

# Specification

**For FRP platforms, walkways, stairways  
and ladders**

Engineering and Environmental Services  
Liveable City Solutions Division  
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## **1 GENERAL**

### **1.1 Scope**

This specification sets out requirements for the supply and installation of Fibre Reinforced Polymer (FRP) platform, walkway, stairway and ladder systems that are permanently installed for operating, inspecting, maintenance and servicing personnel to walk, climb or rest when moving from one place to another. Floor grating, landing, guardrailing, handrail or cage may form part of a system.

A walkway is a designated walking surface with a slope less than 20° (However FRP grating shall not be used on walkways greater than 10 degree). A stairway is a sloping structure with stair treads and a slope within the range of 20° to 45° to the horizontal. A ladder comprises stiles and rungs or treads on which a person may stand on or step in, ascending or descending with a slope within the range of 60° and 90° to the horizontal.

This specification does not cover structural decks, roof coverings and platforms for supporting goods, plant, equipment and vehicular traffic for spans larger than 4.0m long.

### **1.2 Performance**

FRP systems supplied under this specification shall provide safe access to places normally used by operating, inspecting, maintenance and servicing personnel.

They must comply with the relevant requirements for the design, selection, construction and installation as specified in AS 1657 – Fixed platforms, walkways, stairways and ladders.

### **1.3 Manufacturer**

The Contractor shall supply products by manufacturers having adequate experience in the design and manufacture of such systems.

The Contractor shall provide details of at least five past similar successful installations in Australia by the same manufacturer in the last five years.

The Contractor shall submit manufacturer's data required in the Schedule of Technical Data.

### **1.4 Warranty**

The Contractor shall provide a twenty-five (25) year manufacturer warranty on the FRP system supplied under this specification with respect to design, materials and workmanship.

The terms and conditions of the warranty shall be submitted to and accepted by Sydney Water.

## **2 QUALITY**

### **2.1 Quality Assurance**

The FRP system and its components shall be manufactured under a quality management system certified to AS/NZS ISO 9001 – Quality Management Systems.

The Contractor shall supply a third-party certification of the manufacturer's quality system stating the scope of certification and the period of validity. All materials and products must have been supplied or manufactured within the period of validity of the certificate.

## 2.2 Inspection

Sydney Water may inspect or engage third party independent inspectors to carry out quality inspection. The Contractor shall provide all necessary assistance to facilitate the inspections.

## 3 PRODUCT REQUIREMENTS

### 3.1 General

All FRP composites shall be made of fibreglass reinforcement and thermosetting resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the performance requirements stipulated in this specification.

All finished surfaces shall be resin rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibres shall be well covered with resin to protect against their exposure due to wear and weathering.

### 3.2 Reinforcement Fibres

Reinforcement shall be of E-glass, C-glass, S-glass or ECR-glass fibres. E-glass shall not be used in marine, acidic or alkaline environment.

Typical properties of fibres before processing shall be:

	E- glass	C-glass	ECR-glass	S-glass
Specific gravity	2.54	2.5	2.71	2.47
Tensile strength MPa (22°C)	3400	3000	3300	4600
Tensile modulus GPa (22°C)	72	69	72	88
Elongation at break %	4.8	4.8	4.8	3.0
Coefficient of thermal expansion 10 <sup>-6</sup> / °C	5.0	7.2	5.9	2.9

### 3.3 Resins

Resins shall be either polyester or vinylester with the following typical properties:

	Polyester	Vinylester
Specific gravity	1.2 – 1.3	1.12
Tensile strength MPa (22°C)	70	70
Tensile modulus GPa (22°C)	2 – 3	3 – 4
Elongation at break %	4	4

Polyester resins are generally required for common use. Vinylester systems are required for use in marine environments, chemical dosing plants in treatment plants, and in areas in contact with sewage.

Other special chemical formulation may be required for special corrosion resistance properties.

### **3.4 Gel Coats and Surface Veils**

Gel coats and surface veils may be used to increase the durability or to achieve a particular surface finish. Gel coats and veils shall be regarded as non-structural.

### **3.5 Sections and Members**

FRP composite sections and members shall be produced by either pultrusion or resin transfer moulding to achieve constant section profiles. The fibre, resin, matrix system, volume fraction and fibre arrangement shall be selected to produce the required optimum characteristic properties of the composite.

### **3.6 Floor Gratings**

Moulded gratings shall be of a one piece moulded construction with bearing bars and cross bars in the same plane. Gratings shall have a square mesh pattern providing bi-directional strength, with reinforced fibre rovings of equal number of layers in each direction. The top layer of reinforcement shall be no more than 4.5 mm in depth below the top surface of the grating so as to provide maximum stiffness and prevent resin chipping. The percentage of glass by weight shall not exceed 40% so as to achieve maximum corrosion resistance.

