

Technical Specification

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

November 2025

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1 Introduction

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

Noise fences are constructed on Engineering structures (retaining walls, bridges, road safety barriers etc.) and earth mound are included in this Technical Specification, but entire Engineering structures and earth mound are not.

Noise Fence whose primary function is to act as earth retaining structures are not included in this Technical Specification. However, incidental earth retaining functions have been taken into consideration.

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 are as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications*.

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 1111.2	<i>ISO metric hexagon bolts and screws – Product Grade C - Screws</i>
AS 1112.3	<i>ISO metric hexagon nuts – Product Grade C</i>
AS 1237.1	<i>Plain washers for metric bolts, screws and nuts for general purposes - General plan</i>
AS 1237.2	<i>Tolerances for fasteners - Washers for bolts, screws and nuts - Product grades A, C and F</i>
AS 1288	<i>Glass in buildings – 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>

Reference	Title
AS 1397	<i>Continuous hot-dip metallic coated steel sheet and strip – Coatings of Zinc and zinc alloyed with aluminium and magnesium</i>
AS 1720.1	<i>Timber Structures – Design Methods</i>
AS 1874	<i>Aluminium and aluminium alloys – Ingots and castings</i>
AS2159	<i>Piling – Design and installation</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 3700	<i>Masonry structures</i>
AS 4100	<i>Steel structures</i>
AS 4506	<i>Metal finishing – Thermoset powder coatings</i>
AS 5100.3	<i>Bridge design – Part 3: Foundation and soil-supporting structures</i>
AS 5604	<i>Timber – Natural durability ratings</i>
AS ISO 11654	<i>Acoustics – Rating of sound absorption – Materials and systems</i>
AS/NZS 1170.0	<i>Structural design actions – General principles</i>
AS/NZS 1170.2	<i>Structural design actions - Wind actions</i>
AS/NZS 1214	<i>Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)</i>
AS/NZS 1252.1	<i>High strength steel fastener assemblies for structural engineering – Bolts, nuts and washers – Part 1: Technical requirements</i>
AS/NZS 1580.601.1	<i>Paints and related materials - Methods of test - Colour - Visual comparison</i>
AS 1604.1	<i>Preservative treated wood-based products, Part 1: Products and treatment</i>
AS/NZS 1664.1	<i>Aluminium structures – Limit state design</i>
AS/NZS 1734	<i>Aluminium and aluminium alloys – Flat sheet, coiled sheet and plate</i>
AS/NZS 1748.1	<i>Timber – Solid - Stress-graded for structural purposes – General requirements</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 2208	<i>Safety glazing materials in buildings</i>

Reference	Title
AS/NZS 2269.0	<i>Plywood – Structural, Part 0: Specifications</i>
AS/NZS 2908.2	<i>Cellulose-cement products – Flat sheet</i>
AS/NZS 3845.1	<i>Road Safety Barrier Systems and Devices – Road Safety Barrier Systems</i>
AS/NZS 4455.1	<i>Masonry units, pavers, flags and segmental retaining wall units – Masonry units</i>
AS/NZS 4600	<i>Cold-formed steel structures</i>
AS/NZS 4672.1	<i>Steel prestressing materials – General requirements</i>
AS/NZS 4680	<i>Hot-dip galvanized (zinc) coatings on fabricated ferrous articles</i>
AS/NZS ISO 717.1	<i>Acoustics – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation</i>
AS/NZS ISO 9001	<i>Quality management systems - Requirements</i>
AS/NZS ISO/IEC 17067	<i>Conformity assessment – Fundamentals of product certification and guidelines for product certification schemes</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>
Austrroads	<i>Austrroads Guide to Road Design Part 6: Road Design, Safety and Barriers</i>
Broms Theory	<i>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</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 1794-3	<i>Road Traffic Noise reducing devices – Non-acoustic performance, Part 3: Reaction to fire – Burning behaviour of noise reducing devices and classification</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 4892-2	<i>Plastics – Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps</i>
I.S. EN ISO 527-2	<i>Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics</i>

Reference	Title
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>
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS03	<i>Drainage Structures, Retaining Structures and Slope Protections</i>
MRTS04	<i>General Earthworks</i>
MRTS50	<i>Specific Quality System Requirements</i>
MRTS56	<i>Construction Surveying</i>
MRTS70	<i>Concrete</i>
MRTS71	<i>Reinforcing Steel</i>
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>
MRTS78A	<i>Fabrication of Structural Stainless Steelwork</i>
MRTS88	<i>Protective Coating for New Work</i>
SD1602	<i>Fencing - Chainwire fences and gates</i>
SD1608	<i>Noise Fences – Structural Detail –Universal Beam Posts, Concrete Panels, Steel panels</i>
-	<i>Design Criteria for Bridges and Other Structures, Transport and Main Roads</i>
-	<i>Drafting and Design Presentation Standards Manual, Transport and Main Roads</i>
-	<i>Geotechnical Design Standard – Minimum Requirements, Transport and Main Roads</i>
-	<i>Manual Registration of Noise Fence Panel</i>
-	<i>Procedure Manual Prequalification of Noise Barrier Construction Companies</i>
-	<i>Procedure Manual Prequalification of Noise Barrier Design Companies</i>
-	<i>Road Planning Design Manual 2nd Volume 3 Supplement to Austroads Guide to Road Design Part 6: Road Design, Safety and Barriers</i>

Reference	Title
-	<i>Standard Drawings Roads Manual, Transport and Main Roads</i>
-	<i>Transport Noise Management Code of Practice; Volume 1 – Road Traffic Noise, Transport and Main Roads</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
6.2	1. Permission to use noise fence design		Submission of design
6.6.3.1	2. Impact resistance		
6.19.2.3	3. Undrained shear strength		
7.2	4. Clearing and trimming of trees		
7.4	5. Treatment of cut plywood		
7.6		1. Excavation of footings	
7.18			Submission of construction certificate
8.1	6. Submission of certificate of noise fence construction materials		

5 Registered proprietary products and services

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 products and suppliers. The requirements for registration of noise fence panel are outlined in the *Manual Registration of Noise Fence Panel*.

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

Clause	Product Type
6.8, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15	Panels (Plywood, Concrete, Composite, Steel, Aluminium, Transparent, Plastic)
6.17	Acoustic seal
6.18	Paints
7.4	Preservative treatment of cut plywood above ground

Noise fences other than private third party noise fences shall be designed and constructed by a company who is registered with the Department of Transport and Main Roads. The requirements for registration of design and construction companies are outlined in the *Procedure Manual Prequalification of Noise Barrier Design Companies* and *Procedure Manual Prequalification of Noise Barrier Construction Companies*.

For information regarding approved products and suppliers for above items and the registered design and construction companies refer to the [Approved products and registered suppliers webpage](#) on the Transport and Main Roads website.

6 Design

6.1 General

A standard noise fence consists of posts connected by replaceable panels whose length and thickness are standardised and generally based in the earthworks on individual foundations in the form of bored piles or spread footing. It does not impede natural drainage flow paths. If the noise fence interacts with engineering structures (retaining walls, bridges, road safety barriers etc.), design analysis of the supporting structures is required to account for the forces imposed by the noise fence on the engineering structures.

Typical details for noise fences are found on the [Fencing and noise barriers Standard Drawings page](#).

Noise fences shall have adequate strength, durability, acoustical parameters, constructability, safety and maintenance to satisfy the requirements and intentions of the Contract and this Technical Specification. Noise fences shall also include relevant urban design and environmental requirements.

The maximum panel length of a standard noise fence shall be:

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

All parts of the noise fence built by the department shall be located entirely within the road reserve. Third party noise fence (for example, Developer noise fences) shall be entirely outside the road reserve within the property including footing.

An embedded concrete sill beam (refer to Clause 7.10) adjacent to the soil will be necessary for the base units of all type of noise fences.

Noise fences shall avoid entrapment and ponding of water, dirt and debris on or within components.

Noise fences shall be painted.

