kN perpendicular to the track applied at 2 m above top of rail.

Speed Category 3
Collision loads are to be in accordance with the requirements of AS 5100.2 with the following exception:
- Where railway traffic is only freight, supports are to be designed to withstand equivalent collision loads of 750 kN parallel to the track and 500 kN perpendicular to the track applied at 2 m above top of rail.

5.3.5 Zone 5

Speed Categories 1, 2 and 3
Suitable buffer stops are to be provided to prevent trains colliding with structures beyond the end of the track. As a minimum, buffer stops are to prevent a low speed collision with the structure.
Unless additional suitable control measures are provided to prevent collision, supporting elements behind buffer stops are to be designed for the same collision load requirements as described above for Zones 1, 2, 3 or 4 for the main-line speed. For example, a support located 4 m behind a buffer stop with a possible main-line speed of 40 km/hr is to be designed to the same requirements as for Zone 2, Speed Category 2.

6.0 COLLISION PROTECTION MEASURES

6.1 New Structures

In addition to the requirements of AS 5100, the following collision protection measures are to be used.

Because of the risk of derailed rollingstock falling down the embankment slope, piers, walls and columns must not be located in or at the bottom of embankment slopes without protection measures being in place.

Queensland Rail may approve the location of suitable control measures, such as one or more of the following:

- guard and splay rails on the track;
- a retaining structure to widen the embankment; or
- piers, walls or columns complying with this Technical Specification.

The location of the appropriate protection measures shall be discussed with Queensland Rail.

The piers, walls or columns are to be smooth-walled, blade piers of heavy construction parallel to the railway track.

Safety refuges are to be:

- provided where the length of pier or wall is greater than 15 m,
- provided where the clearance between the adjacent existing / future track centreline and face of pier / wall is less than 3 m,
- at a maximum spacing of 15 m centres along the pier / wall,
- at least 1.5 m wide by 600 mm deep and 2.2 m high above the adjacent rail level, and
- clearly defined.

6.2 Upgrading Existing Structures

Existing piers and columns which do not satisfy the above requirements are to have deflection walls provided.

Independent deflection walls are to be provided where space permits. Otherwise deflection walls may be integral and are to be a minimum of 3.6 m high, measured from the highest rail level of the adjacent railway track. Queensland Rail will advise on requirements on a case-by-case basis.

Integral deflection walls are to either:

- extend at least 2 m past the end of each pier (or column) in a direction approximately parallel to the railway track, or
- continue past the next pier (or column) if the piers (or columns) are at a clear spacing of less than 4 m.

The extreme ends of integral deflection walls are to taper on the side adjacent to the railway track at 1:6 from 300 mm thick to the full thickness of the deflection wall.

Deflection walls are to be:

- smooth-faced with the face of integral walls extending a minimum of 150 mm beyond the face of the pier (or column) on the side adjacent to the railway track;
- parallel to the railway track,
- constructed of reinforced concrete with a minimum thickness of 450 mm; and
- designed for the appropriate collision loads in this document.

6.3 Additional Requirements for Footbridges

These additional requirements apply to footbridges with a plan area of up to 50 m^2 per span. For larger spans, the design is to be similar to a road overbridge.

6.3.1 Collision Loads from Railway Traffic

Design is to be in accordance with AS 5100, except for collision loads from railway traffic, which are to be as follows.

Supports located within 7.5 m of the track centre-line, and not complying with the redundancy requirements of AS 5100.2, are to be designed to resist the dead load and a single concentrated load (applied as an ultimate design load with a load factor of 1.0) of:

- 2,000 kN applied at a height of 1.2 m above top of rail or
- 500 kN applied at a height of 3 m above top of rail,

whichever produces the more adverse effect at any section along the height of the support pier or column. The concentrated loads above may act in any direction and are not considered to act simultaneously.

If the supports are within a railway platform and are:

- at least 2.5 m clear of the platform edge; and
- 20 m from the end of the platform,

only the 500 kN collision load need apply.

If the supports are located between 7.5 m and 20 m from the track centre-line, a risk analysis is to be carried out to determine the required concentrated collision load, but with a minimum of 500 kN.

6.3.2 Support Details

Supports are to be monolithic blade piers rather than multiple smaller individual columns.

Blade piers (or blade columns) are to be:

- smooth-faced;
- parallel to the railway track; and
- constructed of reinforced concrete with a minimum thickness of 300 mm and a minimum cross-sectional area of 0.6 m^2.

Multiple individual column supports will only be permitted where blade piers are shown to be impracticable, and must:

- be constructed of reinforced concrete with a minimum thickness of 450 mm;
- have a minimum cross-sectional area of 0.25 m^2 for individual columns;
- have a minimum total cross-sectional area of 0.75 m^2 for all columns in the support; and
- be protected by independent deflection walls designed for the collision loads in Section 6.4.1.

Where steel piers or columns are approved in lieu of reinforced concrete supports, they must:

- comprise at least 4 vertical members suitably braced;
- be designed such that any two members may be demolished without collapse of the structure; and
- be protected by independent deflection walls designed for the collision loads in Section 6.4.1.

Independent deflection walls must be:

- smooth faced,
- constructed of reinforced concrete with a minimum thickness of 450 mm,
- a minimum of 3.6 m high from the top of rail if less than 4 m clear of the track centreline, otherwise a minimum height of 2.0 m is to apply, and
- designed for the collision loads in Section 6.4.1.