Pultruded gratings shall be manufactured by the pultrusion process, shall be of high strength and high stiffness elements having a maximum of 70% and a minimum of 60% glass content by weight of continuous roving and continuous strand mat fibreglass reinforcements. Bearing bars shall be joined into panels, interlocked and epoxied into the proper spacing by passing continuous, notched cross rods through the web of each bearing bar. The notches shall be spaced on centres to match the distance between the load bars. A continuous keeper shall be driven behind the notched cross rods to affix them into place. Chemical bonding shall complete the assembly of the cross bar system to ensure both a mechanical and chemical lock.

The smallest dimension of any opening shall not exceed 45mm and the area of any opening shall not exceed 5000 mm<sup>2</sup>. Any gap between grating panels shall not exceed 10mm. Where personnel have access to or work beneath any platform or landing, the grating floor shall be designed not to permit the passage of a 15mm diameter ball, or be provided with protection to prevent objects falling through the floor reaching the area below. All grating panels shall be evenly laid. Any variation in height between adjacent panels shall not exceed 5 mm.

FRP gratings shall not be used for platforms and walkways with a slope in any direction more than 10°

The minimum imposed load shall be one of the following loads whichever produces the most adverse effect:

- A superimposed uniformly distributed loading of 2.5 kPa, or

- A concentrated loading applied through a 100 mm x 100 mm pad of 1.1 kN at any point.

The deflection at the centre of a simple span shall not exceed 6 mm under full imposed load.

Gratings shall be fixed securely to the supporting framework. The attachment method shall be capable of sustaining the imposed actions and the environment in which the fixing will be placed, such as thermal loading, vibration or chemical attack.

Each grating section shall be readily removable. Grating openings shall be supported to meet load/deflection requirements. Openings for pipe or cable protrusions shall be discontinuous around the centreline of the opening so each section of the grating on either side can be removed.

All grating fasteners or clips shall be made of Grade 316 stainless steel. Fasteners shall be designed to prevent floor panels being dislodged. A minimum of 4 fasteners are required for each panel. Heads proud of the walking surface shall be avoided but, where used, should not pose any risk of tripping.

The Contractor shall supply edge-banding at the leading edge of platforms / walkways, around penetrations or openings and at access hatches.

### 3.7 Fixed Ladders

Fixed ladders shall be tested in accordance with Appendix F, AS 1657. The acceptance criteria are:

Tests (Appendix F, AS 1657)	Acceptance criteria
Test 1 – rung/tread strength test	Permanent set not more than 1% of rung length.
Test 2 – rung/tread shear strength test	No structural failure.
Test 3 – stile deflection test	Deflection not more than L/100 or 40mm, whichever is the lesser, where L is the horizontal span of the ladder between supports
Test 4 – stile strength test	Permanent set not more than 1% of the horizontal span of the ladder between supports
Test 5 – stile side sway test	Deflection of bottom stile not more than 1% of the horizontal span. Permanent set not more than 0.5% of the horizontal span.

### 3.8 UV Resistance

All FRP composites shall be protected from ultraviolet (UV) light degradation by the addition of an UV stabiliser. The item shall be tested in accordance with the requirements of ASTM G154 – Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Non-metallic Materials, or other approved equivalent standards.

### 3.9 Non-slip Surface

Walking surfaces including steps, treads and rungs shall be slip resistant. The minimum grip resistance in both the direction of travel and that at 90° shall not be less than Class R11, Oil-wet

Inclining Platform when tested in accordance with AS 4586 – Slip resistance classification of new pedestrian surface materials.

Moulded gratings shall have a concave profile on the top of each bar. A secondary grit surface shall be applied or integrally moulded to the top surface. Pultruded gratings shall be provided with a grit surface securely bonded to the top of the pultruded sections.

### 3.10 Colour

The colours of FRP composite sections, members, gratings and ladders shall be as agreed with Sydney Water. High quality pigments suitable for continual exposure to sunlight or chemical agents shall be used.

### 3.11 Fire Rating

All FRP items shall not be flammable and shall have fire-retardant properties.

All items shall have a flame spread rating of 25 or less when tested in accordance with ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials (Tunnel Test), or a burn time of less than 30 seconds and burn rate of less than or equal to 10mm when tested in accordance with ASTM D635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

### 3.12 Use in Contact with Drinking Water

When used in contact with drinking water, FRP gratings and components shall be tested and shall comply with the requirements of AS 4020 – Testing of products for use in contact with drinking water.