6.2 Design approval and submission

Noise fence design drawings shall comply with the requirements of *Drafting and Design Presentation Standards Manual*. Drawings and supporting documents (design report including neat and comprehensive design calculations of wind loading, structures, foundations and assumptions which comply with this Technical Specification, relevant Standard Drawings and geotechnical investigation report) of the noise fence design shall be submitted to the Administrator for review not less than 14 business days prior commencement of any construction work. **Milestone**

The drawings shall include but not be limited to show the following:

- alignment of the noise fence(s)
- cadastral / road edge and property boundary
- existing and proposed infrastructure, drains, road safety barriers, signs, known utilities, fences and gates
- topographic data (existing and proposed) over the area of interest including the road
- height and length of noise fence, location of all footings and depths, geotechnical information of the alignment, supporting structures and the drainage requirements in longitudinal sections
- panel material selected for noise fence and the minimum thickness
- height and details of structures that interact with the noise fence in cross sections for each segment of the noise fence

- report numbers of the acoustic assessment and the geotechnical investigation, and
- design wind speeds including relevant parameters used for calculations for each segment of noise fences (refer to Clause 6.6.9).

The noise fence design drawings and the reports shall be certified as complying with this Technical Specification by a suitably qualified Engineer experienced in the design of noise fences and holding a current registration as a Registered Professional Engineer, Queensland with RPEQ number shown on the drawings.

Construction of noise fences shall not commence until the Contractor has been granted permission to use the noise fence design. **Hold Point 1**

6.3 Acoustic requirements

6.3.1 General

There shall be no gap in any part of the noise fence unless the gap is required for surface drainage at ground level. An acoustic seal (refer to Clause 6.17) shall be inserted in any gaps in noise fence units including between panels and the lower side of the panel and concrete sill beam (refer to Clause 7.10), and top of the engineering structures. If appropriate, vertical acoustic seals shall be inserted in gaps between noise fence units and posts.

Noise fence panels shall use either reflective or absorptive type materials, to achieve an A Weighted Sound Reduction Index (R_w) of not less than 25.0 in accordance with AS/NZS ISO 717.1.

Reflective type panel shall be selected if the noise fence does not expressly require absorptive panels.

Absorptive panels shall be selected only when it can be shown through accepted modelling techniques, that noise reflections are a legitimate problem.

Where the reflective surface of a noise fence is within a noise fence overlapping depth to noise fence height ratio of 20:1, the reflective surface of the noise fence shall be an absorptive type.

Both sides absorptive panels shall be used in central reservation in very special circumstances.

6.3.2 Absorptive type

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

In addition to the minimum R_w requirements in Clause 6.3.1, the following properties shall apply to absorptive type noise fences:

- a) the Weighted Sound Absorption Coefficient (α_w) of the noise fence panels shall not be less than 0.8 measured in accordance with AS ISO 11654
- b) the absorptive face shall be on the traffic side of the noise fence, and
- c) the absorptive panel shall be placed on a minimum 500 mm high, above ground concrete sill beam (refer to Clause 7.10) or on a concrete panel (refer to Clause 6.10).

6.3.3 Reflective type

A reflective type of noise fence reflects most sound energy when facing the road.

Reflective type noise fence can be reflecting on both sides or absorbing one or both sides.

In addition to the minimum R_w requirements in Clause 6.3.1, reflective type noise fence panels must have a minimum surface density at air dry moisture content (excluding structural components) of 15 kg/m².

6.4 Aesthetic requirements

Noise fences shall achieve aesthetically pleasing outcomes and be visually integrated with the adjacent natural or built environments in which they are situated to comply with urban design requirements. Notwithstanding, the technical requirements of this Clause 6.4 shall take precedence over the design integration guidelines found in Chapter 7 of *Transport Noise Management Code of Practice; Volume 1 – Road Traffic Noise*.

Noise fences located near the road shall prioritise having a top of fence profile line which is either horizontally level, or visually parallel to the vertical geometry of the road surface. The top line of noise fences must be rationalised (with section heights increased as necessary beyond that required by the acoustic heights) to present as continuously, flat, level top line devoid of stepping to the greatest extent practicable, to be reflective of the smooth vertical geometry of the road and present as visually clean structures with minimal stepped top edges. Localised peaks and troughs less than 100 m length to the top of noise fence profile shall be avoided, with the preferred horizontal top of noise fence profile maximised to the longest noise fence lengths practicable. Alternatively, where noise fences are of significantly different height, consider separating the noise fences with an overlap between noise fences.

Where multiple panels are used in a noise fence, horizontal panel joints within the noise fence shall generally be at a constant height level, to present consistent horizontal lines along the noise fence. This outcome shall be achieved through combined use of the following as required:

- consistent, standard sized panels
- variable height sill beams
- false joints in panels
- burying the base of panels below finished ground level (concrete panels), and
- incorporating additional panel height above that required for noise attenuation function, to achieve the desired top of fence profile line.

Stepping at the top of the noise fence shall follow the following principles:

- Stepping down height shall generally be a maximum of 200 mm
- Where significant grade change makes stepping unavoidable, horizontal, level top line runs are to be maximised and stepping heights are to be of equal increments. Increments shall be increased beyond the 200mm stepping increment
- A uniform modular approach to the stepping of noise fence in lieu of a sloping top of noise fence profile
- Where a modular or stacked panel is being used (for example, absorptive panels, or 500mm x 5000mm concrete panels), the stepping shall be at the maximum panel height of 500 mm in order to provide consistent horizontal lines across the noise fence.
- Where using larger panels and a significant difference in attenuation requirement or grade change requires a larger step, reduce the panel length to half and the step increment or attenuation requirement stepping heights are to be equal increments, however these steps should be consistent across the height transition.

Transparent materials shall be considered for the uppermost sections of tall noise fences height 4.0 m and above to allow solar access to adjacent residential properties, and shade effects to a residence as determined by the Administrator and/or the urban design documents (refer to Clause 7.5.2 of the *Transport Noise Management: Code of Practice* Volume 1).

Transparent materials may be considered where noise fences impact upon the retention of significant views from the roadway to adjacent environmental features of high visual amenity, as determined by the Administrator and/or the urban design documents.

The terminal ends of noise fences shall meet the acoustic attenuation requirements and may finish at a height consistent with the adjoining sections. Where a higher level of urban design finish is required to promote visual integration with the surrounding site and landform subject to achieving the required acoustic performance, the gradually diminishing height may be in or outside end of the noise fence to improve appearance. The noise fence may step down with equal height steps across a maximum of 10.0 m to a terminal end height of 2.0 m.

6.5 Drainage requirements

Potential increased drainage flood risk shall be assessed and appropriate drainage and flood resilience measures shall be included in design without compromising requirements to achieve acceptable noise levels. Placement of noise fences in locations that will impede the passage of water should be avoided. Ponding of water against noise fences or discharge onto private property shall be avoided. Drainage structures or drainage slots (refer to Clause 7.11) shall be provided as required to allow for all stormwater and surface drainage to pass under noise fences. Drainage slots should not be provided at every panel, and shall be provided where necessary for drainage requirements.

6.6 Structural and material requirements

6.6.1 General

Engineering structures (retaining walls, bridges, road safety barriers etc.) supporting or anchoring or in close proximity to a new noise fence shall be structurally assessed to ensure they are adequate to withstand the superimposed load from the noise fence.

Existing engineering structures supporting or anchoring noise fence in structural concrete is not permitted.

Lightweight materials (plywood, aluminium, acrylic and so on) are preferred for noise fence is located on the engineering structures (bridges, retaining walls and road safety barrier).

Retaining walls shall meet the requirements of *Geotechnical Design Standard – Minimum Requirements*, and additional requirements of the *Design Criteria for Bridges and Other Structures*. Timber retaining walls shall not be permitted in the vicinity of noise fences.

Where noise fences are installed on bridges, as far as practicable they shall be tilted away from the carriageway and the noise fences shall extend for a minimum distance of 20 m either side of the bridge abutment.

The design shall account for the effects of both differential temperature and moisture, warping, twisting and bowing.

The noise fence in the transition area between the structure (bridge or retaining wall) and the road shall be able to accommodate movements of the structure and settlement of the structure backfill or of the embankment subsoil without damage.

