Civil Engineering Technical Requirement

CIVIL-SR-014

DESIGN OF NOISE BARRIERS ADJACENT TO RAILWAYS

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Initial	22/12/2009		
B	30/09/2010		Rebranded with new disclaimer
C	30/05/2011		MCE replaced with CIVIL, rebranded.

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1.0 INTRODUCTION

Queensland Rail requires noise barriers that provide the necessary sound attenuation, minimise ongoing maintenance, blend aesthetically and consider community issues.

This Technical Requirement details the criteria which must be met by external party designs for noise barriers adjacent to railway property. Reference is made to the following additional Queensland Rail Technical Requirements which must also be satisfied:

- CIVIL-SR-002 *Work in or about Queensland Rail property,*
- CIVIL-SR-003 *Work adjacent to overhead line equipment,* and
- EMS/STD/46/004 *Code of Practice – Railway Noise Management.*

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.

2.0 SCOPE

This Technical Requirement applies to the design of new noise barriers to be constructed as part of developments adjacent to or in close proximity to Queensland Rail property.

3.0 GENERAL CONSIDERATIONS

Noise barriers will not be required for Queensland Rail stations, platforms, car parks, pedestrian access paths parallel and adjacent to the property boundary and other special areas as agreed by Queensland Rail.

Wherever practicable, noise barriers are to be constructed on the fence / property boundary. Any variation is to be decided upon in consultation with Queensland Rail.
If there is a gap between the barrier and the Queensland Rail corridor boundary which cannot be maintained by the adjoining property owner, the area is to be sealed with concrete. Unless agreed by Queensland Rail, no landscaping is required to stabilize the batter / slope or a specific need is identified.

4.0 NOISE REDUCTION REQUIREMENTS

Any noise reduction measures (including noise barriers) required must be assessed and designed to reduce noise to acceptable quantitative levels outlined in any of the following:

- current Queensland Development Code(s) relating to proposed sensitive building(s) within transport corridors,
- transport noise policy contained in the relevant local government's planning scheme used to condition proposed sensitive building(s) near a transport corridor, and
- Queensland Rail's Code of Practice - Railway Noise Management when retrofitting or augmenting the railway network.

Note: A *sensitive building* is generally considered to be for residential, educational or medical purposes. The noise assessment against these acceptable quantitative levels must be carried out by a suitably qualified noise consultant.

In the case of retrofitting or augmenting the railway network, the noise assessment must be accompanied with a report which must be approved by Queensland Rail. In the case of sensitive buildings, the noise assessment must be accompanied by a report verified by at least the responsible building certifier, but often also Queensland Rail.

5.0 SERVICEABILITY REQUIREMENTS

Service life of materials used in noise barriers is to exceed 40 years with minimal maintenance. Maintenance required during the service life is to be for aesthetic purposes only.

Barrier materials must be fire resistant, and must not produce toxic fumes when burnt. On ignition, flames must not spread easily. The ash left from any burnt material must not be toxic or harmful to the environment.

Panels must be vandal resistant and must pass the Impact Load Tests described in Appendix A.

The panel material must not be easily disfigured by scratching with sharp implements.

Noise barriers must have faces which are not climbable. They are to be environmentally safe and aesthetically pleasing.

6.0 DOCUMENTATION

The drawings and design details for each type of barrier are to be supplied to Queensland Rail. All drawings must be certified as complying with this Technical Requirement by a Registered Professional Engineer of Queensland with RPEQ Number shown on the drawings.

A site plan is also to be provided and is to show:

- track location,
- railway corridor property boundaries,
- contours at 200 mm intervals,
- location of proposed noise barriers,

- type / material selected,
- location of access gates,
- special features,
- drainage, and
- buried services

as appropriate.

Note: Service searches must be undertaken prior to commencing design and construction. Information from DBYD alone is not enough.

7.0 STRUCTURAL DESIGN REQUIREMENTS

All noise barrier components must be designed in accordance with the relevant Australian Standard(s) for the material being used. Loading combinations are to be determined from AS/NZS 1170.0, and as specified within this document.