### 3.13 Fixings and Fasteners

All components shall be fixed securely. The attachment method shall be capable of sustaining the imposed actions and the environment in which the fixing will be placed, such as thermal loading, vibration or chemical attack.

All fixings and fasteners shall be made of Grade 316 stainless steel.

### 3.14 Dimensional Tolerances

FRP sections and members shall comply with the following tolerances:

Measurement	Tolerance
Overall depth	+/- 2 mm
Overall width	+/- 2 mm
Overall length of section	+/- 5 mm
Lateral bow	5 mm over length of section
Squareness	Not greater than 1 degree out of square on any cross section
Twist	With one end cross section taken as reference, any cross section shall not exceed 1 degree
Position of holes in section	+/- 1 mm



FRP gratings shall comply with the following tolerances:

<b>Panel Tolerances (as manufactured)</b>	
Panel size – moulded (width, length and diagonal)	+/- 3 mm
Panel size – pultruded (width, length and diagonal)	+/- 6 mm
Grating depth	+/- 1.5 mm
Panel flatness (warp) - length direction	+/- 2.6 mm per lin m
- width direction	+/- 5.2 mm per lin m
<b>Cutting Tolerances</b>	
Straight cuts	+ 0 - 6 mm
Circular cuts	+ 0 - 9 mm

### 3.15 Test Certificates

Material tests shall be carried out by competent testing laboratories approved by NATA, or other equivalent agencies. Typical product properties and performance characteristics not specific to the product batch may not be accepted.

The Contractor shall supply manufacturer's test certificates or compliance documentation for the following product tests (other equivalent standards may be accepted), where applicable:

	<b>Floor Gratings</b>	<b>Sections and Members</b>	<b>Test Method</b>
Flexural strength (min)	206 MPa	Axial: 240 Transverse: 100	ASTM D790 – Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
Tensile strength (min)	206 MPa	Axial: 300 Transverse: 55	ASTM D638 – Standard Test Method for Tensile Properties of Plastics
Thermal expansion	~ 15 x 10 <sup>-6</sup> per °C		ASTM D638 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics
Slip resistance	R11		AS 4586 – Slip Resistance Classification of New Pedestrian Surface Materials (Oil Wet Inclining Platform Test)
UV resistance	Comply		ASTM G154 – Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Non-metallic Materials, or other equivalent standards
Burn time	Less than 30 seconds		ASTM E84 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
Burn rate	Less than or equal to 10 mm		
Toxicity (if applicable)	Comply		AS 4020 – Testing of Products for Use in Contact with Drinking Water

## **4 DESIGN**

### **4.1 Basis of Design**

The structure shall be designed to be fit for the purpose for which it is required, to sustain all actions likely to occur during its use and to be durable having due regard to its intended life.

### **4.2 Design Code**

Design shall be carried out using the limit state method in accordance with the EUROCOMP Design Code – Structural Design of Polymer Composites. Other equivalent design codes published by recognised institutions may be used.

### **4.3 Loading**

Except otherwise specified, design loadings shall be in accordance with AS 1170.1. Where loading due to wind is seen, provision shall be made for the design loadings of AS 1170.2. Reference shall be made to AS 1170.0 for appropriate load factors and combinations of actions.

Physical edge protection including guardrailing, toeboard and infill panels shall be designed to sustain the imposed actions as outlined in Clause 6.1 of AS 1657.

### **4.4 Design Personnel and Documentation**

The design shall be carried out by a structural engineer or other appropriately qualified personnel with at least 3 years of design experience using a recognised FRP design code.

Design calculations shall be documented, checked and verified. Design calculations shall include the following:

- Applicability of codes and standards
- Aim of design
- Basis of design including strength and serviceability performance, design assumptions, economic, physical, aesthetic and other constraints
- Design life
- Design actions or loads
- Design resistance or strength
- Analytical methods or software used
- Safety considerations.

### **4.5 Section and Member Design**

Section and member design shall take into account tension, compression, flexure, shear, stability, creep, fatigue, impact, rupture, stress corrosion and chemical attack.

Sydney Water discourage application when conditions such as unbalanced loads, asymmetrical sections and members resulting in bending and torsion actions are present.

#### **4.6 Brittle Failure**

Due to the brittle behavior of FRP composites, the structure and its members shall be designed to give reasonable and adequate warning at an appropriate serviceability limit prior to reaching its ultimate limit state failure.