6.6.2 Design and maintenance life

The design life of noise fences, for the purpose of strength, serviceability and stability calculations shall be 40 years.

The design life for any noise fence connections to a bridge or retaining walls shall be 100 years. The design life of noise fence post and panels on bridge or retaining wall shall be 40 years.

The minimal maintenance-free life of the main construction materials other than protective coating shall be 25 years.

6.6.3 Vandal resistance

6.6.3.1 Impact resistance

Noise fence panels shall be able to withstand the impact of a 4 kg steel ball dropped from a height of 3 m when the panel is supported at its edges horizontally above the ground.

The test panel shall be set up such that its ends are supported with similar edge distance to that used in service (refer to Appendix A of *Manual Registration of Noise Fence Panel*).

The test panel shall be set up for the worse 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. Glass and plastic panels shall not crack or shatter.

The testing shall be performed in the presence of the Administrator. **Hold Point 2**

6.6.3.2 Resistance to being defaced

Noise fences shall be resistant to defacing by sharp implements (e.g. a knife).

6.6.4 Fire

Noise fence panels which are susceptible to fire (plastic and plywood) shall not be used in fire prone areas. Noise fence panels which may emit noxious fumes or leachates (plastics) in environmentally dangerous concentrations if impacted by fire shall not be used directly adjoining residential properties.

Noise fences adjacent to bushland or other unmaintained vegetation areas shall not be constructed of timber or any other materials which are combustible when exposed to very high temperatures, noting all noise fences are to be concrete unless approved otherwise by the Principal's Representative via the Administrator.

The required fire resistance shall be estimated based on the surrounding facilities and considering the amount of risk in accordance with the requirements of I.S. EN 1794-3 minimum Class 2 – Resistance to fire; and Reaction to fire, smoke density and toxic fumes.

6.6.5 Vehicle impact and traffic safety

Noise fences are not required to withstand vehicle impact. Vehicle impacts may be mitigated either by installing a suitable road safety barrier system to shield the noise fence or by providing adequate offset from the traffic lane to minimise the risk of a vehicle impact with the noise fence. Where neither of these options are available, a combined noise fence and road safety barrier system which fulfils all the objectives and requirements of both system can be considered. Roadside risk evaluation shall be undertaken in accordance with the *Road Planning and Design Manual* Volume 3, Part 6.

Noise fences installed on bridges, retaining walls and similar exposed positions over or immediately next to public traffic shall be fitted with additional securing measures to protect them against falling onto the traffic below.

6.6.6 Light reflection and transparency

Noise fence surfaces shall not produce excessive glare from incident light sources such as sun or vehicle headlight. Metals and transparent panels are susceptible to glare from light sources. Light reflection class of the panel surface shall be determined in accordance with Appendix E of I.S. EN 1794-2 in order to better define and assess the level of possible risks to road users. If necessary, matte finish shall be applied to the panel surface to prevent excessive reflective glare.

The effective transparency of the noise fence shall be assessed in accordance with Appendix F of I.S. EN 1794-2.

6.6.7 Robustness

Noise fence panels shall not become detached from their supports or fixings both in the horizontal and vertical planes 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.

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.

The bottom of the noise fence panel shall be restrained from bowing and warping due to temperature, differential temperature and differential moisture.

6.6.8 Self-weight

Where panels are stacked vertically, the underlying panel shall not deform when exposed to a load of 1.35 times of the overlaying wet weight of the panels.

6.6.9 Wind loading

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

- a) Regional wind speeds shall be based on Table 3.1(A) of AS/NZS 1170.2 using the following Average Recurrence Intervals (ARI)
 - i. ultimate – 1000 year ARI for standard noise fence and noise fence attached to road safety barrier;
ultimate – 2000 year ARI for noise fence post and connections attached to bridge and retaining walls, and
 - ii. serviceability – 20 year ARI
- b) 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
- c) Terrain Category shall consider current and future use and take the worst effect. Transitions between adjacent terrain areas shall be calculated in accordance with Clause 4.2.3 of AS/NZS 11270.2
- d) Shielding Multiplier – M_s 1.0
- e) Net Pressure Coefficient – $C_{p,n}$ Appropriate value from Table B2(B) or B2(C) of AS/NZS 1170.2 on end panels (that is, 0 to 2 times height) and internal panels (that is, greater than 2 times height) with wind perpendicular and at 45 degrees to the noise fence.

Where noise fences are within 4 m 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.

6.6.10 Load combinations

Where the noise fence is required to retain earth fill, the minimum live load surcharge shall be 5 kPa.

6.7 Steel posts

6.7.1 General

Steel posts shall comply with the requirements stated in Clauses 6.7.1 to 6.7.5, inclusive.

6.7.2 Materials

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

All mild steel components shall be hot-dip galvanised after fabrication in accordance with the requirements of AS/NZS 4680 with an average coating mass of 600 g/m².

Base plates shall be at least as thick as the diameter of the anchor bolts / rods in assembly they are attached to the steel posts.

Minimum 180 range of Universal Beam section shall be used a convenient means of supporting noise fence panels.

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

6.7.3 Fabrication of steel posts

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

6.7.4 Structural design

Steel components shall be designed in accordance with AS 4100 or AS/NZS 4600.

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

$$\frac{\text{Height of fence}}{150}$$

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

Post elements in contact with retaining soil shall be provided with an additional corrosion protection system - either embed them in concrete or cover with minimum 1.0 mm dry thickness of water based bituminous paint (refer to Clause 6.18).

Post elements in direct contact with other metals and materials causing galvanic corrosion shall be protected by an appropriate method. The protection may comprise electrical isolation of the contacting surfaces of both metals by thick coating, or, if this is not possible, by at least coating the cathodic metal.

Steel posts shall be restricted from coming into contact with any other corrosive material, to prevent steel corrosion.

Universal Beam section shall be securely attached top capping plate, if necessary (refer to Clause 7.12).

6.7.5 Testing and acceptance

Steel posts shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

6.8 Plywood

6.8.1 General

Plywood panels shall be preservative treated either softwood or hardwood and shall comply with the requirements stated in Clauses 6.8.1 to 6.8.6, inclusive.

Plywood panels shall conform to the requirements of reflective type noise fence in Clause 6.3.3.

Plywood panels shall not be used in bushfire prone areas.

Plywood panels shall not come in contact with the ground. The plywood panel shall be placed on a minimum 100 mm high, above ground concrete sill beam (refer to Clause 7.10) or on a concrete panel (refer to Clause 6.10).

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

6.8.2 Materials

6.8.2.1 Plywood

Structural plywood shall be Stress Grade F14 or better in accordance with AS/NZS 2269.0.

The grade of veneer on the face and back of panels shall be CC or better in accordance with AS/NZS 2269.0. 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 2269.0.

Plywood shall be supplied kiln dried with a moisture content between 8% and 15%.

The plywood shall have a minimum thickness of 27 mm.

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

6.8.2.2 Battens

Structural sawn softwood shall be Stress Grade F5 or better, and either machine stress graded in accordance with AS/NZS 1748.1, or visually graded in accordance with AS 2858.

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

Battens shall be supplied kiln dried with a moisture content between 8% – 15%.

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.

6.8.3 Manufacture of plywood panels

Manufacture of plywood panels shall be in accordance with the requirements of AS/NZS 2269.0 and this Technical Specification.

Plywood panels shall be a registered product. For registration the manufacturer shall demonstrate third party product certification to AS/NZS 2269. Certification shall be undertaken by a conformity assessment body accredited by the Joint Accreditation System for Australia and New Zealand (JAS / ANZ) in accordance with the requirements of AS/NZS ISO/IEC 17067 (Type 5) scheme. The certifier shall be acceptable to the Administrator.

The finish on both sides of the panel shall be textured wood with slimline grooves to reduce checking of the surface.

6.8.4 Structural design

Structural design shall be in accordance with AS/NZS 2269.0 and AS 1720.1.

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

$$\frac{\text{Span of panel}}{65}$$

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 this Technical Specification. 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 (for example, aluminium), suitably protected against corrosion shall be attached to the top of the upper panel section of noise fence.