All calculations (including serviceability design) are to be based on material properties at an ambient temperature of 40 °C.

7.1 Wind Loads

Wind loads are to be calculated in accordance with AS/NZS1170.2:

- Ultimate – 1000 year ARI
- Permissible – 100 year ARI
- Serviceability – 20 year ARI

The minimum net pressure coefficient to be used is 1.2.

Attention is drawn to the requirements of Table D2(C) of AS/NZS 1170.2 for end and internal panels, where different pressure coefficient values will be required. Where shown on the drawings, barrier overlaps are not to be classified as end panels.

7.2 Posts

7.2.1 Post Materials

Posts are to be structurally designed Universal Beam (UB) section, unless at a bend or gate. All posts must conform to the relevant Australian Standard(s). Base plates and associated supports are to conform to AS 3678 and AS/NZS 3679.1.

All steel components are to be hot dip galvanised after fabrication in accordance with AS 4680. Damaged areas of galvanising must be made good in accordance with AS 1650.

Timber posts are not to be used.

7.2.2 Post Serviceability Design

The horizontal deflection of the noise barrier post is to be limited to (Height of Barrier)/150 under serviceability wind load.

7.2.3 Post Structural Design

Design of steel components is to be in accordance with AS4100 or AS4600.

Steel posts are to have a minimum section wall thickness of 3 mm.

7.3 Panels

7.3.1 Panel Material

The panel material is to be selected on the basis of acoustic attenuation ability, strength, durability and economy.

Materials must be manufactured in accordance with the relevant Australian Standard(s). If an Australian Standard does not cover the material, full size tests are to be undertaken and certified by a Registered Professional Engineer of Queensland (RPEQ) to prove the material can satisfy the design requirements.

Patterned concrete and fibre composites are the preferred materials for noise barriers. However, plywood panels may be used if agreed to by Queensland Rail.

The panel material must be capable of meeting the following requirements whether above or in contact with the ground:

- Panels are to have a service life of at least 40 years with minimal maintenance. Accelerated testing or other approved methods are to be used to demonstrate the panels will attain the service life specified.
- Panels must be suitable for application of a fire retardant paint to mask graffiti or manufactured from a material that will allow easy removal of graffiti. The process for removal must be environmentally safe and easy to perform.

a) It is preferable to use graffiti-resistant material for the panels.
b) Generally panels are not required to be coated with anti-graffiti paint, except where specified. In these instances, suitable anti-graffiti paint, approved by Queensland Rail must be used.
c) Panels are to be coloured in a way that will not be damaged / faded by graffiti removal, weather or UV light. A texture finish should be of 15 mm depth at maximum.

- The materials comprising the barrier are to be environmentally safe.
- The material must have a surface density of at least 15 kg/$m^{2,}$ to reduce transmitted sound and provide structural integrity.

7.3.2 Concrete & Cementitious Panels

Precast textured concrete panels must have a minimum concrete strength of Grade N40.

The concrete panels must adhere to the *Colour and Texture in Concrete Walling*, Briefing - 03 of Cement & Concrete Association of Australia (C&CCA).

7.3.3 Fibre Composite Panels

Fibre composite materials are to have their suitability and durability verified by relevant

standards or proven by full size testing. The material is to comply with current relevant Australian / overseas standards. Information on the material is to be provided to Queensland Rail for assessment and approval.

7.3.4 Plywood Panels

If the use of plywood panels is agreed to by Queensland Rail, structural design must be in accordance with AS/NZ 2269 and AS/NZ1720.0. The panel minimum surface density of 15 kg/m^2 must be satisfied at a site equilibrium moisture content of (approx. 14%.

Structural plywood is to have a minimum Stress Grade of F14 in accordance with AS/NZS 2269. A surface grade quality of CC or better is required. Permitted imperfections under this grade may be left unfilled as long as they are within the size limitations defined in AS/NZS 2269.

Plywood veneers are to be as free of heart as possible and manufactured from hoop pine.

