

Superseded

Technical Specification

**Transport and Main Roads Specifications
MRTS15 Noise Fences**

July 2017

Superseded

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1 Introduction

This Technical Specification applies to the design and construction of noise fences.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms used in this Technical Specification shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications*.

Where used in this Technical Specification, "TUMA" shall mean the *Timber Utilisation and Marketing Act*.

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AS 1111.1	<i>ISO metric hexagon bolts and screws – Product Grade C – Bolts</i>
AS 1112.3	<i>ISO metric hexagon nuts – Product Grade C</i>
AS 1214	<i>Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)</i>
AS 1237.1	<i>Plain washers for metric bolts, screws and nuts for general purposes - General plan</i>
AS 1237.2	<i>Plain washers for metric bolts, screws and nuts for general purposes - Tolerances</i>
AS 1288	<i>Glass in building – Selection and installation</i>
AS 1366.2	<i>Rigid cellular plastics sheets for thermal insulation – Part 2: Rigid cellular polyisocyanurate (RC/PIR)</i>
AS 1366.3	<i>Rigid cellular plastics sheets for thermal insulation – Part 3: Rigid cellular polystyrene - Moulded (RC/PS-M)</i>
AS 1720.1	<i>Timber Structures – Design Methods</i>
AS 2082	<i>Timber – Hardwood – Visually stress-graded for structural purposes</i>
AS 2209	<i>Timber – Poles for overhead lines</i>
AS 2334	<i>Steel nails - Metric series</i>
AS 2858	<i>Timber - Softwood - Visually stress-graded for structural purposes</i>
AS 3566.1	<i>Self-drilling screws for the building and construction industries – General requirements and mechanical properties</i>
AS 3600	<i>Concrete structures</i>
AS 3818.11	<i>Timber – Heavy structural products – Visually graded Part 11: Utility poles</i>
AS 4100	<i>Steel structures</i>
AS 4506	<i>Metal finishing – Thermoset powder coatings</i>

Reference	Title
AS 5604	<i>Timber – Natural durability ratings</i>
AS ISO 11654	<i>Acoustics – Rating of sound absorption – Materials and systems</i>
AS/NZS 908.2	<i>Cellulose-cement products – Part 2: Flat sheets</i>
AS/NZS 1170.2	<i>Structural design actions - Wind actions</i>
AS/NZS 1252	<i>High strength steel bolts with associated nuts and washers for structural engineering</i>
AS/NZS 1594	<i>Hot-rolled steel flat products</i>
AS/NZS 1605.2	<i>Methods for sampling and analysing timber preservatives and preservative-treated timber – Determination of preservative penetration by spot tests</i>
AS/NZS 1664.1	<i>Aluminium structures – Part 1: Limit state design</i>
AS/NZS 1734	<i>Aluminium and aluminium alloys – Flat sheet, coiled sheet and plate</i>
AS/NZS 1748	<i>Timber - Mechanically stress-graded for structural purposes</i>
AS/NZS 1866	<i>Aluminium and aluminium alloys – Extruded rod, bar, solid and hollow shapes</i>
AS/NZS 1867	<i>Aluminium and aluminium alloys – Drawn tubes</i>
AS/NZS 1874	<i>Aluminium and aluminium alloys – Ingots and castings</i>
AS/NZS 2208	<i>Safety glazing materials in buildings</i>
AS/NZS 2269	<i>Plywood – Structural – Specifications</i>
AS/NZS 2908.2	<i>Cellulose-cement products Flat sheet</i>
AS/NZS 4600	<i>Cold-formed steel structures</i>
AS/NZS 4680	<i>Hot-dip galvanized (zinc) coatings on fabricated ferrous articles</i>
AS/NZS 1580.601.1	<i>Paints and related materials – Methods of test – Colour – Principles of colour measurement</i>
AS/NZS ISO 717.1	<i>Acoustics – Rating of sound insulation in building and of building elements – Part 1: Airborne sound insulation</i>
ASTM C158 - 02	<i>Standard Test Methods for Strength of Glass by Flexure (Determination of Modulus of Rupture)</i>
ASTM E111 - 04	<i>Standard Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus</i>
ASTM E424 - 71	<i>Standard Test Methods for Solar Energy Transmittance and Reflectance (Terrestrial) of Sheet Materials</i>
Broms Theory	Broms, B. B. "Lateral Resistance of Piles in Cohesive and Cohesionless Soils". ASCE Journal of the Soil Mechanics and Foundations Division 90, No. SM2 and SM3, 1964
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS04	<i>General Earthworks</i>
MRTS15	<i>Noise Fences</i>
MRTS50	<i>Specific Quality System Requirements</i>
MRTS70	<i>Concrete</i>
MRTS71	<i>Reinforcing Steel</i>

Reference	Title
MRTS72	<i>Manufacture of Precast Concrete Elements</i>
MRTS73	<i>Manufacture of Prestressed Concrete Members and Stressing Units</i>
MRTS78	<i>Fabrication of Structural Steelwork</i>
MRTS79	<i>Fabrication of Aluminium Components</i>
MRTS88	<i>Protective Coating for New Work</i>
I.S. EN 1794-2	<i>Road Traffic Noise reducing devices – Non-acoustic performance, Part 2: General safety and Environmental Requirements</i>
I.S. EN 1999-1-4	<i>Eurocode 9 - Design of Aluminium structures – Part 1 – 4: Cold-formed structural sheeting</i>
I.S. EN ISO 178	<i>Plastics – Determination of flexural properties</i>
I.S. EN ISO 527-2	<i>Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics</i>
I.S. EN ISO 4892-1	<i>Plastics – Methods of Exposure to Laboratory Light Sources – Part 1: General Guidance</i>
I.S. EN ISO 4892-3	<i>Plastics – Methods of Exposure to Laboratory Light Sources – Part 3: Fluorescent UV Lamps</i>
I.S. EN ISO 7823-1	<i>Plastics – Poly(methyl methacrylate) sheets – Types, dimensions and characteristics – Part 1: Cast Sheets</i>
I.S. EN ISO 7823-2	<i>Plastics – Poly(methyl methacrylate) sheets – Types, dimensions and characteristics – Part 2: Extruded Sheets</i>
I.S. EN ISO 11963	<i>Plastics – Polycarbonate Sheets – Types, dimensions and characteristics</i>
I.S. EN ISO 13468-2	<i>Plastics – Determination of the total luminous transmittance of transparent materials – Part 2: Double – beam instrument</i>
SD1602	<i>Fencing - Chainwire fences and gates</i>
TUMA	<i>Timber Utilisation and Marketing Act</i>

4 Quality system requirements

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 4.

Table 4 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
5	1. Alternative products		
7.1	2. Permission to use noise fence design		Submission of design
7.1.3.1	3. Impact resistance		
7.9.2	4. “Brush” blasting of galvanised panels		
8.2	5. Clearing and trimming of trees		
8.4	6. Treatment of cut plywood		

Clause	Hold Point	Witness Point	Milestone
8.6		1. Excavation of footings	
9.1.1		2. Selection of samples for testing	
9.1.1	7. Assessment of preservative penetration and retention in an independent laboratory		
9.1.5	8. Supply of certification of the construction of plywood sheeting and supply of test results for plywood prior to erection		
9.2.1	9. Supply of certification of the construction of cementitious and sandwich panels and supply of test results for both cementitious and sandwich panels prior to erection		
9.3.1	10. Supply of test results and warranty statement of transparent safety sheeting		

5 Registered proprietary products

Transport and Main Roads maintains a register of pre-approved proprietary products for noise fences.

The requirements for noise fence construction for the items listed in Table 5 include the use of Transport and Main Roads registered suppliers and products.

Table 5 – Items requiring use of Transport and Main Roads registered suppliers and products

Clause	Category of Work
7.1.5	Acoustic seals
7.5, 7.6, 7.7, 7.8, 7.9, 7.10, 7.11	Panels (Plywood, Concrete, Cementitious, Sandwich, Steel, Aluminium, Transparent)
8.4	Preservative treatment of cut plywood above ground

Registered products are listed in Clause 1 of Annexure MRTS15.1. Alternative products may be submitted to the Administrator for approval prior to their use. **Hold Point 1**

For information regarding approval of suppliers and products for above items refer to the 'Approved products and registered suppliers' on the Transport and Main Roads website www.tmr.qld.gov.au/business-industry/Business-with-us/Approved-products-and-suppliers/Traffic-engineering-and-road-safety-approved-products.aspx

6 Removal and salvage of existing noise fence

6.1 General

Clause 6 describes the work to be carried out where an existing noise fence is to be removed and/or salvaged under the Contract.

6.2 Components to be salvaged

Sections and components of noise fence to be salvaged are detailed in Clause 2.1 of Annexure MRTS15.1.