6.8.5 Preservative treatment

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 AS/NZS 1604.1. Plywood panels in contact with the ground shall be treated to Hazard Level 4 (H4) as specified in AS/NZS 1604.1.

Battens shall be treated to Hazard Level 4 (H4) as specified in AS/NZS 1604.1.

For veneer treatment, each veneer shall be treated with a proprietary preservative approved under AS/NZS 1604.1.

For envelope treatment, panels and battens shall be treated with a proprietary preservative approved under AS/NZS 1604.1.

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

After preservative treatment, the moisture content, dimensions and shape of the plywood shall conform to AS/NZS 2269.0 criteria.

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

Untreated material exposed on cutting shall be treated in accordance with Clause 7.4.

On delivery all preservative treated material purporting to comply with this Technical Specification shall be branded in accordance with the requirements of AS/NZS 1604.1 for battens and plywood.

Approved preservative treatments for wood-based products are given in 'Approved Preservative Treatment Notification' issued by the Chief Executive under AS/NZS 1604.1 for battens and plywood.

6.8.6 Testing and acceptance

Plywood panels shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

Plywood panels require adherence to manufacturing product and preservative treatment standards specified in this Technical Specification to ensure that the advantages of their low cost, ease of construction, aesthetics, availability and

sustainability can be realised. Non-conformance to this Technical Specification can result in high levels of maintenance, warping and fastener failure.

6.9 Masonry

6.9.1 General

Masonry walls shall comply with the requirements of stated in Clauses 6.9.1 to 6.9.4, inclusive.

Masonry walls shall be either unreinforced or reinforced masonry.

Masonry walls shall conform to the requirements of reflective type fences in Clause 6.3.3.

6.9.2 Materials

6.9.2.1 Blocks

Masonry block material shall be either burned clay, plain concrete or autoclaved aerated concrete in accordance with AS/NZS 4455.1.

6.9.2.2 Reinforcing steel

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

6.9.2.3 Concrete

Concrete shall be in accordance with MRTS70 *Concrete* unless specified otherwise in Clauses 6.10.2.3 and 6.10.2.4.

6.9.3 Structural design

Design of masonry components shall be in accordance with AS 3700.

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

$$\frac{\text{Height of wall}}{150}$$

The top of the masonry wall shall be provided with protective capping or flashing.

Masonry walls in contact with soil shall be coated with minimum 1 mm dry thickness of water based bituminous paint to the extent of the soil in contact.

A continuous concrete beam shall be provided at the base of all masonry walls and vertical reinforcing steel anchored into the footing.

Articulation / control joints shall be incorporated in all masonry walls at a maximum 8 m spacing.

The foundation shall be designed in such a way that cracks do not form in the area between the expansion joints.

6.9.4 Testing and acceptance

Masonry walls shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

Brick and block masonry are best used on a more domestic scale or where some detail is desired, for example where walls are in close proximity to residences or pedestrian paths. Some form of pier is usually required to provide the necessary support for the wall.

6.10 Concrete

6.10.1 General

Concrete walls and panels shall comply with the requirements stated in Clauses 6.10.1 to 6.10.8, inclusive.

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

Concrete walls and panels shall conform to the requirements of reflective type fences in Clause 6.3.3.

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

6.10.2 Materials

6.10.2.1 Concrete

Concrete shall be in accordance with MRTS70 *Concrete* unless specified otherwise in Clause 6.10.3.

6.10.2.2 Reinforcing steel

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

6.10.2.3 Prestressing strand

Strand used for longitudinal stressing shall be 7-wire ordinary strand compliant with AS/NZS 4672.1.

6.10.3 Cover

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

6.10.4 Formwork removal

Formwork shall not be removed from the concrete walls until the concrete has attained 60% of the specified 28 day characteristic strength.

6.10.5 Manufacture of precast concrete panels

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

Precast concrete panels shall be manufactured only by a Transport and Main Roads registered supplier.

6.10.6 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*.

Prestressed concrete panels shall be manufactured only by a Transport and Main Roads registered supplier.

6.10.7 Structural design

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

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.

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

$$\frac{\textit{Span of panel}}{150}$$

Concrete walls and panels in contact with soil shall be coated with minimum 1.0 mm dry thickness of water based bituminous paint (refer to Clause 6.18) minimum 150 mm above to the extent of the soil in contact.

6.10.8 Testing and acceptance

Concrete panels shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

Concrete has great inherent flexibility, and is therefore very suitable for noise fences. It is highly durable, weathers well and is not damaged easily. Whilst it is possible to construct concrete walls insitu, this is not recommended due to the difficulty of ensuring quality control. Texture and pattern can be created in precast concrete panels. Concrete panels typically last beyond their minimum design life and may be reused in the future. The disadvantage of patterned panels is, if damaged some years after initial construction, they may be difficult to replace (when using block systems).

6.11 Composite

6.11.1 General

Composite panels shall comply with the requirements stated in Clauses 6.11.1 to 6.11.5, inclusive.

Composite panels shall conform to the requirements of reflective type fences in Clause 6.3.3.

Composite panels are defined as panels having a low density and thick core bonded between 2 relatively thin, hard, strong and rigid faces.

Composite panels shall not come in contact with the ground. The composite panel shall be placed on a minimum 100 mm high, above ground concrete sill beam (refer to Clause 7.10) or on a concrete panel (refer to Clause 6.10).

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

6.11.2 Materials

6.11.2.1 Faces

Facing materials shall be fibre reinforced cement flat sheet conforming to the requirements of AS/NZS 2908.2 and require acceptance by the Administrator. Hot-dip metallic coated steel sheet conforming to the requirements of AS 1397 may be attached to the inner faces, if necessary.

6.11.2.2 Core

Core material 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.

6.11.2.3 Adhesive

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

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

6.11.3 Manufacture of composite panels

Composite panels shall be manufactured in accordance with the details shown on the approved Drawings and supporting documents and in accordance with this Technical Specification.

Composite panels shall be a registered product. For registration the manufacturer shall provide certification of their quality management system to AS/NZS ISO 9001. Certification shall be undertaken by a conformity assessment body accredited by the Joint Accreditation System for Australia and New Zealand (JAS / ANZ). The certifier shall be acceptable to the Administrator.

6.11.4 Structural design

Composite panels shall be designed for handling and transport loads equivalent to 50% of their self-weight in addition to self-weight.

Composite panels shall incorporate a proprietary mechanical system that restricts face-sheet core delamination. The system shall conform to the service life requirements of this Technical Specification and eliminate air gaps if movement occurs.

Design of composite panel shall be by a recognised design method or a recognised accelerated proof load test method accepted by the Administrator. In addition, the testing shall satisfy the intent of Appendix B of AS 3600.

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

$$\frac{\text{Span of panel}}{150}$$

Top and bottom edge capping (for example, aluminium), 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 by a system approved by the Administrator.

Capping shall be attached at top of the post (refer to Clause 7.12).

6.11.5 Testing and acceptance

Composite panels shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

These characteristics highlight the high strength and low weight advantages of composite panel their excellent design flexibility qualities provide simple to construct and cost-effective alternatives to timber panels. Composite panels are generally inert, do not rot in wet and/or moist environments and are termite proof.

6.12 Steel

6.12.1 General

Steel panels shall comply with the requirements stated in Clauses 6.12.1 to 6.12.5, inclusive.

Steel panels shall be either absorptive or reflective.

Absorptive steel panels shall conform to the requirements of absorptive type fences in Clause 6.3.2 and the reflective steel panels shall conform to the requirements of reflective type fences in Clause 6.3.3.

Steel panels shall not come in contact with the ground. The steel panel shall be placed on a minimum 500 mm high, above ground concrete sill beam (refer to Clause 7.10) or on a concrete panel (refer to Clause 6.10).

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

6.12.2 Materials

6.12.2.1 Steel

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

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

All mild steel components shall be hot-dip galvanised after fabrication in accordance with the requirements of AS/NZS 4680 with an average coating mass of 600 g/m².

