

# PermaStruct® FRP Structural Design Guide



*Confidence with every step*

# PermaStruct®

V2020.03





## Our Expertise 03

### PermaStruct® FRP Profiles 04

Material Properties	05
Design Considerations	05
Connection Details	06
Corner Connection	06
Corner Cut Length Connection	06
3 Way Beam Column Connection	07
4 Way Beam Column Connection	07
Channel to Ground Connection	08
Channel Plate Connection	08

### PermaStruct® FRP Staircases 09

Material Properties	10
Design Considerations	11
Connection Details	12
Stair Tread Connection	12
Handrail Connection	13
Inclined Handrail Connection (Start)	14
Inclined Handrail Connection (End)	15
Landing Connection	16

### PermaStruct® FRP Boardwalks 17

#### PermaStruct® RapidDeck System 18

Material Properties	19
Design Considerations	20
Connection Details	21
General Connections	21
Handrail Connections - Pedestrian Access	24
Handrail Connections - Shared Access	25
Footing Connections	26

#### PermaStruct® Boardwalks 27

Material Properties	27
Design Considerations	28
Connection Details	29
Boardwalk Frame Connection	29
Boardwalk Deck Connection (FRP)	30
Boardwalk Deck Connection (WPC)	31
Handrail / Kick Rail Frame Connection	32
Beam Column / Leg Connection	33

### PermaStruct® FRP Ladders 34

Material Properties	35
Design Considerations	35
Connection Details	38
Ladder Platform Connection (Fixed)	38
Ladder Platform Connection (Mobile)	39

### PermaStruct® FRP Jetties 40

Material Properties	41
Design Considerations	42
Connection Details	43
Beam to Pier Connection	43

## Appendix 44

Appendix 1: PermaStruct® FRP Profile Material Properties	45
Appendix 2: PermaStruct® FRP Grating Material Properties	45
Appendix 3: PermaStruct® RapidDeck Material Properties	45
Appendix 4: PermaTimber® WPC Material Properties	45
Appendix 5: PermaTimber® WPC Decking Spans	45
Appendix 6: PermaStruct® FRP Profile Load Table	46
Appendix 7: PermaStruct® FRP Grating Load Table	52



**PermaStruct® by Perma Composites® offer a range of high quality fibre-reinforced plastic products and composite solutions. We specialise in creating custom, unique solutions for major projects, with a dedication to designing, engineering and customer service.**

The following design guide provides general guidelines to be used when designing PermaStruct® FRP Structures, and includes the typical design considerations and connection details. Each project will have different site conditions such as terrain, soil strength and wind conditions.

## QUALITY ASSURANCE

Perma Composites® have been accredited to ISO 9001:2015 for quality and AS/NZS 4801 for occupational health and safety. This means that you can buy with confidence knowing that our standards and procedures keep with the highest quality measures.

Furthermore, all PermaStruct® FRP Structures have been designed and engineered to comply with the following standards:

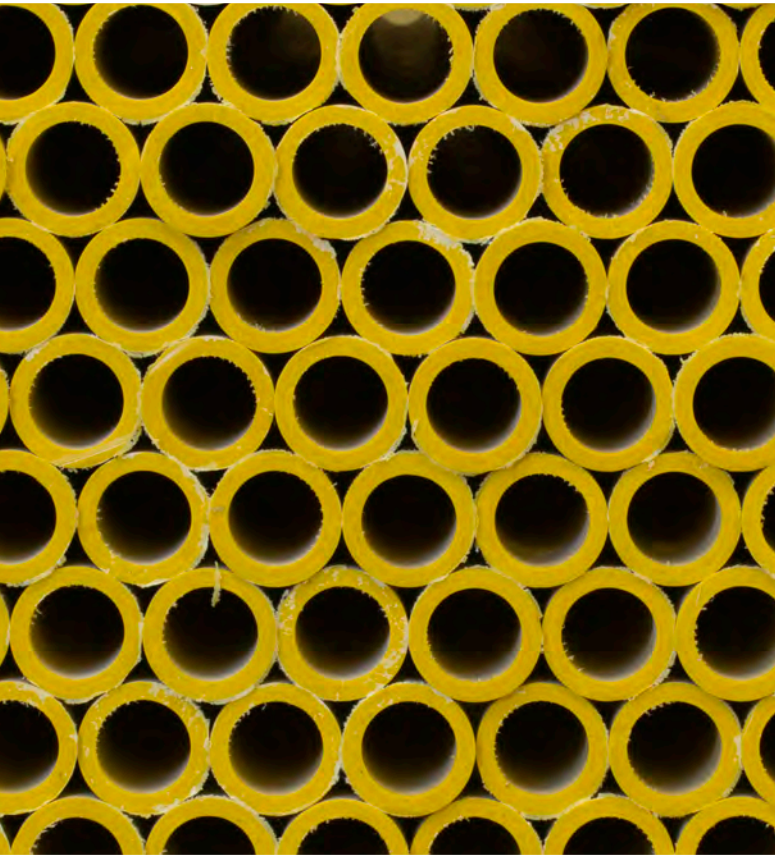
- ✓ National Association of Testing Authorities Australia
- ✓ AS 1657- 2013 Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation
- ✓ AS 1170 Structural Design Actions (includes permanent, imposed, wind and other actions)
- ✓ AS 4100 Steel Structures
- ✓ AS 5100 - Bridge Design Standard
- ✓ AS 3996 - Access Covers & Grates