6.3 Location of storage site

Salvaged items shall be transported to the storage site nominated in Clause 2.2 of Annexure MRTS15.1.

6.4 Demolition

Noise fence components that are to be removed and/or salvaged under the Contract shall be dismantled and removed with minimum damage to the components regardless of the original construction method.

Footings shall be demolished to a minimum of 0.5 m below ground level and the depression backfilled in accordance with MRTS04 *General Earthworks*. Hollow post sections shall be filled with 'lean mix' concrete.

Salvaged materials shall be directly transported, such that no damage is incurred, to the storage site.

Salvaged materials shall be neatly stacked at the storage site on suitable timber packers.

The remainder of the existing noise fence including non-salvageable materials shall be demolished and disposed of in accordance with MRTS04 *General Earthworks*. Non-salvageable materials include connectors, and all miscellaneous items, e.g. acoustic seals, etc.

Any materials that have been damaged during the salvage operation shall be rejected. The Contractor shall replace or reimburse the Principal for materials damaged during salvage.

7 Design

7.1 General

A noise fence normally consists of foundation elements and posts with interchangeable panel units placed between.

Typical details for noise fences are found online in Transport and Main Roads Standard Drawings (www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Standard-drawings-roads/Roadworks-drainage-culverts-and-geotechnical.aspx#FencingAndNoiseBarriers).

Noise fences shall have adequate strength, durability, acoustical parameters, constructability and maintenance to satisfy the requirements and intentions of the Contract, including this Technical Specification, and be environmentally safe and aesthetically pleasing.

In general, noise fences are not required to withstand vehicle impact. Vehicle impacts may be prevented either by using a road safety barrier system or by providing adequate distance from the road.

Engineering structure/s (retaining walls, bridges, road safety barriers etc.) supporting or anchoring a noise fence shall be structurally adequate to withstand the superimposed load from the noise fence.

The maximum distance between posts for standard noise fences shall be:

- a) 5.00 m, and
- b) on an engineering structure 2.5 m.

The detailed drawings on Transport and Main Roads plan sheets in accordance with the Transport and Main Roads Drafting and Design Presentation Standards (<https://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Drafting-and-design-presentation-standards>) and design calculations of the noise fences shall be submitted to Transport and Main Roads. **Milestone**

The drawings shall show the plan, both longitudinal and cross sections of noise fences, location of all footings and design details and shall clearly state a design wind speed. Drawings shall be certified as complying with this Technical Specification by a Registered Professional Engineer, Queensland with RPEQ number shown on the drawings.

Any variation in the vertical alignment of the noise fence shall be shown in longitudinal section on the drawings. Where noise fence sections are stepped in height, the dimensions between steps (i.e. between the top of noise fences) shall be consistent as far as possible and acceptable to the Administrator utilising equal increments or multiples of even increments with maximum increment of 200 mm.

The termination of a noise fence should be treated as a design feature with a higher level of design finish. The height should be gradually reduced at a maximum gradient of 1:8 to a minimum end height of 1.8 m with a maximum of 500 mm step in height, to integrate within the surrounding site.

Construction of noise fences shall not commence until the Contractor has been granted permission to use the noise fence design. **Hold Point 2**

Any specific material types required to be incorporated into the Contract are set out in Clause 3 of Annexure MRTS15.1.

If any material is not covered in this Technical Specification, detail structural design in accordance with relevant Australian or International Standards or recognised design methods and full size load tests are to be undertaken to prove the material can satisfy the design requirements of this Technical Specification.

7.1.1 Design requirements

7.1.2 Design life

The design life of noise fences shall be 40 years with minimal maintenance, except for those constructed from transparent safety panels. The design life for transparent safety panels shall be 10 years with minimal maintenance.

7.1.3 Vandal resistance

7.1.3.1 Impact resistance

Noise fence panels shall be able to withstand the impact of a 4 kg steel ball dropped from a height of three metres when the panel is supported horizontally above the ground.

A test panel shall be supported at the ends with a similar edge distance to that used in service. The test panel shall be the worst case of span and width to be used in service.

The impact shall cause only superficial scratches and marks on the panel. The depth of permanent deformation considered to be acceptable is 4 mm within a circle of 20 mm diameter.

The testing shall be performed in the presence of the Administrator. **Hold Point 3**

7.1.3.2 Resistance to being defaced

Noise fences shall exhibit durable properties taking into account such possibilities as:

- a) defacement by sharp implements (e.g. a knife), and
- b) ignition by cigarettes or similar.

7.1.3.3 Detachment of panels

Noise fence panels shall not become detached from their supports or fixings when subjected to a combination of the ultimate wind load, and the most unfavourable combination of the allowable tolerances on the manufacture of panels and construction of a noise fence.

7.1.4 Rattle

Noise fences shall not rattle in any breeze or wind. A durable material shall be placed between all components so that no audible noise emanates from the noise fences.

7.1.5 Acoustic seal

An acoustic seal shall be provided in any gaps in a noise fence.

Acoustic seals shall be one of the Transport and Main Roads registered products (refer Clause 5).

7.1.6 Wind loading

Design loads on noise fences shall be in accordance with AS/NZS 1170.2, unless modified below:

- a) wind speeds shall be based on Table 3.1 of AS/NZS 1170.2 using the following average recurrence intervals (ARI)
 - I. ultimate – 1000 year ARI, and
 - II. serviceability – 20 year ARI
- b) Terrain Refer to Clause 4.1 of Annexure MRTS15.1
- c) Region B or C as defined in Clause 4.2 of Annexure MRTS15.1. Region B shall be used where no region is specified. Region A of AS/NZS 1170.2 shall be defined as Region B for the purpose of this Technical Specification
- d) M_s 1.0
- e) M_t Refer to Clause 4.3 of Annexure MRTS15.1.

Where noise fences are within four metres of the road edge line, the design shall include an additional load of 0.65 kPa representing dynamic suction imposed by moving vehicles for serviceability wind. For noise fences greater than 4.0 m high, the suction load shall only be applied to the lower 4.0 m.

Attention is drawn to the specific requirements of Table D2 of AS/NZS 1170.2 for end panels (i.e. 0 to 2h) and internal panels.

7.1.7 Load combinations

A factor of 1.25 shall be applied to dead load for ultimate load combinations.

7.1.8 Acoustic

7.1.8.1 General

There shall be no gaps in any part of the noise fence unless the gap is required for surface drainage at ground level. To prevent gaps at the ground level forming due to subsidence, an embedded sill beam will be necessary for some panels on ground.

Noise fence panels shall be either reflective or absorptive type materials.

The noise fence panels shall have a Weighted Sound Reduction Index (R_w) not less than 25.0 in accordance with AS/NZS ISO 717.1.

7.1.8.2 Absorptive type

An absorptive type noise fence absorbs a significant percentage of sound energy when facing the road. An absorptive type noise fence can be absorptive on one or both sides of panel materials.

In addition to the minimum R_w requirements in Clause 7.1.8.1, the following properties shall apply to absorptive type noise fences:

- a) the Weighted Sound Absorption Coefficient (α_w) of the noise fence panel shall not be less than 0.8 measured and calculated in accordance with AS ISO 11654
- b) between 0 mm and 500 mm above the ground, the noise fence shall not be absorptive panel.

7.1.8.3 Reflective type

A reflective type noise fence reflects most sound energy when facing the road. A reflective type noise fence can be reflecting on both sides or absorbing one or both sides panel materials.

In addition to the minimum R_w requirements in Clause 7.1.8.1, reflective type noise fence panels must have a minimum surface density at air dry moisture content (excluding structural components) of 15 kg/m².

7.2 Steel posts

7.2.1 General

Steel posts shall comply with the requirements stated in Clauses 7.2.1 to 7.2.4, inclusive.

7.2.2 Materials

Materials used in the manufacture of steel posts shall be in accordance with materials referenced in AS 4100 or AS/NZS 4600 and the minimum wall thickness of 4 mm.

All fabrication shall be in accordance with the requirements of MRTS78 *Fabrication of Structural Steelwork*. All mild steel components shall be hot-dip galvanised after fabrication in accordance with the requirements of AS/NZS 4680.

Post elements in contact with soil shall be provided with an additional corrosion protection system approved by the Administrator.

The top of closed section steel posts shall be covered by a capping plate, which shall be held in place with a continuous fillet weld. The capping plate shall completely seal the top of the post. Any vent hole provided for hot-dip galvanising shall be on the vertical face of the erected post and prior to erection, shall be filled with silicon compatible with galvanised steel.

The minimum of 180UB16 section shall apply when panel is placed inside a flange.

The fence label and post number shall be identified by welding on the fence post or other method approved by the Administrator.

7.2.3 Serviceability design

The horizontal deflection of the post under serviceability wind shall be limited to:

Height of Fence

150

7.2.4 Structural design

Design strength of steel components shall be in accordance with AS 4100 or AS/NZS 4600.