Both sides of the galvanised surface shall be 'brush' blasted to reduce glare prior to erection, 'Brush' blasting shall be in accordance with AS/NZS 4680.

6.12.2.2 Insulation

The sound insulation for absorptive panels shall be hydrophobic, free of materials promoting corrosion and resistant to light, weathering, salting and rotting. It consists of glass fibre or mineral wool with a minimum specific gravity of 100 kg/m³. The sound insulation shall retain dimensional stability even after ageing, and maintain its designed position.

6.12.3 Fabrication of steel panels

Steel panels shall be fabricated in accordance with the details shown on the approved Drawings and supporting documents and in accordance with this Technical Specification.

Steel panels shall be a registered product. For registration the manufacturer shall provide certification of their quality management system to AS/NZS ISO 9001. Certification shall be undertaken by a conformity assessment body accredited by the Joint Accreditation System for Australia and New Zealand (JAS / ANZ). The certifier shall be acceptable to the Administrator.

6.12.4 Structural design

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 this Technical Specification and eliminate air gaps if movement occurs.

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

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

$$\frac{\textit{Span of panel}}{150}$$

The sound insulation in an absorptive panel shall be placed a minimum 20 mm from front or back of the steel panel.

Hollow sections shall be ventilated.

If spacers are used to ensure back ventilation of absorptive panels, no more than 20% of the area between the sound insulating material and the closed section of the panel shall be obstructed. Sound insulation in the absorptive panel shall be covered on the absorbent

side with glass fleece to protect from water, rain or road spray. Protective films shall not be used.

All water penetrating an absorptive panel shall drain off rapidly and completely. Drain water shall not be channelled into underlying units (drainage towards steel posts). Water shall not be retained in the groove and tongue system.

6.12.5 Testing and acceptance

Steel panels shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

Steel is the least expensive and most common of all metals used in construction. Absorptive steel panels shall be securely attached at top of the post to avoid theft (refer to Clause 7.12).

6.13 Aluminium

6.13.1 General

Aluminium panels shall comply with the requirements stated in Clauses 6.13.1 to 6.13.5, inclusive.

Aluminium panels shall be either absorptive or reflective.

Absorptive aluminium panels shall conform to the requirements of absorptive type fences in Clause 6.3.2 and reflective aluminium panels conform to the requirements of reflective type fences in Clause 6.3.3.

Aluminium panels shall not come in contact with the ground. The aluminium panel shall be placed on a minimum 500 mm high, above ground concrete sill beam (refer to Clause 7.10) or on a concrete panel (refer to Clause 6.10).

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

6.13.2 Materials

6.13.2.1 Aluminium

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 1874.

Aluminium panels shall be protected against corrosion to show minimal deterioration in general appearance by means of coating with 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, or 100 µm nominal thickness of 2 coats of polyurethane wet paint as site coating.

6.13.2.2 Insulation

The sound insulation for absorptive panels shall be hydrophobic, free of materials promoting corrosion and resistant to light, weathering, salting and rotting. It consists of glass fibre or mineral wool with a minimum specific gravity of 100 kg/m³. The sound insulation shall retain dimensional stability even after ageing, and maintain its designed position.

6.13.3 Fabrication of aluminium panels

Aluminium panels shall be fabricated in accordance with the details shown on the approved Drawings and supporting documents and in accordance with this Technical Specification.

Aluminium panels shall be a registered product. For registration the manufacturer shall provide certification of their quality management system to AS/NZS ISO 9001. Certification shall be undertaken by a conformity assessment body accredited by the Joint Accreditation System for Australia and New Zealand (JAS / ANZ). The certifier shall be acceptable to the Administrator.

6.13.4 Structural design

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 this Technical Specification and eliminate air gaps if movement occurs.

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.

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

$$\frac{\textit{Span of panel}}{150}$$

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

The sound insulation in an absorptive panel shall be placed a minimum 20 mm from front or back of the aluminium panel.

Hollow sections shall be ventilated.

If spacers are used to ensure back ventilation of absorptive panels, no more than 20% of the area between the sound insulating material and the closed section of the panel shall be obstructed. Sound insulation shall be covered on the absorbent side with glass fleece to protect from water, rain or road spray. Protective films shall not be used.

All water penetrating an absorptive panel shall drain off rapidly and completely. Drain water shall not be channelled into underlying units (drainage towards steel posts). The water shall not be retained in the groove and tongue system.

6.13.5 Testing and acceptance

Aluminium panels shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

Aluminium is a lightweight and high strength metal. Aluminium panel is typically coated with a bonded powder or enamel paints. Aluminium panels are sometimes stolen because of the resale value. They should only be used in locations where there is low risk. Remote locations are more likely to be subject to theft than populated areas. Aluminium panels shall be securely attached at top of the post to avoid theft (refer to Clause 7.12).

6.14 Transparent

6.14.1 General

The panels shall comply with the requirements stated in Clauses 6.14.1 to 6.14.5 inclusive.

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

Thermoplastic safety panels shall be either acrylic or polycarbonate.

Transparent safety panels shall conform to the requirements of reflective type fences in Clause 6.3.3.

Transparent panels shall not come in contact with the ground. The transparent panel shall be placed on a minimum 500 mm high, above ground concrete sill beam (refer to Clause 7.10) or on a concrete panel (refer to Clause 6.10).

Special conditions apply to transparent noise fences:

- a) in public areas to ensure that no dangerous shards are created and they remain intact when accidentally impacted

- b) on bridges and elevated structures to ensure that no dangerous shards are created if 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
- d) multi-coloured transparent panels may create undesirable shadows extending across traffic lanes may be distracting to drivers, and
- e) in areas where birds frequently fly, to ensure prevention of bird collisions with the transparent panel and to ensure that such measures have no adverse effect on the performance and maintenance of the transparent panel.

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

6.14.2 Materials

6.14.2.1 General

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

Characteristic values of panel parameters may be subjected to a change due to:

- The effect of roadside environmental degradation (Solar Ultraviolet (UV) radiation, vehicle exhaust fumes, graffiti removal solvent and chemical attack). In the case of thermoplastic safety panels, transparency must not be visibly reduced during the useful design life. To improve resistance to environmental degradation and abrasion, they must either have added stabiliser or be surface coated.
- Deformation and breakage under service conditions from impact, fire and vandalism.
- Variations in the manufacturing process.
- Installation damage, including weathering during storage and/or mechanical damage during installation.

Consequently, it is necessary to evaluate transparent safety panels in an 'as new' condition and after accelerated ageing to the equivalent of their expected design life.

6.14.2.2 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) density shall be between 24.0–26.0 kN/m³
- c) coefficient of thermal expansion shall be less than 8.8×10^{-6} mm/m°C to 150°C
- d) heat soaked
- e) Grade A to AS/NZS 2208
- f) optical transmission and strength properties as per Table 6.14.2.2, and
- g) no mottling and Colour Rating less than 2 to AS/NZS 1580.601.1 at the end of the 40 year period when exposed to weather conditions appropriate for Queensland.

Table 6.14.2.2 – Optical and strength properties of Toughened Laminated Safety Glass

Property	Testing standard	Minimum value		
		As new	After 10 years	After 40 years
Light Transmission	ASTM E424	85%	80%	80%
Modulus of Elasticity	ASTM E111	69 GPa	69 GPa	69 GPa
Tensile Strength	ASTM C158	19 MPa	19 MPa	19 MPa
Flexural Strength	ASTM C158	140 MPa	140 MPa	140 MPa

6.14.2.3 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 materials which may include up to 5% colourants, UV absorbers and pigments. Polyamide threads shall be embedded in processes for sites (a) and (b) specified in Clause 6.14.1
- b) density shall be not less than 11.7 kN/m³
- c) coefficient of thermal expansion shall be less than 70×10^{-6} mm/m°C to 50°C
- d) Grade A to AS/NZS 2208

- e) optical transmission and strength properties as per Table 6.14.2.3, and
- f) no mottling and Colour Rating less than 2 to AS/NZS 1580.601.1 at the end of the 40 year period when exposed to weather conditions appropriate for Queensland.