Plywood panels used on the bottom layer of the barrier wall are to be treated to at least Hazard Level 4. Panels used from the second layer upwards must be treated to at least Hazard Level 3 in accordance with the Timber Utilisation and Marketing Act 1987.

The plywood must be treated with ACQ 2100 or Tanalith E wood preservative chemicals. CCA preservative chemicals must not be used. All plywood panels must be free of treatment sludge deposits.

Each veneer must be treated and seasoned before the veneers are bonded.

The treated plywood is to be seasoned to a moisture content of below 18% before delivery to site. Material supplied above this value will be rejected.
The minimum thickness of plywood panels is to be 27 mm.

Slash pine veneers will not be accepted.

The finish on both sides of the panel is to be textured wood with slim line grooves to reduce checking of the surface.

Edge joints must have a strong polypropylene tongue and groove joining system to help prevent warping and eliminate gaps after shrinkage. The edge strip is to be positively fixed to one panel to ensure the strip does not move with potential vibration of the noise barrier.

Ground level panels are to be at least 400 mm high. The upper most panels are to be positively secured by bolts.

7.3.5 Panel Design

Where the method of construction requires that the top of the barrier be stepped, the Contractor is to build the noise barrier so that the top of the wall is not less than the calculated minimum height, and steps are to be equally incremented in height, as far as possible.

Top panels are to have a rounded edge to deter people walking on it, and also to improve the appearance of the barrier. Any edge capping must be suitably protected against corrosion and have the same life span as the panel.

The bottoms of noise barrier panels are to follow either ground level or an edge strip.

Where the method of construction requires that the bottom of the barrier be stepped, no gaps are to be left as a result of stepping, unless required for drainage purposes. The Contractor is to fill all gaps with concrete or other material approved by Queensland Rail.

The barrier must be continuous and solid with no visible or light gaps between panels. For maximum effectiveness, the barrier is to be continuous down to ground level, with any gaps filled (e.g. as a result of stepping).

If damming of water at the bottom of the barrier is likely, discrete drainage points are to be incorporated into the designs without compromising the barrier's ability to achieve acceptable noise levels. The drainage points must not concentrate water flow.

Panels must have positive fastening devices to deter theft. Connection details are to permit erection and removal of the panels on a regular basis.

Noise barriers located close to tracks, such that vehicles cannot gain access between track and barrier, must consist of panels that can be easily removed and manhandled.

7.3.6 Panel Serviceability Design

The horizontal deflection of the panel under serviceability wind is to be limited to Span/150.

To eliminate the need for electrical earthing, steel components from panel to panel must be insulated from each other.

7.4 Fasteners

Connections must be designed to adequately secure all members for the design loading and allow for panel movement where necessary.

Use of screws will not be permitted.

For connections involving timber components, the bolts, etc. must be retightened when the structure reaches the site equilibrium moisture content.

All bolts, nuts and washers must comply with AS 1111, 1112 and 1237, as appropriate.

All bolts, nuts and washers must be hot dip galvanised with a minimum 50 microns thickness coating in accordance with AS 1214. All washers must be hot dip galvanised in accordance with AS 4680.

Alternative coatings will be considered, provided they have at least the equivalent durability as that specified.

Zinc plated bolts or nails are not acceptable.

7.5 Footings

7.5.1 Footing Type

Footings are preferably to be *"bored"*, but *"block"* footings are allowed if circumstances render boring impractical.

7.5.2 Block Footing

The block footing may be used where one of the following constraints exists:

- access for drilling rig is not practical,
- the ground is not suitable for boring or
- the foundation depth is limited because of an underground service or culvert.

The footing must be designed to prevent instability in overturning, uplift and sliding in accordance with AS/NZS 1170.0 for ultimate loads.

To resist temperature and shrinkage cracking, reinforcement of not less than 500 mm^2/m in each direction must be used in exposed surfaces.

The top of the footing is to be at least 300 mm below ground level.

7.5.3 Bored Footing

The bored footing is to be used where access is available and the ground is suitable for boring.