7.3 Timber posts

7.3.1 General

Timber posts shall be preservative treated either softwood or hardwood and shall comply with the requirements stated in Clauses 7.3.1 to 7.3.6 inclusive.

7.3.2 Materials

All preservative treated softwood/hardwood shall be supplied at a moisture content of 20% or below before use.

Softwood structural posts shall be unseasoned Strength Group S5, or better and shall be:

- a) sawn softwood graded to Stress Grade F11 in accordance with AS 2858, or
- b) round softwood poles graded to Stress Grade F11 in accordance with AS 3818.11.

Hardwood structural posts shall be unseasoned Strength Group S5, or better and shall be:

- a) sawn hardwood graded to Stress Grade F11 in accordance with AS 2082, and
- b) Durability Class 1 in accordance with AS 5604.

7.3.3 Serviceability design

The horizontal deflection of the post under serviceability wind shall be limited to:

Height of Fence

160

7.3.4 Structural design

Structural design shall be in accordance with AS 1720.1.

The minimum of 100 mm dimension section sizes shall apply to the design.

7.3.5 Performance requirements

All structural posts shall be treated to Hazard Level 5 (H5) with a proprietary preservative approved under TUMA.

Following treatment, all timber posts shall be stacked outside with strip spacers (not block stacked) for a minimum of four weeks prior to usage to:

- a) enable proper fixation of the preservative salts, and

- b) partially season to lower the moisture content, thereby reducing the capacity of the treated timber to cause severe corrosion on metal fixings.

The surfaces of all timber posts shall be free of treatment sludge deposits when the posts are supplied.

Posts shall be supplied to the Site with a nail plate covering a minimum of 80% of each end.

End grain of posts exposed to weather shall be protected by a solid capping or shall be slope cut and an end sealant applied.

On delivery all preservative treated material purporting to comply with this Technical Specification shall be branded in accordance with the requirements of TUMA.

Approved preservative treatments for timber are given in 'Approved Preservative Treatment Notification' issued by the Chief Executive under TUMA.

7.3.6 Sampling and acceptance

Timber posts shall be sampled and tested as stated in Clause 9. Acceptance shall be as stated in Clause 9.

7.4 Timber panels

7.4.1 General

All panel timbers, including planks and battens, shall be preservative treated either softwood or hardwood and shall comply with the requirements stated in Clauses 7.4.1 to 7.4.6, inclusive.

Timber panels shall conform to the requirements of reflective type fences in Clause 7.1.8.3.

Painting of panels shall be in accordance with MRTS88 *Protective Coating for New Work*.

7.4.2 Materials

7.4.2.1 General

All preservative treated softwood / hardwood shall be supplied at a moisture content range of 8% – 18%. Material supplied outside this range will be rejected.

7.4.2.2 Planks

Planks shall be approximately 150 mm wide and shall have a minimum thickness of 25 mm.

Shiplapped planks shall have a minimum lap/rebate of 20 mm so that spring of the plank will not affect the acoustic performance of the noise fence. Double planks shall have a minimum lap of 25 mm and the length shall be limited to 2000 mm. Top edge capping, suitably protected against corrosion, shall be attached to the top of the upper panel section.

Softwood planks shall be visually graded to Structural Grade No. 5 and Stress Grade F5 or better in accordance with AS 2858 and the hardwood planks shall be visually graded to Structural Grade No. 4 and Stress Grade F7 or better in accordance with AS 2082, with the following overriding limitations:

- a) individual knots (sound, tight, or partial bark encased) shall not exceed one third of the width of the face
- b) knot holes shall not exceed 20 mm in diameter (as visible after assembly of panels), and no more than two knot holes shall be present in any one cladding board

- c) heart-in material shall:
 - i. not exceed 20% of the cross-sectional area
 - ii. not extend from face to face, and
 - iii. not contain pith
- d) termite galleries shall not be present, and
- e) decay shall not be present.

All knot holes shall be filled with silicon compatible with timber.

Hardwood planks shall be Durability Class 2 or better in accordance with AS 5604.

Timber panels are the least preferred panel materials for noise fences even despite their low cost, ease of construction, natural aesthetic appeal, and ready availability. The common problems associated with timber physical characteristics are shrinkage, deterioration, warping, moisture content, quality control by installers, and discoloration around fasteners. These characteristics negatively affect the acoustic performance, unobtrusive and increase the need for ongoing maintenance. Any opening in a noise fence due to shrinkage, warping, splitting, weathering and design or construction faults can decrease the acoustic performance and can seriously compromise the overall performance of a noise fence. Timber panels need replacement after as little as two years, depending on design and quality of material and construction. The acoustic properties of timber panels are less than those of more solid materials. Timber panels are useful on domestic scale, away from the road along property boundaries.

7.4.2.3 Battens

Structural sawn softwood shall be Stress Grade F5 or better, and either machine stress graded in accordance with AS/NZS 1748, or visually graded in accordance with AS 2858, with the overriding limitations given in Clause 7.4.2.2.

Hardwood battens shall be Durability Class 2 or better in accordance with AS 5604.

The cross-sectional dimensions of battens shall be not less than 70 mm x 35 mm. The maximum spacing of intermediate battens shall be 900 mm for shiplapped profile planks. For double planks noise fences, the maximum spacing for horizontal battens shall be 800 mm.

7.4.3 Serviceability design

The horizontal deflection of the timber panel under serviceability wind shall be limited to:

Span of Panel

65

7.4.4 Structural design

Timber fence panels shall be designed in accordance with AS 1720.1.

7.4.5 Performance requirements

Any softwood or hardwood structural timber not in contact with the ground shall be treated to at least Hazard Level 3 (H3) as specified in TUMA. Any softwood or hardwood structural timber in contact with

the ground shall be treated to Hazard Level 4 (H4) as specified in TUMA. The treatment shall be a proprietary preservative approved under TUMA and a proprietary water repellent that penetrates the timber to the same degree as the preservative.

The surfaces of all timber panels shall be free from treatment sludge deposits.

On delivery all preservative treated material purporting to comply with this Standard shall be branded in accordance with the requirements of TUMA.

Approved preservative treatments for timber are given in 'Approved Preservative Treatment Notification' issued by the Chief Executive under TUMA.

7.4.6 Sampling and acceptance

Timber panels shall be sampled and tested as stated in Clause 9. Acceptance shall be as stated in Clause 9.

7.5 Plywood panels

7.5.1 General

Plywood panels shall be preservative treated either softwood or hardwood and shall comply with the requirements stated in Clauses 7.5.1 to 7.5.6, inclusive.

Plywood panels shall conform to the requirements of reflective type fences in Clause 7.1.8.3.

Plywood panels shall be one of the Transport and Main Roads registered products (refer Clause 5).

Painting of panels shall be in accordance with MRTS88 *Protective Coating for New Work*.

7.5.2 Materials

7.5.2.1 Plywood

Structural plywood shall be Stress Grade F14 or better in accordance with AS/NZS 2269.

The grade of veneer on the face and back of panels shall be CC or better in accordance with AS/NZS 2269. Permitted imperfections under this grade may be left unfilled as long as they are within correct size limitations. Plywood veneers shall be as free of heart as possible.

The grade of all core veneers shall be Quality D or better in accordance with AS/NZS 2269.

Plywood panels shall incorporate a proprietary mechanical system that restricts differential movement of the panels. The system shall conform to the service life requirements of the Contract. Edge joints shall have a strong polypropylene tongue and groove jointing system to help prevent warpage and eliminate gaps if movement occurs. The edge strip shall be glued to one panel to ensure that the strip does not move with vibration of the noise fence. Top edge capping, suitably protected against corrosion, shall be attached to the top of the upper panel section.

The plywood shall have a minimum thickness of 25 mm.

The bottom sheet of plywood shall be at least 450 mm high and the top sheet of plywood shall be 1200 mm high.

Plywood shall be supplied kiln dried with a moisture content between 8% and 18%. The finish on both sides of the panel shall be textured wood with slimline grooves to reduce checking of the surface.

After preservative treatment, the dimensions and shape of the plywood shall conform to AS/NZS 2269 criteria.

Plywood panels are generally more durable than timber panels as the strong polypropylene tongue and groove jointing system helps to prevent warping and eliminate gaps. They can be used in a modular system.

7.5.2.2 Battens

Battens shall conform to the requirements of Clause 7.4.2.3.

The batten in cross-section shall not be less than 70 x 35 mm.

A minimum of one batten (mid-span of the panel) shall be provided.

7.5.3 Serviceability design

The horizontal deflection of the panel under serviceability wind shall be limited to:

Span of Panel

65

7.5.4 Structural design

Structural design shall be in accordance with AS/NZS 2269 and AS 1720.1.

7.5.5 Performance requirements

The preservative treatment shall be either veneer treatment or treatment in the final form (envelope).