Table 6.14.2.3 – Optical and strength properties of acrylic

Property	Testing standard	Minimum value		
		As new	After 10 years	After 40 years
Light Transmission	I.S. EN ISO 13468-2	90%	88%	80%
Modulus of Elasticity	I.S. EN ISO 527-2	2900 MPa	2600 MPa	2000 MPa
Tensile Strength	I.S. EN ISO 527-2	60 MPa	50 MPa	45 MPa
Flexural Strength	I.S. EN ISO 178	100 MPa	80 MPa	75 MPa

6.14.2.4 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:

- a) manufactured from 100% Bisphenol A (BPA) using phosgene free processes with colorants, additives and by both UV absorbing coating on both sides and processing aids up to a total content of 5% and continuous polymeric hard over-coat sheet adhered permanently
- b) density shall be not less than 11.8 kN/m³
- c) coefficient of thermal expansion shall be less than 65×10^{-6} mm/m°C to 50°C
- d) Grade A to AS/NZS 2208
- e) optical transmission and strength properties as per Table 6.14.2.4, and
- f) no mottling and Colour Rating less than 2 to AS/NZS 1580.601.1 at the end of the 40 year period when exposed to weather conditions appropriate for Queensland.

Table 6.14.2.4 – Optical and strength properties of polycarbonate

Property	Testing standard	Minimum value		
		As new	After 10 years	After 40 years
Light Transmission	I.S. EN ISO 13468-2	80%	73%	50%
Modulus of Elasticity	I.S. EN ISO 527-2	2200 MPa	1800 MPa	1700 MPa
Tensile Strength	I.S. EN ISO 527-2	55 MPa	49 MPa	42 MPa
Flexural Strength	I.S. EN ISO 178	90 MPa	80 MPa	75 MPa

6.14.2.5 Gaskets

All gaskets shall be neoprene or Ethylene Propylene Diene Monomer (EPDM) or Thermos Plastic Vulcanised (TPV) (EPDM and Polypropylene (PP) blend) Grade 121-73W175 with the following material properties:

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

6.14.3 Manufacture of transparent panels

Manufacture of transparent panels shall be in accordance with the requirements of this Technical Specification.

Transparent panels shall be a registered product. For registration the manufacturer shall provide certification of their quality management system to AS/NZS ISO 9001. Certification shall be undertaken by a conformity assessment body accredited by the Joint Accreditation System for Australia and New Zealand (JAS / ANZ). The certifier shall be acceptable to the Administrator.

6.14.4 Structural design

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.

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

A minimum of 50 mm bearing on support is needed for all types of panels. If necessary, both acrylic and polycarbonate panels shall be installed in a channel frame engaging all edges.

Steel fastenings through panels shall be avoided.

Bolts connecting components of the structural frame and holding down bolts shall be stainless steel.

The panel shall meet the requirements stated in Clause 6.6.7.

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

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

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

$$\frac{\textit{Span of panel}}{80}$$

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

$$\frac{\textit{Span of panel}}{70}$$

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 where the panel is more than 4 m of pedestrian areas and the edge line of the road, or
- b) 20 mm where the panel is within 4 m of pedestrian areas and the edge line of the road.

The permanent horizontal deflection of the transparent panel under 1.5 times the ultimate wind shall be less than:

$$\frac{\textit{Span of panel}}{320}$$

6.14.5 Testing and acceptance

Transparent panels shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

The selection of suitable transparent materials involves consideration of vandalism or accidental damage, 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 and tends not to accumulate static electricity which attracts dirt, it is more prone to breaking or shattering through vandalism than acrylic or polycarbonate. Both acrylic and polycarbonate can become more brittle due to the ageing process, tending to become yellow and less solid. 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 becoming opalescent over time than glass or acrylic as it absorbs water, especially at exposed edges. Therefore, hard coating shall be applied to polycarbonate. In most applications, acrylic panels will not shatter but instead break into large dull pieces. Acrylic is more established and recommended internationally and in Australia for noise fences than polycarbonate. Many manufacturers will offer warranties for acrylic up to 30 years and polycarbonate up to 15 years.

6.15 Plastic

6.15.1 General

Plastic panels include recycled plastic, exclude the transparent thermoplastic safety panels in Clause 6.14, and shall comply with the requirements stated in Clauses 6.15.1 to 6.15.5 inclusive.

Plastic panels shall conform to the requirements of reflective type fences in Clause 6.3.3.

Plastic panels shall not come in contact with the ground. The plastic panel shall be placed on a minimum 500 mm high, above ground concrete sill beam (refer to Clause 7.10) or on a concrete panel (refer to Clause 6.10).

Special conditions apply to plastic noise fences:

- a) in public areas and on bridges and elevated structures to ensure that no dangerous shards are created and they remain intact when accidentally impacted
- b) in areas where light reflection is a potential hazard, to ensure to minimise risks resulting from possible light reflection from the plastic panels (refer to Clause 6.6.6), and
- c) shall not be used in fire prone areas (refer to Clause 6.6.4).

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

6.15.2 Materials

6.15.2.1 General

Plastic panels shall be evaluated as a system consisting of panel and restraint / support system. The source of all components for the panels shall be specified.

All plastic components shall have a minimum thickness of 6.0 mm.

Characteristic values of panel parameters may be subjected to a change due to:

- the effect of roadside environmental degradation (Solar Ultraviolet (UV) radiation, vehicle exhaust fumes and graffiti-removal solvent chemical attack)
- creep deformation and rupture under service conditions from impact, fire and vandalism
- variations in the manufacturing process, and
- installation damage, including weathering during storage and/or mechanical damage during installation.

Additives and measures to improve fire protection shall only be permissible if these do not lose their effect in the course of time and do not negatively influence other characteristics of the plastic.

Plastic shall be coated with UV-light protection with a pigmented protective coating or be completely integrally coloured.

6.15.2.2 Plastics

Materials used in the manufacture of plastic panels including recycled panels shall comply with the requirements and satisfy the following criteria:

- a) Plastic is manufactured from a synthetic or semi-synthetic material made from various organic polymers, like Polyvinyl Chloride (PVC), polyethylene and nylon. It is also known as polymers of long carbon chains.
- b) Recycled plastic is manufactured from waste plastic that has been collected and processed, by physical, chemical, or other means, and developed in the finished product. Definitions shall be taken from the Australian Standard for Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling).

- c) Characteristic values of recycled plastic shall be comparable to virgin plastic material as benchmarked against different blend formulations of virgin plastic and recycled plastic.
- d) Coefficient of thermal expansion at 50°C shall be tested ISO 11359-2 or equivalent internationally recognised standard.
- e) Evaluate plastic panels in an 'as new' condition and after accelerated ageing to the equivalent of their expected design life, when exposed to UV radiation, vehicle exhaust fumes and graffiti removal at cyclic elevated temperature of 600°C with humidity, and condensation temperature of 400°C with active moisture in standard QUV weatherometer as described in I.S EN ISO 4892-2
- f) Modulus of elasticity and strength properties (tensile strength and flexural strength) of new, after 10 years and 40 years shall be tested I.S. EN ISO 527-2 and I.S. EN 178 or equivalent international recognised standards.
- g) Assess chemical properties, such as organic polymer chemistry and its resistance and its reactions to various other chemical materials and processes, such as ionizing radiation, oxidation and organic solvents.
- h) No mottling and Colour Rating less than 2 to AS/NZS 1580.601.1 at the end of the 40 year period when exposed to weather conditions appropriate for Queensland.

6.15.2.3 Gaskets

Where a gasket is required, all gaskets shall be neoprene or Ethylene Propylene Diene Monomer (EPDM) or Thermoplastic Vulcanised (TPV) (EPDM and Polypropylene (PP) blend) Grade 121-73W175 with the following material properties:

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

6.15.3 Manufacture of plastic panels

Plastic panels shall be manufactured sufficiently strong, stable and durable to comply with the performance and design requirements of this Specification.