#### **4.7 Deflection**

The deformation of a member shall be such that it does not adversely affect its proper function or appearance. The sum of all relevant deformations due to short and long term loading actions shall not exceed the  $L/250$  where L is the length of the member.

#### **4.8 Connection Design**

Connections may be mechanical or bonded, or a combination of both. A primary structural connection providing major strength and stiffness for the whole service life of the structure shall be of the mechanical type. Bonded connections are only allowed in ladders and handrails.

All joint designs shall either be by calculations or numerical analysis, or by acceptable testing methods.

### **5 INSTALLATION**

#### **5.1 Shop Drawings**

The Contractor shall verify all measurements on site. Correct size, length and location of cut-outs shall be determined prior to fabrication.

The Contractor shall prepare and submit installation drawings showing location, configuration, sizes, dimensions, fastenings, anchors and connection details.

#### **5.2 Fabrication**

Members and components shall be shop fabricated for easy of assembly on site. Each piece shall be match-marked to shop drawings.

All members and components shall be fabricated free from warps, twists and other defects. All cut ends, holes and abrasions shall be sealed with a resin in accordance with the manufacturer's instruction.

#### **5.3 Delivery and Storage**

All components shall be delivered in original, unbroken pallets, packages or bundles bearing the label of the manufacturer. Adhesives, resins and hardeners, if required, shall be crated or boxed separately for dry indoor storage.

All materials shall be handled carefully to prevent them from abrasion, cracking, chipping, twisting and any type of damage. Items shall be stored in an enclosed area free from contact with soil and water.

## SCHEDULE OF TECHNICAL DATA – SECTIONS AND MEMBERS

<b>FRP Composite</b>		
Manufacturer	-	
Place of manufacture	-	
<b>Glass Fibre</b>		
Fibre type	-	
Specific gravity	-	
Tensile strength (22° C)	MPa	
Tensile modulus (22° C)	GPa	
Elongation at break	%	
Coefficient of thermal expansion	10 <sup>-6</sup> /°C	
<b>Resin</b>		
Resin type	-	
Specific gravity	-	
Tensile strength (22° C)	MPa	
Tensile modulus (22° C)	GPa	
Elongation at break	%	
<b>FRP Composite Characteristic Properties</b>		
Volume fraction of fibre	%	
Specific gravity	-	
Tensile strength	MPa	
Tensile modulus	GPa	
Compressive strength	MPa	
Compressive modulus	GPa	
Shear strength	MPa	
Shear modulus	GPa	
Flexural strength	MPa	
Flexural modulus	GPa	
Strain at failure	%	
Poisson ratio	-	
Thermal expansion	per °C	
Slip resistance	-	
UV resistance	-	
Burn time	second	
Burn rate	mm	
Use in contact with drinking water	-	
<b>Fasteners</b>		
Material description	-	
<b>Documentation</b>		
Structural calculations	Clause 4.3	
Dimensioned drawings		
Chemical resistance Table	-	
Material Safety Data Sheets	-	
Installation instructions	-	
Maintenance instructions	-	
Warranty	-	

## SCHEDULE OF TECHNICAL DATA – FLOOR GRATINGS

<b>General</b>		
Manufacturer	-	
Place of manufacture	-	
Grating designation	-	
Resin system	-	
<b>Moulded Grating</b>		
Percentage by weight of glass fibre	%	
Bar depth	mm	
Bar thickness	mm	
Bar centres	mm	
Cross bar depth	mm	
Cross bar thickness	mm	
Cross bar centres	mm	
Mesh opening width	mm	
Mesh opening length	mm	
% open area	%	
Weight	kg/m <sup>2</sup>	
<b>Pultruded Grating</b>		
Percentage by weight of glass fibre	%	
Load bar section dimensions	mm	
Load bar centres	mm	
Cross bar section dimensions	mm	
Cross bar centres	Mm	
% open area	%	
Weight	kg/m <sup>2</sup>	
<b>Fasteners</b>		
Material description	-	
Type	-	
<b>FRP Composite Characteristic Properties</b>		
Weight fraction of fibre	%	
Specific gravity	-	
Flexural strength	MPa	
Flexural modulus	GPa	
Tensile strength	MPa	
Tensile modulus	GPa	
Thermal expansion	per °C	
Slip resistance	-	
UV resistance	-	
Burn time	seconds	
Burn rate	Mm	
Use in contact with drinking water	-	
<b>Documentation</b>		
Load / deflection Table	-	
Dimensioned drawings		
Chemical resistance Table	-	
Material Safety Data Sheets	-	
Installation instructions	-	
Maintenance instructions	-	
Warranty	-	