Plywood panels not in contact with the ground shall be treated to Hazard Level 3 (H3) as specified in TUMA. Only panels that are veneer treated to Hazard Level 4 (H4) as specified in TUMA shall be used for panels in contact with the ground.

For veneer treatment, each veneer shall be treated with a proprietary preservative approved under TUMA. A proprietary water repellent shall be applied to all external surfaces of the plywood panel in the factory, not each veneer.

For treatment in the final form (envelope), panels shall be treated with a proprietary preservative approved under TUMA and a proprietary water repellent that penetrates the plywood to the same degree as the preservative.

Adequate time shall be allowed for fixation of the preservative in the plywood veneers before the panels are kiln dried.

If a plywood panel is to be painted following or before erection, it shall not be treated with proprietary water repellent.

The surfaces of all plywood panels shall be free from treatment sludge deposits.

Untreated material exposed on cutting shall be treated in accordance with Clause 8.4.

On delivery all preservative treated material purporting to comply with this Standard shall be branded in accordance with the requirements of TUMA.

Approved preservative treatments for timber are given in 'Approved Preservative Treatment Notification' issued by the Chief Executive under TUMA.

7.5.6 Sampling and acceptance

Plywood panels shall be sampled and tested as stated in Clause 9. Acceptance shall be as stated in Clause 9.

7.6 Concrete panels

7.6.1 General

Concrete panels shall comply with the requirements stated in Clauses 7.6.1 to 7.6.8, inclusive.

Concrete panels shall be either precast concrete or prestressed concrete panels.

Concrete panels shall conform to the requirements of reflective type fences in Clause 7.1.8.3.

Concrete panels shall be one of the Transport and Main Roads registered products (refer Clause 5).

Concrete panels shall be designed for handling and transport loads equivalent to 50% of the self weight in addition to self weight.

Painting of panels shall be in accordance with MRTS88 *Protective Coating for New Work*.

7.6.2 Materials

7.6.2.1 Concrete

Concrete shall be in accordance with MRTS70 *Concrete* unless specified otherwise in Clause 7.6.3.

7.6.2.2 Reinforcing steel

Reinforcing Steel shall be in accordance with MRTS71 *Reinforcing Steel*.

7.6.3 Cover

The cover requirements shall conform to the requirements of AS 3600. Normal conditions shall have an exposure classification of B1.

7.6.4 Manufacture of precast concrete panels

Manufacture of precast concrete panels shall be in accordance with MRTS72 *Manufacture of Precast Concrete Elements*.

7.6.5 Manufacture of prestressed concrete panels

Manufacture of prestressed concrete panels shall be in accordance with the relevant requirements of MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units*.

7.6.6 Serviceability design

The horizontal deflection of the panel under serviceability wind shall be limited to:

Span of Panel

150

7.6.7 Structural design

Design of concrete components shall be by:

- a) calculation in accordance with AS 3600, or
- b) a recognised test method subject to acceptance by the Administrator. As a minimum, the testing shall satisfy the requirements of Appendix B of AS 3600.

7.6.8 Sampling and acceptance

Concrete panels shall be sampled and tested as stated in Clause 9. Acceptance shall be as stated in Clause 9.

7.7 Cementitious panels

7.7.1 General

Cementitious panels shall comply with the requirements stated in Clauses 7.7.1 to 7.7.7, inclusive.

Cementitious panels shall conform to the requirements of reflective type fences in Clause 7.1.8.3.

Cementitious panels shall be one of the Transport and Main Roads registered products (refer Clause 5).

Cementitious panels shall be designed for handling and transport loads equivalent to 50% of the self weight in addition to self weight.

Painting of panels shall be in accordance with MRTS88 *Protective Coating for New Work*.

7.7.2 Materials

7.7.2.1 General

Cementitious panels are defined as having a cement based binder and a filler and do not conform to the requirements of AS 3600. Cementitious material is consisting of general purpose or blended cement blended with one or more fly ash, ground granulated iron blast-furnace slag and silica fume.

7.7.2.2 Cementitious materials

Cementitious materials shall conform to the requirements of Clauses 7.1 to 7.6 of MRTS70 *Concrete*.

7.7.2.3 Reinforcing steel

Reinforcing steel shall conform to the requirements of MRTS71 *Reinforcing Steel*. Minimum reinforcement shall be 5 mm bars at 150 mm centres on each face.

All reinforcement shall be hot-dip galvanised in accordance with AS/NZS 4680.

7.7.3 Cover

The cover to reinforcement shall be sufficient to conform to serviceability and structural design criteria.

7.7.4 Formwork removal

Formwork shall not be removed until the cementitious material has attained 60% of the specified 28 day characteristic strength.

7.7.5 Serviceability design

The horizontal deflection of the panel under serviceability wind shall be limited to:

Span of Panel

150

All panels in contact with the ground shall be coated with bitumen to the extent of the inground contact.

7.7.6 Structural design

Design of cementitious components shall be by either:

- a) a recognised design method.

In addition to the requirements of the design method, the design shall satisfy the intent of AS 3600 for:

- i. anchorage at the support
 - ii. restraint of compression reinforcement if the compression reinforcement is used in calculating the bending strength
 - iii. minimum shrinkage steel requirements, and
 - iv. crack control requirements of slabs, or
- b) a recognised test method subject to acceptance by the Administrator. In addition, the testing shall satisfy the intent of Appendix B of AS 3600.

7.7.7 Sampling and acceptance

Cementitious panels shall be sampled and tested as stated in Clause 9. Acceptance shall be as stated in Clause 9.

7.8 Sandwich panels

7.8.1 General

Sandwich panels shall comply with the requirements stated in Clauses 7.8.1 to 7.8.7, inclusive.

Sandwich panels shall conform to the requirements of reflective type fences in Clause 7.1.8.3.

Sandwich panels shall incorporate a proprietary mechanical system that restricts differential movement of the panels. The system shall conform to the service life requirements of the Contract and eliminate air gaps if movement occurs.

Top and bottom edge capping, suitably protected against corrosion, shall be attached to the top of the upper and bottom section of noise fence and the vertical edges shall be protected system approved by the Administrator.

Sandwich panels shall be one of the Transport and Main Roads registered products (refer Clause 5).

Sandwich panels shall be designed for handling and transport loads equivalent to 50% of the self weight in addition to self weight.

Painting of panels shall be in accordance with MRTS88 *Protective Coating for New Work*.

7.8.2 Materials

7.8.2.1 General

Sandwich panels are defined as having a low density core bonded between two relatively thin faces.

7.8.2.2 Faces

Facing materials shall be either plywood conforming to the requirements of Clause 7.5 or fibre reinforced composite material conforming to the requirements of AS/NZS 2908.2 and acceptance by the Administrator.

7.8.3 Core

Core materials shall be either rigid cellular polyisocyanurate (RC/PIR) conforming to the requirements of AS 1366.2 and having a minimum density of 30 kg/m³, or rigid cellular expanded polystyrene (EPS) conforming to the requirements of AS 1366.3 and having a minimum density of 11 kg/m³.

7.8.4 Adhesive

Adhesive material shall be phenolic or similar material type that maintain its adhesive properties for extreme long-term exposure to weather or wet or damp conditions and/or long-term structural performance without glueline breakdown or glueline failure and acceptable to the Administrator.

The bond between the face and core shall continue over the whole area of the sheet.

7.8.5 Serviceability design

The horizontal deflection of the panel under serviceability wind shall be limited to:

Span of Panel

150

7.8.6 Structural design

Design of sandwich panel shall be by a recognised design method and test method subject to acceptance by the Administrator. In addition, the testing shall satisfy the intent of Appendix B of AS 3600.

7.8.7 Sampling and acceptance

Sandwich panels shall be sampled and tested as stated in Clause 9. Acceptance shall be as stated in Clause 9.

7.9 Steel panels

7.9.1 General

Steel panels shall be either hot-dip galvanised or weather-resistant steel panels.

Absorptive and reflective steel panels shall comply with the requirements stated in Clauses 7.9.1 to 7.9.4, inclusive.

Steel panels shall conform to the requirements of absorptive type fences in Clause 7.1.8.2 or the requirements of reflective type fences in Clause 7.1.8.3.

Steel panels shall incorporate a proprietary mechanical system that restricts differential movement of the panels. The system shall conform to the service life requirements of the Contract and eliminate air gaps if movement occurs.

Steel panels (absorptive and reflective) shall be one of the Transport and Main Roads registered products (refer Clause 5).

Painting of hot-dip galvanised panels shall be in accordance with MRTS88 *Protective Coating for New Work*.

7.9.2 Materials

All steel components shall have a minimum thickness of 1.0 mm.

Materials used in the fabrication of absorptive panels shall be in accordance with AS 4100 and AS/NZS 4600.