Plastic panels shall be a registered product. For registration the manufacturer shall provide certification of their quality management system to AS/NZS ISO 9001. Certification shall be undertaken by a conformity assessment body accredited by the Joint Accreditation System for Australia and New Zealand (JAS / ANZ). The certifier shall be acceptable to the Administrator.

6.15.4 Structural design

The structural behaviour of panels is heavily influenced by the support method.

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

A minimum of 50 mm bearing on support is needed. Panels must not be drilled for mounting purposes.

Steel fastenings through panels shall be avoided.

The panel shall meet the requirements stated in Clause 6.6.7.

Structural design of plastic panels shall utilise a recognised design method.

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

$$\frac{\textit{Span of panel}}{130}$$

6.15.5 Testing and acceptance

Plastic panels shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

Plastics are prone to damage from fire and become brittle after prolonged exposure to sunlight. Plastics may be coloured as required, but colour may bleach in prolonged strong sunlight. It is important to establish whether the recycled product is comparable with new material and ensure it will not tend to degrade more quickly.

6.16 Connectors

6.16.1 General

Connectors shall comply with the requirements stated in Clauses 6.16.1 to 6.16.5, inclusive.

Connectors through panels shall be avoided except timber.

The thickness of base plate connecting the noise fence posts to engineering structures shall be at least as the anchor bolt diameter.

6.16.2 Angles

Steel angles shall be in accordance with those of materials referenced in AS 4100 and the minimum wall thickness shall be 5 mm.

Angles shall be hot-dip galvanised after fabrication in accordance with the requirements of AS/NZS 4680 with an average coating mass of 600 g/m².

Minimum 50 x 50 x 5 equal angle shall be used for supporting noise fence panels to steel post.

6.16.3 Bolts, nuts, screws and washers

All bolts, nuts, screws and washers shall be in accordance with AS 1111.1, AS 1111.2, AS 1112.3, AS 1237.1, AS 1237.2 and AS/NZS 1252.1, as appropriate. All bolts, nuts and screws shall be hot-dip galvanised with a minimum 50 microns thickness in accordance with AS/NZS 1214. All washers shall be hot-dip galvanised in accordance with AS/NZS 4680.

All steel bolts, nuts and washers shall conform to MRTS78 *Fabrication of Structural Steelwork*.

All stainless steel bolts, nuts and washers shall be in accordance with Clause 7.3 of MRTS78A *Fabrication of Structural Stainless Steelwork*.

Levelling nuts under a post base plate shall be avoided if anchor bolts are used.

6.16.3.1 Anchor bolt / rod

Cast-in anchor bolts / rods are manufactured from reinforcing steel rod. The reinforcing steel shall be supplied in accordance with MRTS71 *Reinforcing Steel*. Drilled-in chemical anchors are not permitted to anchoring noise fence to engineering structures. The maximum unsupported length of the anchor bolt / rod from top of footing to the bottom of the base plate shall be not more than one anchor diameter.

6.16.4 Self-drilling screws

6.16.4.1 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.

6.16.4.2 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, 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.

6.16.5 Structural design

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

6.16.6 Testing and acceptance

Connectors shall be tested as stated in Clause 8. Acceptance shall be as stated in Clause 8.

6.17 Acoustic seal

Acoustic seals shall be composed of durable inert materials resistant to atmospheric attack, which will maintain joint thickness within design requirements.

Horizontal acoustic seals shall be one of the closed cell Transport and Main Roads registered products (refer to Clause 5).

Vertical acoustic seals shall be one of the open cell Transport and Main Roads registered products (refer to Clause 5).

6.18 Paints

Paint shall be in accordance with the requirements of MRTS88 *Protective Coating for New Work*.

Painting system shall protect the panel surfaces from atmospheric corrosion, weathering, and exposure to Ultra Violet (UV) colour degradation, and be suitable for application to mask graffiti.

Painting shall be in such a way that the colour changes as little as possible due to weather or Ultra Violet (UV) light and under no circumstances is mottling to appear during the guarantee period.

The painting system shall give a minimum coating life of 15 years.

Paint system shall be one of the Transport and Main Roads registered products (refer to Clause 5) and suitable for the particular type and finish of the panel.

Water based bituminous paint shall be one of the Transport and Main Roads registered products (refer to Clause 5).

Generally anti-graffiti paint is not required, except where specified.

Unless specified otherwise in drawing or in Annexure, the colour shall be either beige (paperbark) or grey (dune) for urban background, and green (wilderness) or black (monument) for vegetative background from the Colourbond® range of colours.

6.19 Footings

6.19.1 General

Footings shall preferably be circular bored pile, depending on the properties of the subsoil and whether they are located on flat or sloping ground or earth mound. Spread footings are allowed if circumstances render drilling impractical.

Footings shall comply with the requirements stated in Clauses 6.19.1 to 6.19.5 inclusive.

The footing of any noise fence located near a property boundary shall be located completely outside the abutting property.

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 noise fence, and access for construction and maintenance. Spread footing shall not be located closer than 1.5 m from the edge of the batter.

Footings shall be designed for both ultimate and serviceability limit states based on site-specific geotechnical investigation parameters. Serviceability limit deflection requirements shall meet the specified deflection tolerance limits of Table 7.14.

It is necessary to verify whether underground utilities and services lie within the zone of influence of the footings or piles or are liable to disturbance due to excavation or pile driving operations. If so, the safety and serviceability of the affected utilities must be analysed and a suitable bridging member designed.

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

6.19.2 Materials

6.19.2.1 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.

6.19.2.2 Reinforcing steel

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

6.19.2.3 Foundation material

The design strength of the subsoil encountered during the geotechnical investigation shall be used for the footing design. The pile shall be proportioned so that the design geotechnical strength is not less than the design action effect. The design geotechnical strength shall be calculated as the design ultimate geotechnical strength multiplied by a geotechnical strength reduction factor. The geotechnical strength reduction factor shall be determined in accordance with Section 4.3.2 of AS 2159.

The ultimate geotechnical strength shall be calculated using total stress approach (e.g. undrained shear strength) and effective stress approach (e.g. effective angle of internal friction) for cohesive and cohesionless soils respectively. For both cases the characteristic shear strength and the angle of internal friction shall be in accordance with Clause 2.3.4 of AS 5100.3.

A design undrained shear strength of no more than 50 kPa can be assumed for engineered fill subject to submit a geotechnical investigation report validating the assumed undrained shear strength of the foundation soil acceptance by the Administrator. **Hold Point 3**

The geotechnical investigation report shall provide the undrained strength, effective angle of internal friction and ultimate bearing strength of each segment of the noise fences.

6.19.3 Cover

Concrete cover shall be in accordance with AS 3600.

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

6.19.4 Circular footings

6.19.4.1 General

The details of the proposed footing locations and depths shall be included on the drawings.

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

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

6.19.4.2 Footing depth on flat terrain

The acceptable method for estimation of ultimate lateral capacity of minimum footing depth design is based on *Brom’s Method* or Section 5.2.2.2 of *Geotechnical Design Standard - Minimum Requirements*.

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

6.19.4.3 Footing depth on batters

For batters, where the noise fence is less than 4.0 m high and the post is within 5 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 6.19.4.3. These factors may be changed where a detailed geotechnical assessment has been undertaken.

If the noise fence is greater than 4.0 m high geotechnical assessment will be required.

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

Table 6.19.4.3 – Adjustment factors for 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

6.19.5 Spread footings

The location, details and dimensions of the spread footing shall be included in the drawings.

Spread footings shall be designed to prevent instability in overturning, sliding and uplift in accordance with AS/NZS 1170.0 Ultimate loads and a maximum bearing pressure of 100 kPa under serviceability wind load shall be assumed.

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

7 Construction

7.1 General

Noise fences shall be constructed in accordance with the details shown on the approved drawings and this Technical Specification. Construction of the noise fence/s shall ensure that the design requirements are met.

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

7.2 Clearing and trimming of trees

Clearing and trimming of trees and disturbance to surrounding ground are to be minimised. Clearing will comprise the orderly removal or trimming of all trees, plants and shrubs that would prevent normal construction of the noise fence. Disturbed areas shall be reinstated to a condition at least equivalent to the existing before the construction. No clearing or trimming of trees shall be carried out unless detailed in the drawing.