The designer is to use the Broms method (refer to Appendix B) to calculate footing depth. Footing depth is to be increased by an appropriate factor (at least 1.5) if the footing is less than 1.5 m from the edge of an embankment or cutting.

It is to be assumed that existing cuttings within Queensland Rail property will be widened to within 1.0 m of the property boundary. The minimum depth of footing is to be twice the footing diameter.

7.5.4 Finish

The top of the footing must be shaped to shed water away from the post.

7.6 Protective Painting of Steel Posts and Footings

After post installation, a neat, continuous, water-based, bituminous paint *"collar"* is to be applied on every post up to 150 mm above the finished concrete footing level. This collar is to extend onto the adjacent concrete surface of the footing for a minimum 100 mm from any point on the post.

8.0 CONSTRUCTION TOLERANCES

Tolerances are only permitted in order to cater for variations caused during manufacture and construction.

The following tolerances are to apply to the construction of the noise barriers.

TABLE 1 – TOLERANCES

CRITERIA	TOLERANCE
Depth of footing	+ 200 mm - 50 mm
Centre to centre distance between posts	+ 10 mm - 10 mm
Thickness of noise barrier panels	+ 5 mm - 1 mm
Posts: Variation from vertical	5 mm/m for isolated posts Parallel for adjoining posts
Protective treatment of timber	In accordance with this document and TUMA
Hot dip galvanizing: structural members	Coating thickness of 80 microns min. in accordance with AS4680

9.0 ASSOCIATED COSTS INCURRED BY QUEENSLAND RAIL

All of Queensland Rail's costs associated with the review, design and construction of the noise barriers and the implementation of Queensland Rail's Technical Requirements will be charged to the building owner or its agent. This includes any remedial work necessary to Queensland Rail property as the result of this work and any accidental damage, as well as costs associated with train delays. Rates will be set by Queensland Rail.

APPENDIX A: IMPACT TEST FOR NOISE BARRIER PANELS

Noise Barrier Panels must be able to withstand the following Impact Test.

The test panel is to be subjected to impact energy of 150 Joule, consisting of four (4) load repetitions of an impactor. This is to simulate a concerted attack by vandals.

The impactor is to be manufactured from steel of density 7.8 t/m^3 and spherical in shape.

An impact energy of 150 Joule is achieved by dropping the impactor from a specific height, H (in mm) onto the horizontal test panel. The impactor is raised so that its centre of gravity is at height, H which is calculated from the equation:

$$H = \frac{15300}{m}$$

where H = Drop Height in millimetres
m = Mass of Impactor in kilograms

For solid panels, the point of impact is typically at mid-span and 150 mm from the free edge or in a location to give the worst effect. If the panel consists of boards that have internal voids, the point of impact must be mid-span and centrally between the internal stiffeners of the outermost board. Where applicable, the panel must not weigh more than the maximum allowable weight defined in the Technical Requirement.

The panel is considered to have passed the test if it remains serviceable after the four load repetitions. That is, it will still perform its function as a noise barrier and can withstand its design load without shortening its service life.

The results of the test are to be certified by a Registered Professional Engineer of Queensland (RPEQ).

APPENDIX B: BROMS METHOD FOR BORED FOUNDATIONS

An acceptable method for the design of footing depth is based on Brom's theory as follows.

Applicable case is short pile in cohesive soils.

$$F = \frac{H_u}{9 \times S_u \times D}$$

$$M_{max} = H_u \times (E + 1.5D + 0.5F)$$

$$G = \sqrt{\left(\frac{M_{max}}{2.25 \times S_u \times D} \right)}$$

$$L = 1.5D + F + G$$

Where:

D = **Diameter of footing (m)**

E = **Height of barrier / 2 (m)**

F = ***Depth to zero shear point minus 1.5*D (m)***

G = ***Depth of footing minus F minus 1.5*D (m)***

H_u = **Ultimate lateral shear (kN)**

L = **Depth of footing (m)**

M_{max} = **Maximum ultimate lateral bending moment in footing (kN.m)**

S_u = **Factored undrained shear strength of soil (kPa)**