Materials used in the fabrication of reflective panels shall be:

- a) in accordance with AS 4100 and AS/NZS 4600 for hot dipped galvanised steel, or
- b) in accordance with AS/NZS 1594 Grade HW350 for weather-resistant steel.

All fabrication shall be in accordance with MRTS78 *Fabrication of Structural Steelwork*.

Hot-dipped galvanised steel panels shall be galvanised in accordance with the requirements of AS/NZS 4680. Both sides of the galvanised surface shall be "brush" blasted to reduce glare prior to erection, **Hold Point 4** "Brush" blasting shall be in accordance with AS/NZS 4680.

Any sound insulation shall be covered on the absorbent side with glass fleece to protect from water, rain or road spray. The sound insulation shall be hydrophobic, free of materials promoting corrosion and resistant to light, weathering, salting and rotting. Protective films may not be used. The sound insulation shall retain dimensional stability even after ageing, and maintain their reference position.

Steel panels shall not come in contact with the ground. A concrete sill beam, 100 mm (minimum) above the ground surface shall be provided to conform to the requirements of Clause 8.8.

7.9.3 Serviceability design

The horizontal deflection of the panel under serviceability wind shall be limited to:

Span of Panel

150

7.9.4 Structural design

Structural design of both reflective and absorptive panels shall comply with the requirements of AS 4100 and AS/NZS 4600.

7.10 Aluminium panels

7.10.1 General

Absorptive and reflective aluminium panels shall comply with the requirements stated in Clauses 7.10.1 to 7.10.4, inclusive.

Aluminium panels shall conform to the requirements of absorptive type fences in Clause 7.1.8.2 or the requirements of reflective type fences in Clause 7.1.8.3.

Aluminium panels shall incorporate a proprietary mechanical system that restricts differential movement of the panels. The system shall conform to the service life requirements of the Contract and eliminate air gaps if movement occurs.

Aluminium panels (absorptive and reflective) shall be one of the Transport and Main Roads registered products (refer Clause 5).

7.10.2 Materials

All aluminium components shall have a minimum thickness of 1.0 mm.

Materials used in the manufacture of absorptive and reflective panels shall be in accordance with AS/NZS 1734, AS/NZS 1866, AS/NZS 1867 and AS/NZS 1874.

All fabrication shall be in accordance with MRTS79 *Fabrication of Aluminium Components*.

Aluminium panels shall be protected against maximum corrosion to show minimal deterioration in general appearance by means of 60 µm nominal thickness of polyester powder stove enamel or polyurethane wet paint with forced oven drying in accordance with the requirements of AS 4506.

Any sound insulation shall be covered on the absorbent side with glass fleece to protect from water, rain or road spray. The sound insulation shall be hydrophobic, free of materials promoting corrosion and resistant to light, weathering, salting and rotting. Protective films may not be used. The sound insulation shall retain dimensional stability even after ageing, and maintain their reference position.

Aluminium panels shall not come in contact with the ground. A concrete sill beam, 100 mm (minimum) above the ground surface shall be provided to conform to the requirements of Clause 8.8.

Aluminium panels shall be separated from timber, concrete, steel, copper and copper alloys by means of appropriate insulating layers.

7.10.3 Serviceability design

The horizontal deflection of the panel under serviceability wind shall be limited to:

Span of Panel

150

7.10.4 Structural design

Structural design of absorptive panels shall comply with the requirements of I.S. EN 1999-1-4.

Structural design of reflective panels shall comply with the requirements of either AS/NZS 1664.1 or I.S. EN 1999-1-4.

7.11 Transparent panels

7.11.1 General

Transparent panels shall be either toughened laminated safety glass or thermoplastic safety panels.

Thermoplastic safety panels shall be either acrylic or polycarbonate.

The panels shall comply with the requirements stated in Clauses 7.11.1 to 7.11.5 inclusive.

Transparent safety panels shall conform to the requirements of reflective type fences in Clause 7.1.8.3.

Transparent safety panels may be subjected to a change in physical properties due to the effect of environmental exposures. In the case of thermoplastic safety panels, transparency must not be visibly reduced during the useful design life. In order to improve resistance to environmental degradation and abrasion, they must either have added stabiliser or be surface-coated. Consequently, it is necessary to evaluate transparent safety panels in an "as new" condition and after accelerated ageing to the equivalent 10 years.

Special conditions apply to transparent noise fences:

- a) in public areas to ensure they remain intact when accidentally impacted
- b) on bridges and elevated structures to ensure that no dangerous shards are created when the transparent panel is impacted by an errant vehicle

- c) in areas where light reflection is a potential hazard, to ensure to minimise risks resulting from possible light reflection from the transparent panels, and
- d) in areas where birds frequently fly to ensure prevention of bird collisions against the transparent panel and to ensure that such measures have no adverse effect on the performance and maintenance of the transparent panel.

Transparent panels shall be evaluated as a system consisting of panel, gasket, and restraint/support system and shall specify the source of all components for the panels, including gasket source.

Transparent safety panels shall be one of the Transport and Main Roads registered products (refer Clause 5).

7.11.2 Materials

7.11.2.1 Toughened Laminated Safety Glass

Toughened Laminated Safety Glass shall conform to AS/NZS 2208 and satisfy the following criteria:

- a) two or more layers of equal thickness of toughened safety glass permanently bonded together by one or more sheets of polyvinyl butyral or equivalent type interlayer with a minimum thickness of 1.52 mm, and Modulus of Elasticity of 24.1 MPa and Poisson's Ratio of 0.50 at 20°C
- b) heat soaked
- c) Grade A to AS/NZS 2208
- d) optical transmission and strength properties as per Table 7.11.2.1, and
- e) no mottling and Colour Rating less than two to AS/NZS 1580.601.1 at the end of the 10 year period when exposed to weather conditions existing in Queensland.

Table 7.11.2.1 – Optical and strength properties of Toughened Laminated Safety Glass

Property	Testing Standard	Minimum value	
		As new	After 10 years
Light Transmission	ASTM E424	85%	80%
Modulus of Elasticity	ASTM E111	69 GPa	69 GPa
Tensile Strength	ASTM C158	19 MPa	19 MPa
Flexural Strength	ASTM C158	140 MPa	140 MPa

7.11.2.2 Acrylic

Material used in the manufacture of acrylic panels shall comply with the requirements of I.S. EN ISO 7823-1 or I.S. EN ISO 7823-2 and satisfy the following criteria:

- a) manufactured from 100% virgin poly methyl methacrylates (PMMA), using processes which may include with up to 5% colorants, UV absorbers and pigments. Polyamide threads shall be embedded in processes for sites (a) and (b) specified in Clause 7.10.1
- b) Grade A to AS/NZS 2208
- c) optical transmission and strength properties as per Table 7.11.2.2, and

- d) no mottling and Colour Rating less than two to AS/NZS 1580.601.1 at the end of the 10 year period when exposed to weather conditions existing in Queensland.

Table 7.11.2.2 – Optical and strength properties of acrylic

Property	Testing Standard	Minimum value	
		As new	After 10 years
Light Transmission	I.S. EN ISO 13468-2	90%	85%
Modulus of Elasticity	I.S. EN ISO 527-2	2900 MPa	2600 MPa
Tensile Strength	I.S. EN ISO 527-2	65 MPa	50 MPa
Flexural Strength	I.S. EN ISO 178	100 MPa	80 MPa

7.11.2.3 Polycarbonate

Material used in the manufacture of polycarbonate panels shall comply with the requirements of I.S. EN ISO 11963 and satisfy the following criteria:

- manufactured from 100% bisphenol A (BPA) using phosgene free processes with up to 5% colorants, UV absorber and processing aids up to a total of 5% and adhered permanently on both sides with a continuous polymeric sheet
- Grade A to AS/NZS 2208
- optical transmission and strength properties as per Table 7.11.2.3, and
- no mottling and Colour Rating less than two to AS/NZS 1580.601.1 at the end of the 10 year period when exposed to weather conditions existing in Queensland.

Table 7.11.2.3 – Optical and strength properties of polycarbonate

Property	Testing Standard	Minimum value	
		As new	After 10 years
Light Transmission	I.S. EN ISO 13468-2	80%	73%
Modulus of Elasticity	I.S. EN ISO 527-2	2100 MPa	1800 MPa
Tensile Strength	I.S. EN ISO 527-2	55 MPa	45 MPa
Flexural Strength	I.S. EN ISO 178	90 MPa	80 MPa

The selection of suitable transparent materials involves consideration of vandalism, accessibility by the public and probability of graffiti. Remote locations are more likely to be subject to vandalism than populated areas. Although glass possesses excellent light transmittal, resistance to chemicals, strength and ease of cleaning, it is more prone to breaking or shattering through vandalism than acrylic or polycarbonate. Both acrylic and polycarbonate can become brittle, yellowed and less solid due to ageing process. Acrylic is stronger than polycarbonate with better light transmittal and excellent environmental stability, but it is easily scratched. Polycarbonate is the most vandal resistant transparent material available. However it is more susceptible to abrasion and discoloration than glass or acrylic. Therefore hard coating shall be applied to polycarbonate. In the majority of applications, acrylic panels will not shatter but instead break into large dull pieces. Acrylic is more established internationally for noise fences than polycarbonate.