Hold Point 4

7.3 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.

7.4 Treatment of cut plywood / batten

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 for preservative treatment of cut plywood (refer to Clause 5) **Hold Point 5** applied as per the manufacturer's requirements. The applied product shall be completely dry before incorporation of the panel into the noise fence.

Alternatively, the cut plywood panels shall be retreated in accordance with Clause 6.8.5.

Plywood panels in contact with the ground shall be veneer treated and such cut plywood will then not have to be retreated. Plywood panels / battens off the ground shall be treated with a product registered for preservative treatment of cut plywood.

7.5 Battens

Battens shall be fixed to the noise fence panel within 5 days of the panel being erected.

7.6 Footings

Excavation for the footings shall not commence until the requirements for identifying and protecting cadastral reference marks have been met as specified in MRTS56 *Construction Surveying* and notice of such works provided to the Administrator.

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

Where any geotechnical characteristic of the footing material is found to be different from what was assumed in the design, assess the impact of this on the approved design and amend the design.

Prior to placement posts, the centre and invert location of the excavation shall be surveyed and must comply with the requirements as prescribed in MRTS56 *Construction Surveying* and notice of such works provided to the Administrator.

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.

Concrete footings shall be a minimum of 3 days of age prior to fixing the panels.

Before placement of the concrete footing, steel posts shall be coated with minimum 1 mm dry thickness of water based bituminous paint (refer to Clause 6.18) 150 mm above and minimum 100 mm below the finish ground level.

7.7 Retaining walls

Retaining walls shown on the drawings shall be undertaken in accordance with the requirements of MRTS03 *Drainage Structures, Retaining Structures and Slope Protections*.

7.8 Earth mounds

Earth mounds shown on the drawings and shall be constructed in accordance with the requirements of MRTS04 *General Earthworks* and the batters shall be landscaped in order to provide erosion control.

7.9 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.

7.10 Sill beam

Any 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, minimum 100 mm above the finished ground level and 150 mm embedded below the finished ground level. 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. Typical concrete levelling sill beam is shown in SD1608 *Noise Fences – Structural Detail – Universal Beam Posts, Concrete Panels, Steel panels*.

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

7.11 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 coordinated with drainage infrastructures (for example, riprap, batter chutes, stormwater drainage) to ensure damage does not occur with concentrated water flow passing through the drainage slot. 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. A typical drainage slot is shown in SD1608 *Noise Fences – Structural Detail – Universal Beam Posts, Concrete Panels, Steel panels*

Unless detailed on the drawings, where a defined drainage path crosses under the noise fence, a minimum of 2 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*.

7.12 Post capping

Hot-dip galvanised mild steel plate shall be securely attached at top of the post for composite, aluminium and steel absorptive panel noise fences.

7.13 Painting

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

Both sides of noise fences shall be painted after installation including steel supports and other items.

Generally, one base coat and 2 topcoats painting shall be applied to the noise fences.

Minimum thickness of 1.0 mm water based bituminous paint (refer to Clause 6.18) shall be applied to the noise fence elements required.

7.14 Tolerances

The tolerances specified in Table 7.14 shall apply to the construction of noise fences.

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

Table 7.14 - 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 between the posts	+ 10 mm - 0 mm
Thickness of plywood, concrete and composite panels	+ 5 mm - 1 mm
Thickness of steel and aluminium panels	+ 3 mm - 0 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 or plastic panels	+ 0.5 mm
Height and span of panels	+ 20 mm - 5 mm
Warping and twisting any point on a surface of a panel	- 10 mm
Maximum out-of-verticality of posts	5 mm/m Maximum of 10 mm

Criteria	Tolerance
Maximum out-of-verticality of panels	2 mm/m
Cover to reinforcement	+ 10 mm - 5 mm
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
Bottom of clamp angle surface clearance	± 50 mm

7.15 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 1 m inside the property or lesser distance as may be possible to allow construction of the noise fence
- b) supply and erect temporary security fencing (refer to Clause 7.16)
- c) backfill excavations/holes associated with work carried out in (a) above
- d) 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
- e) reinstate side fences to new noise fence including supply of any materials similar to the side fences
- f) dismantle and remove temporary security fencing
- g) reinstate facilities temporarily removed to facilitate construction of the noise fence, and
- h) 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.

7.16 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 SD1602 *Fencing - Chainwire fences and gates*.

Where a swimming pool is present, temporary security fencing shall comply with the pool safety legislation.

The Contractor may use 'removable concrete shoes' in lieu of the permanent concrete footings shown on SD1602, 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.

7.17 Removal and salvage of existing noise fence

7.17.1 Components to be salvaged

Sections and components of noise fence to be salvaged are detailed in Clause 1.1 of Annexure MRTS15.1.

7.17.2 Location of storage site

Salvaged items shall be transported to the storage site nominated in Clause 1.2 of Annexure MRTS15.1.

7.17.3 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 to the storage site, such that no damage to the materials is incurred.

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.

7.18 Acceptance of construction

At the end of construction, the Registered Professional Engineer, Queensland who supervised the construction shall forward a certificate to the Administrator including the 'as constructed' drawings in which all information and details for the completed noise fences and all relevant tests records that meet the requirements of the approved drawings and this Technical Specification and as-constructed 3D attributed BIM information models created from as-constructed survey data capture. **Milestone**

8 Testing and acceptance of construction materials

8.1 General acceptance requirements

Acceptance shall follow the requirements of this Technical Specification and the relevant Australian Standards or when such requirements in Australian Standards is unavailable, International Standards, European Standards or American Standards.

At least twenty business days before the supply of noise fence materials, a certification of construction materials with supporting documents including any Performance Warranty Statement that the materials conform to this Technical Specification shall be submitted to the Administrator. **Hold Point 6**

Registered products (refer to Clause 5) shall be delivered without modification.

8.2 Structural steelworks

Testing and acceptance of structural steelwork shall be in accordance with MRTS78 *Fabrication of Structural Steelwork*.

8.3 Plywood panels

Plywood panel shall conform to this Technical Specification. Plywood panel shall be stamped with the compliance data specified by AS/NZS 1604.1. In addition, a certified compliance certificate including laboratory test results of preservative treatment shall be submitted to the Administrator.

Third (3rd) party certification shall be submitted to the Administrator.

8.4 Masonry

Masonry walls shall satisfy the requirements of AS 3700 and shall conform to this Technical Specification.

8.5 Concrete

Concrete walls, panels and concrete footing shall satisfy the requirements of MRTS70 *Concrete*. Precast concrete elements shall comply with MRTS72 *Manufacture of Precast Concrete Elements*.

8.6 Composite panels

Composite panels shall conform to this Technical Specification.

The composite panels shall be substantially free of defects such as chipped or marked edges, unintentional surface roughness, fractures, cracks, dents and bulges.

8.7 Aluminium panels

Aluminium panel members shall conform to this Technical Specification.

8.8 Transparent safety panels or plastic panels

Transparent safety panel or plastic panel members shall conform to this Technical Specification.

The transparent safety panel or plastic panel shall remain in good condition 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.

8.9 Acoustic seal

Horizontal and vertical acoustic seal shall conform with this Technical specification

8.10 Connectors

Angles, bolts, nuts, screws and washers shall conform with this Technical Specification.

8.11 Painting

Painting shall conform with this Technical Specification.

Testing and acceptance of the painting shall be in accordance with MRTS88 *Protective Coating for New Work*.

The Contractor shall submit colour samples and proposed arrangement to the Administrator for approval not less than 2 weeks prior to application to the noise fences. These samples shall be applied to the specified noise fence panel material and shall be a minimum of 1 m². Each sample shall show all separate stages of coating.

Painting shall have no checking, cracking, blistering or loss of adhesion.

8.12 1.4 Other materials

Other materials are used for the noise fence shall conform this Technical Specification and the relevant Standards.

9 Supplementary requirements

The requirements of MRTS15 *Noise Fences* are varied by the supplementary requirements given in Clause 2 of Annexure MRTS15.1.