7.11.2.4 Gaskets

All gaskets shall be neoprene or EPDM with the following material properties:

- a) hardness = 70°–75° Shore 'A', and
- b) elongation at break = 200% minimum.

7.11.3 Serviceability design

7.11.3.1 Optical properties

Transparent panels shall conform to the requirements of Appendix E and F of I.S. EN 1794–2, for Light Reflection and Transparency respectively.

7.11.3.2 Serviceability deflection

The horizontal deflection of the toughened laminated safety glass panel under serviceability wind shall be limited to:

Span of Panel

80

The horizontal deflection of the acrylic or polycarbonate safety panel under serviceability wind shall be limited to:

Span of Panel

70

However, the maximum horizontal deflection for all transparent safety panels under serviceability wind shall be 50 mm, but it shall never exceed:

- a) 33 mm when pedestrian areas and the edge line of the road are more than four metres from the panel, or
- b) 20 mm where the panel is within four metres of pedestrian areas and the edge line of the road.

7.11.3.3 Bending stress

Toughened laminated safety glass panels and acrylic or polycarbonate safety panels shall have a maximum bending stress of 30 MPa and 6 MPa respectively under serviceability wind.

7.11.4 Structural design

7.11.4.1 General

This Technical Specification applies only to flat panels supported on:

- a) 4 sides, or
- b) 3 sides and bent on the top side, or
- c) 3 sides and no bend on the top side, or
- d) 2 sides, or
- e) 2 sides and bent on both top and bottom side.

Curved sheets are outside the scope of this Technical Specification.

The structural behaviour of panels is heavily influenced by the support method. The Contractor shall demonstrate that the behaviour of the supports conforms to the support fixing assumed by the designer.

Steel fastenings through panels shall be avoided.

7.11.4.2 Design criteria

The panel shall not dislodge with the requirements stated in Clause 7.1.3.3.

Structural design of toughened laminated safety glass panels shall be in accordance with AS 1288.

Structural design of acrylic or polycarbonate safety panels shall be a recognised design method.

7.11.5 Sampling and acceptance

Transparent panels shall be sampled and tested as stated in Clause 9. Acceptance shall be as stated in Clause 9.

7.12 Connectors

7.12.1 General

Connectors shall comply with the requirements stated in Clauses 7.12.1 to 7.12.5, inclusive.

7.12.2 Bolts, nuts, screws and washers

All bolts, nuts, screws and washers shall be in accordance with AS 1111.1, AS 1112.3, AS 1237.1, AS 1237.2 and AS/NZS 1252, as appropriate. All bolts, nuts and screws shall be hot-dip galvanised in accordance with AS 1214. All washers shall be hot-dip galvanised in accordance with AS/NZS 4680.

7.12.3 Self-drilling screws

7.12.3.1 Steel member

Screws used to connect a noise panel to steel shall be:

- a) ST 6.3 (No. 14) Type CSD Point Hexagon washer head self-drilling screws; or
- b) ST 6.3 (No. 14) Type ASD Point Hexagon washer head screw (self-drilling or non-self-drilling) utilising a 5.8 mm diameter pilot hole within the steel, manufactured in accordance with AS 3566.1.

Screws shall have a minimum of 40 micron hot-dip galvanising or 50 micron mechanical/chemical galvanised corrosion protection over the length of the screw. The manufacturer's test certificate shall be provided to the Administrator.

7.12.3.2 Timber member

Screws used to connect a noise panel to timber shall be ST 6.3 (No. 14) Type 17 Point Hexagon washer head screws with 10 threads per inch, manufactured in accordance with AS 3566.1 and shall have a minimum of 40 micron hot-dip galvanising or 50 micron mechanical/chemical galvanised corrosion protection over the length of the screw. Washers for screws shall be moulded with EPDM Polymer. The manufacturer's test certificate shall be provided to the Administrator.

7.12.4 Nails

Nails shall be used only when connecting timber panels together.

All nails shall be minimum 2.8 mm diameter flathead nails in accordance with AS 2334 and shall have a minimum of 50 micron hot-dip galvanising in accordance with AS 1214.

7.12.5 Structural design

All connections shall be designed to adequately secure all members for the design loading.

7.13 Footings

7.13.1 General

Footings shall preferably be circular bored pile, but spread footings are allowed if circumstances render drilling impractical.

Footings shall comply with the requirements stated in Clauses 7.13.1 to 7.13.5 inclusive.

Footings shall be designed for both ultimate and serviceability limit states. Serviceability limit requirements shall be in accordance with Table 8.10.

Footings shall be designed based on site-specific geotechnical investigation parameters.

Steel posts shall be located at 100 mm (nominal) from the bottom of the footing.

The base of timber posts shall be placed on a 100 mm (nominal) layer of gravel, to prevent ponding of water at the base of the post.

All footing designs shall be certified by a Registered Professional Engineer, Queensland.

7.13.2 Materials

7.13.2.1 Concrete

Concrete in footings shall be in accordance with MRTS70 *Concrete*.

Concrete in circular bored pile footings shall be N25/20, minimum.

Concrete in spread footings shall be S32/20 minimum.

7.13.2.2 Reinforcing steel

Reinforcing steel shall be in accordance with MRTS71 *Reinforcing Steel*.

7.13.2.3 Foundation material

The design strength of the subsoil encountered during the geotechnical investigation shall be used for the footing design. Factored short-term undrained shear strength and factored effective angle of internal friction shall be considered for cohesive and cohesionless soils respectively. Both factored short-term undrained shear strength and the effective angle of friction shall be the characteristic undrained shear strength and the angle of internal friction divided by a Factor of Safety of 1.5. For both cases the characteristic shear strength and the angle of internal friction shall be the smaller of the average value over a depth equal to the proposed noise fence height or a depth equivalent to 1.5 times of the proposed noise fence height.

A design undrained shear strength of no more than 50 kPa can be assumed for engineered fill subject to acceptance by the Administrator.

7.13.3 Cover

Concrete cover shall be in accordance with AS 3600.

7.13.4 Circular footings

7.13.4.1 General

The Contractor shall include in the drawings details of the proposed footing locations and depths.

The depth of footings shall be not less than the larger of 1.5 times the footing diameter and 1500 mm.

The minimum diameter of a circular footing shall be 450 mm.

7.13.4.2 Footing depth on flat terrain

The acceptable method for estimation of ultimate lateral capacity of minimum footing depth design is based on Broms Theory.

Estimation of the serviceability lateral deflection of footing is based on the subgrade reaction approach or the elastic continuum approach or alternative methods accepted by the Administrator.

7.13.4.3 Footing depth on batters

For batters, where the noise fence is less than 4.0 metres high and the post is within five times the footing diameter of the batter point, the depth of footing on flat terrain shall be adjusted for the effect of the batter in accordance with Table 7.13.4.3. These factors may be changed where a detailed geotechnical assessment has been undertaken.

All noise fence footing designs shall be certified by a Registered Professional Engineer, Queensland.

Table 7.13.4.3 – Adjustment factors for 450 mm diameter footing on batters

Slope of Batter (V:H)	Footing Depth for well compacted embankment
Flat – 1:5	As for flat ground
1:5 – 1:3	1.25 x footing depth for flat ground
1:3 – 1:2	1.5 x footing depth for flat ground
> 1:2	Specialist design required

7.13.5 Spread footings

The Contractor shall include in the drawings details of the proposed locations and dimensions of the spread footing.

Spread footings shall be designed for a maximum bearing pressure of 100 kPa under serviceability wind.

Design of concrete components shall be in accordance with AS 3600.

8 Construction of noise fence

8.1 General

Noise fences shall be constructed in accordance with the details shown on the drawings.

The noise fence shall be vertical and continuous with no visible air gap between components.

8.2 Clearing and trimming of trees

Clearing and trimming of trees and disturbance to surrounding ground are to be minimised. No clearing or trimming of trees shall be carried out unless detailed in the Drawing. **Hold Point 5**

8.3 Disposal of treated timber waste

All treated timber or plywood off-cuts/waste shall be removed from Site daily and disposed of as per local government requirements. Treated timber or plywood shall not be burnt.

8.4 Treatment of cut plywood

Where an envelope treated plywood panel is cut on Site 100 mm or more from an edge of a sheet, the cut area shall be treated with one of the Transport and Main Roads registered products (refer Clause 5) **Hold Point 6** applied as per the manufacturer's requirements. The applied product shall be completely dry before incorporation into the noise fence works.

Alternatively, the cut plywood panels shall be retreated in accordance with Clause 7.5.5.

Products used for the treatment of cut plywood shall be Transport and Main Roads registered products (refer Clause 5). **Hold Point 6** Plywood panels in contact with the ground shall be veneer treated and such cut plywood will then not have to be retreated. Plywood panels off the ground shall be treated with a product registered for preservative treatment of cut plywood.

8.5 Battens

Battens shall be fixed to the noise fence panel within five days of the panel being erected.

8.6 Footings

The Contractor shall carry out all necessary excavations for footings. **Witness Point 1**

Posts shall be set in the concrete footing truly vertical and to the dimensions shown on the drawings. The entire top of the concrete footing shall not be lower than ground level and be shaped such that water flows away from the post.

Posts on earth mounds or on batters shall have a 1.0 m minimum berm between the posts and the top of batter to provide for footing protection, prevention of gaps below the fence, and access for construction and maintenance.

A minimum of 45 mm concrete cover shall be provided from the edge of the footing to the post.

Concrete footings shall be a minimum of three days of age prior to fixing the panels.

Between five and seven days after placement of the concrete footing, a compatible silicon sealant shall be placed completely around the interface of a timber post and the concrete footing, to seal cracks due to shrinkage.

8.7 Batter restoration

Where excavation for foundations on, or adjacent to the batter face results in some over-break of the batter face, the over-break of the batter face shall be backfilled in accordance with the requirements of MRTS04 *General Earthworks*, so that the backfill around the foundations is flush with the adjoining batter surface.

8.8 Sill beam

The concrete sill beam shall be connected to the ground and the posts to ensure the acoustic properties and the drainage performances are not impeded. Concrete sill beam height varies with design requirements. Depending on the design requirements, the concrete sill beam shall be either plain concrete or reinforced concrete. Sill beams shall be constructed as detailed on the drawings.

Concrete sill beams are not necessary for concrete panel noise fences.

Concrete shall be Class N25/20, in accordance with MRTS70 *Concrete* and the reinforcing steel shall be in accordance with MRTS71 *Reinforcing Steel*.

8.9 Drainage slots

Drainage slots shall be integrated with the sill beam to ensure that the noise fence does not impede natural drainage flow paths. Drainage slots shall be constructed at low points along the noise fence, and at the minimum intervals nominated on the drawings. The internal dimensions and effective cross sectional area of the drainage slot shall not reduce the acoustic performance of the noise fence. Drainage slots shall be constructed as detailed on the drawings.

Unless detailed on the drawings, where a defined drainage path crosses under the noise fence, a minimum two drainage slots shall be provided. The drainage slots shall be provided separately in adjoining noise fence panels. One slot shall be located directly over the drainage path, and the other slot shall be provided as close as possible in level to the first slot.

The concrete slab at drainage slots shall be finished flush with the finished ground level, and shall be shaped to suit the natural contours of the surrounding ground. Concrete shall be Class N25/20, in accordance with MRTS70 *Concrete*.

8.10 Tolerances

The tolerances specified in Table 8.10 shall apply to the construction of the noise fences.

Tolerances are permitted to cater for variability caused during manufacture and construction only.

Table 8.10 – Allowable tolerances

Criteria	Tolerance
Depth of footing	+ 200 mm - 0 mm
Diameter of footing	+ 150 mm - 0 mm
Centre-to-centre distance between posts for panels supported on the outside of the post	+ 50 mm - 200 mm
Centre-to-centre distance between posts for panels supported between the posts	+ 10 mm - 0 mm
Thickness of timber, plywood, concrete, cementitious and sandwich panels	+ 5 mm - 1 mm
Height and span of panel (excluding transparent safety panels)	+ 10 mm - 5 mm
Maximum out-of-verticality of posts	10 mm at any height (maximum)

Criteria	Tolerance
Maximum out-of-verticality of panels	2 mm/metre
Protective treatment of timber	Refer to Clause 9
Cover to reinforcement	Refer to MRTS71 <i>Reinforcing Steel</i>
Tendon exit holes and formwork end plates	± 2 mm
Tendon location along panel	± 5 mm
Horizontal alignment	± 50 mm over 3 posts
Hot-dipped galvanising	Refer to AS/NZS 4680
Centre-to-centre distance between supports of transparent safety panels	± 10 mm
Thickness of extruded toughened laminated safety glass panels	± 0.5 mm
Thickness of cast toughened laminated safety glass panels	+ 15% - 0%
Thickness of acrylic or polycarbonate panels	+ 0.5 mm
Height and span of toughened laminated safety glass panels	± 5 mm
Height and span of acrylic or polycarbonate panels	+ 9 mm - 0 mm
Bottom of clamp angle surface clearance	± 50 mm

8.11 Noise fences at property boundaries

Where an existing property boundary fence requires removal to facilitate construction of the noise fences, the Contractor shall:

- a) remove and dispose of existing fences, walls, footings and other obstructions for a distance of one metre inside the property or lesser distance as may be possible to allow construction of the noise fence
- b) backfill excavations/holes associated with work carried out in (a) above
- c) perform ground surface treatment including:
 - i. supplying, placing and compacting fill material in holes and localised depressions, and
 - ii. adjusting the moisture content of insitu material and compacting material below the existing ground surface
- d) reinstate side fences to new noise fence including supply of any materials similar to the side fences
- e) supply, erect, dismantle and remove temporary fencing
- f) reinstate facilities temporarily removed to facilitate construction of the noise fence, and
- g) where pools/ponds exist within property, the noise fence shall comply with the pool safety legislation.

If there is any damage to the property including gardens, pools, sheds, lawns, mulching, retaining walls, trees, shrubs, paths drainage and other fixtures and features, the property shall be reinstated to the original condition.

8.12 Temporary security fencing

Where the existing property boundary fence requires removal to facilitate construction of the noise fences, the Contractor shall liaise with property owners and occupants regarding the location of temporary fencing. The alignment of the temporary fence shall be approved by the property owners.

Temporary security fencing shall be man-proof and a minimum of 1.8 m high chain wire fencing. Materials shall be as shown on Standard Drawing 1602 (www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Standard-drawings-roads/Roadworks-drainage-culverts-and-geotechnical.aspx#FencingAndNoiseBarriers).

The Contractor may use "removable concrete shoes" in lieu of the permanent concrete footings shown on Standard Drawing 1602, provided that the temporary security fence is securely fixed in position and adequately tied down against storm damage.

Temporary fencing shall be erected prior to the removal of the existing fences or noise fences in order to maintain the security and protection of private properties and the occupants, pets or livestock. The temporary fence shall be located approximately 1 m offset inside the private property where possible. The alignment of the fence shall deviate to avoid fixed objects and trees.

A shade cloth or equivalent shall be installed on the inside face of the temporary security fence to provide visual privacy to the occupants.

The temporary fencing shall only be removed upon completion of the noise fence, or property being secured otherwise by permanent fencing. During the progress of the Works, the Contractor shall dismantle and re-erect temporary fencing as necessary to maintain the security of private properties and the occupants. On completion of the Works, all temporary fencing shall be dismantled, removed from Site and disposed of by the Contractor.

Temporary fencing shall comply with the pool safety legislation.

9 Sampling and acceptance

9.1 Timber and plywood

9.1.1 General

All preservative treated material purporting to comply with this Technical Specification shall be sampled to determine compliance. The Contractor shall order sufficient extra material to obtain samples for testing.

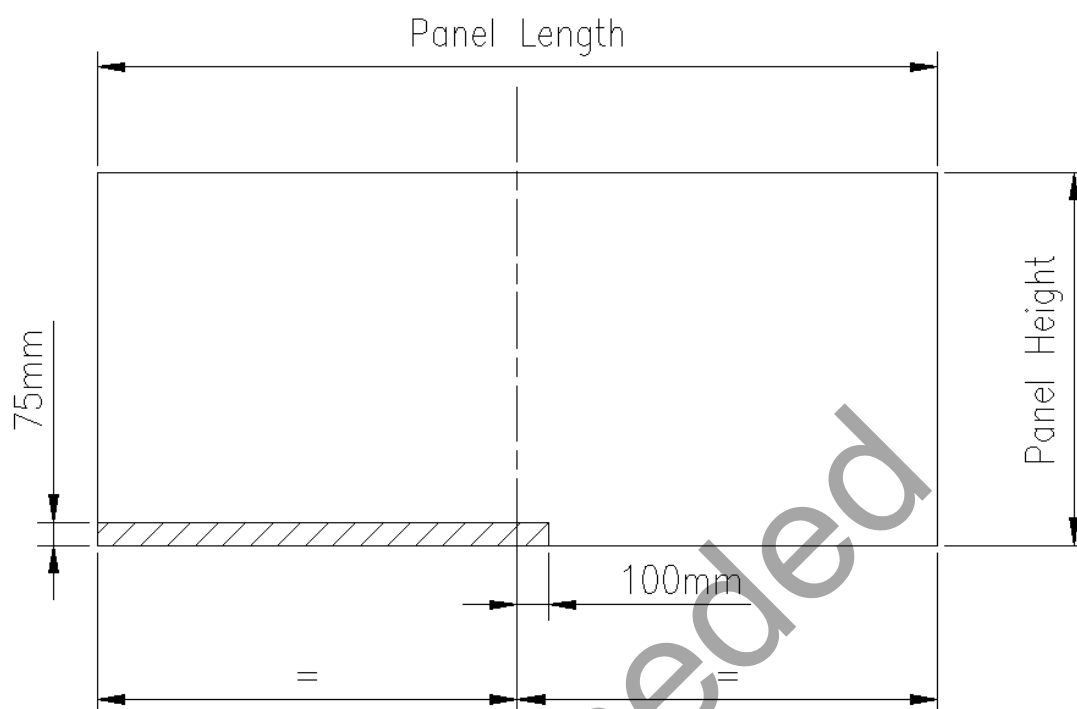
The Contractor shall give the Administrator not less than 24 hours notice of when sample selection is to occur. **Witness Point 2** For the purpose of this Technical Specification, a lot is defined as the timber and plywood of the same size from one supplier that has been treated in the same chemical treatment charge.

The number of pieces to be sampled and tested by the Contractor shall be 5% of a lot. Where there is less than 20 pieces in a lot, a minimum of one piece shall be tested.

Timber or plywood to be tested shall be randomly selected from a lot. In the case of solid timber, swatches shall be at least 600 mm long and include the end of a piece. In the case of plywood, the

test piece shall be sampled as illustrated by the hatched area in Figure 9.1.1 with the cut faces clearly identified.

Figure 9.1.1 – Area to be sampled when testing plywood



Assessment of preservative penetration and retention shall be undertaken in an independent laboratory. **Hold Point 7**

9.1.2 Reporting requirements

In addition to the reporting requirements of AS/NZS 1605.2, all test certificates shall include the following information for each sample tested:

- supplier's sample identification
- test element
- test result for each element (% of each chemical for retention and 'Satisfactory/Unsatisfactory' for Sapwood and Heartwood penetration)
- overall Test Outcome (Pass or Fail TUMA), and
- TUMA requirements for each Hazard Level tested.

9.1.3 Penetration requirements

Samples shall be tested for preservative penetration. Assessment of preservative penetration shall be in accordance with either of the methods specified in Clauses 1.7.1 or 1.7.2 of AS/NZS 1605.2. Failure to pass the penetration requirements of TUMA will be deemed to be a "failure" for that lot.

The lot shall be rejected if less than 95% of the samples pass the penetration requirements of TUMA.

9.1.4 Retention requirements

9.1.4.1 General

Subject to the preservative retention meeting all requirements set out in this Technical Specification it will be accepted or rejected on a statistical basis using the results of tests as set out below.

A lot shall be rejected on the basis of preservative retention if either of the following apply:

- a) any preservative retention test result is less than 90% of the minimum preservative retention specified in TUMA for that Hazard Class, or
- b) the average preservative retention of any three samples from the lot is less than the minimum preservative retention specified in TUMA for that Hazard Class.

In addition, where 10 or more samples of a particular lot fail these conditions, the lot shall be rejected if the average preservative retention level of all the tests for the job is less than:

$$0.5(P_{\text{Min}} + P_{\text{Target}})$$

where:

P_{Min} = TUMA minimum preservative retention level

P_{Target} = Target preservative retention level (Refer Clause 9.1.4.2)

9.1.4.2 Target preservative retention level

The minimum target preservative retention level shall be calculated from the equation:

$$P_{\text{Target}} = P_{\text{Min}} + 1.65 s$$

Where, s = standard deviation of all the results for the job.

Where adequate plant records are available, the current standard deviation for the similar preservative retention levels may be used but it shall not be less than $0.08 P_{\text{Min}}$.

Where adequate plant records are not available an estimated value of standard deviation shall be used which is not less than $0.12 P_{\text{Min}}$ or greater than $0.20 P_{\text{Min}}$ depending on the degree of quality control nominated.

9.1.5 Acceptance of timber and manufacture of plywood

Prior to erection of any preservative treated materials, the Contractor shall supply certification of the timber and manufacture of the plywood sheeting and a copy of all test results to the Administrator.

Hold Point 8

9.2 Concrete panels, cementitious panels, sandwich panels and concrete footings

The Contractor shall carry out sufficient testing to ensure that all concrete panels, cementitious panels, sandwich panels and concrete footings constructed under the Contract comply with the requirements of this Technical Specification.

Process requirements shall be checked during and after the construction operation, as relevant.

Sampling and acceptance of concrete shall be in accordance with MRTS70 *Concrete* except that the minimum rate of sampling shall be:

- a) 2 cylinders per day where the production rate exceeds 5 m^3 per day, and
- b) 2 cylinders per two days where the production rate is equal to or less than 5 m^3 per day.

9.2.1 Acceptance of manufacture of cementitious and sandwich panels

Prior to erection, the Contractor shall supply certification of manufacture of cementitious and sandwich panels, a copy of all test results including structural properties and the fully dimensioned fabrication and installation details of cementitious and sandwich panels to the Administrator. **Hold Point 9**

The manufacture of cementitious and sandwich panels will be audited by an Auditor acceptable to the Administrator. The Auditor shall ensure that the manufacture is working as stated in their system requirements and the system confirm to the requirements of Transport and Main Roads contracts.

9.2.2 Warranty of sandwich panels

The Contractor shall provide to the Administrator a Performance Warranty Statement from the sandwich panel manufacturer. The warranty shall cover the complete sandwich panel, including all components thereon, and shall guarantee the sandwich panel against any defects except for accidental damage or vandalism caused by failure of the components for the design life from the date of manufacture. Responsibility for failure shall be limited to poor workmanship, use of unapproved materials and inappropriate use of approved materials.

9.3 Transparent safety panels

The Contractor shall carry out sufficient testing to ensure that the transparent safety panels comply with the requirements of this Technical Specification. If any detectable transmission occurs in the UV region of the spectrum (200 – 350 nm) by simple UV / visible spectrophotometry testing, the acrylic or polycarbonate panel shall be rejected for further testing.

Sampling and acceptance for transparent safety panels shall be in accordance with Table 9.3.

Table 9.3 – Sampling requirements for transparent safety panels

Test	Frequency
Height and span of panel:	
Extruded sheet	1 in 50 sheets
Cast Sheet	1 in 2 sheets
Thickness of panel:	
Extruded sheet	Every 100 m of production (min. of 1 sample per project)
Cast Sheet	Every sheet
Optical transmission and strength properties	1 in 100 sheets

After successful screening, the sample of the acrylic or polycarbonate panel material shall be subject to artificial weathering, that is, exposed to accelerated UV radiation, moisture, atmospheric pollution and cleaning and maintenance procedures, in a NATA-recognised weatherometer. The accelerated environmental exposures included the following is derived from the guidelines given in I.S. EN ISO 4892-1 and I.S. EN ISO 4892-3:

- UV irradiation of 550 W/m² to 800 W/m² in the wavelength range of 290 nm to 800 nm
- UV exposure at elevated temperature of 60°C with high humidity and condensation temperature of 40°C with moisture

- UV exposure consisting of four hour irradiation periods followed by four hour condensation periods
- UV exposure irradiation period of 3500 hours and
- Chemical exposure to cleaning and graffiti removal products.

9.3.1 Acceptance of manufacture of transparent safety panels

Prior to erection of any transparent safety panels, the Contractor shall supply a copy of all test results and warranty statement, as stated in Clause 9.3.2 to the Administrator. **Hold Point 10**

Sufficient quantity of UV stabilisers present in the acrylic panel and polycarbonate panel protected on both sides by both a UV-absorbing coating and a hard top-coat will be acceptable.

9.3.2 Warranty

The Contractor shall provide to the Administrator a Performance Warranty Statement from the transparent safety sheet manufacturer. The transparent safety panel shall remain in good condition except for accidental damage or vandalism for the period specified in Clause 7.11. Good condition is defined as:

- a) no evidence of cracking, crazing, peeling, delamination blistering, chalking, wrinkling, bubbling, or edge shrinkage greater than 2 mm, and
- b) no evidence of visible or visual defects, inclusions or faults that can be seen from a moving vehicle under normal or night driving conditions by a driver with normal vision.

10 Supplementary requirements

The requirements of MRTS15 *Noise Fences* are varied by the supplementary requirements given in Clause 5 of Annexure MRTS15.1.

Superseded