**Please Note:** The information contained in this PermaStruct® FRP Structural Design Guide is intended to be used as a general guide. It is not a substitute for proven engineering practices and designs.

VOLUME 1

# PermaStruct® FRP Profiles





# 1. PERMASTRUCT FRP PROFILES

PermaStruct® FRP Profiles represent a modernised progression in building technologies. These durable profiles are as strong as traditional materials and can be manufactured into a range of external structures, such as platforms, boardwalks and staircases.

## MATERIAL PROPERTIES

The material properties of PermaStruct® FRP Profiles are detailed in Appendix 1. For the loading capabilities of PermaStruct® FRP Profiles please refer to Appendix 6.

## DESIGN CONSIDERATIONS

PermaStruct® Profiles should be designed for both Ultimate Limit State (ULS) and Serviceability Limit State (SLS) for bending and shear. It is also important that the PermaStruct® FRP Profiles used in a structure are designed for a deflection limit of  $L/300$ .

The lack of available technical standards and guidelines for FRP in Australia means that all structures should be checked for stresses compared to the material properties outlined in Appendix 1. For example, the shear stress of a beam under a load should be compared against shear strength of the FRP material with an appropriate factor of safety applied. A FOS should also be applied to the moment of inertia ( $I$ ) of all profiles, to consider the effects of creep and fatigue cracking.

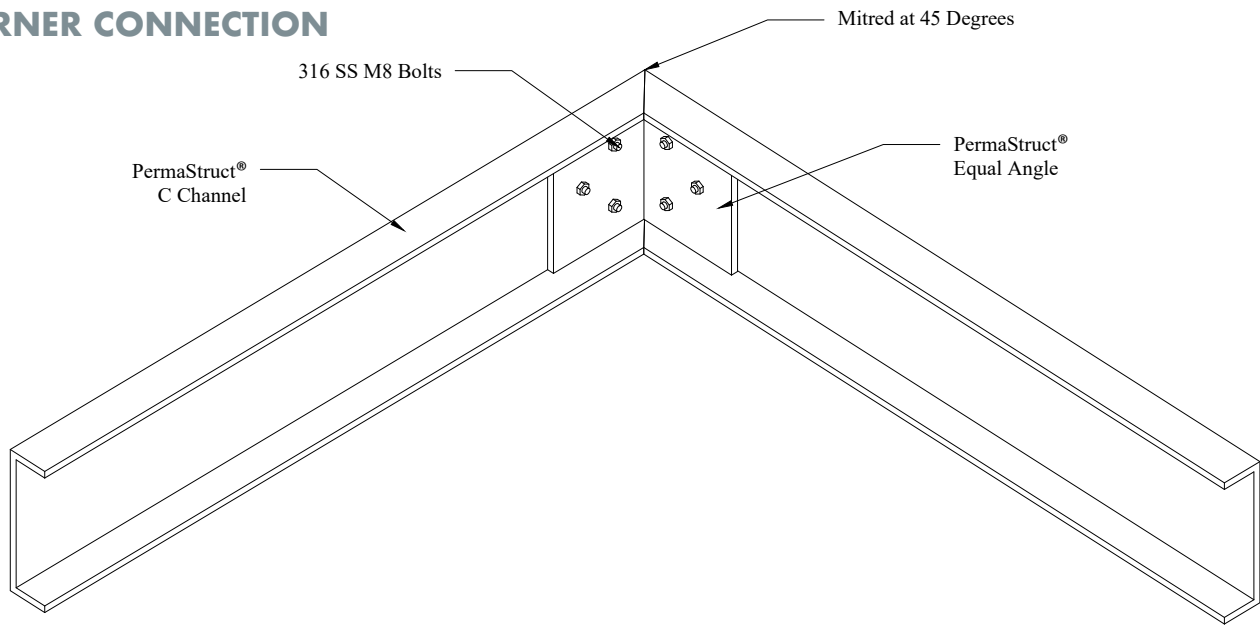


# 1. PERMASTRUCT FRP PROFILES

## CONNECTION DETAILS

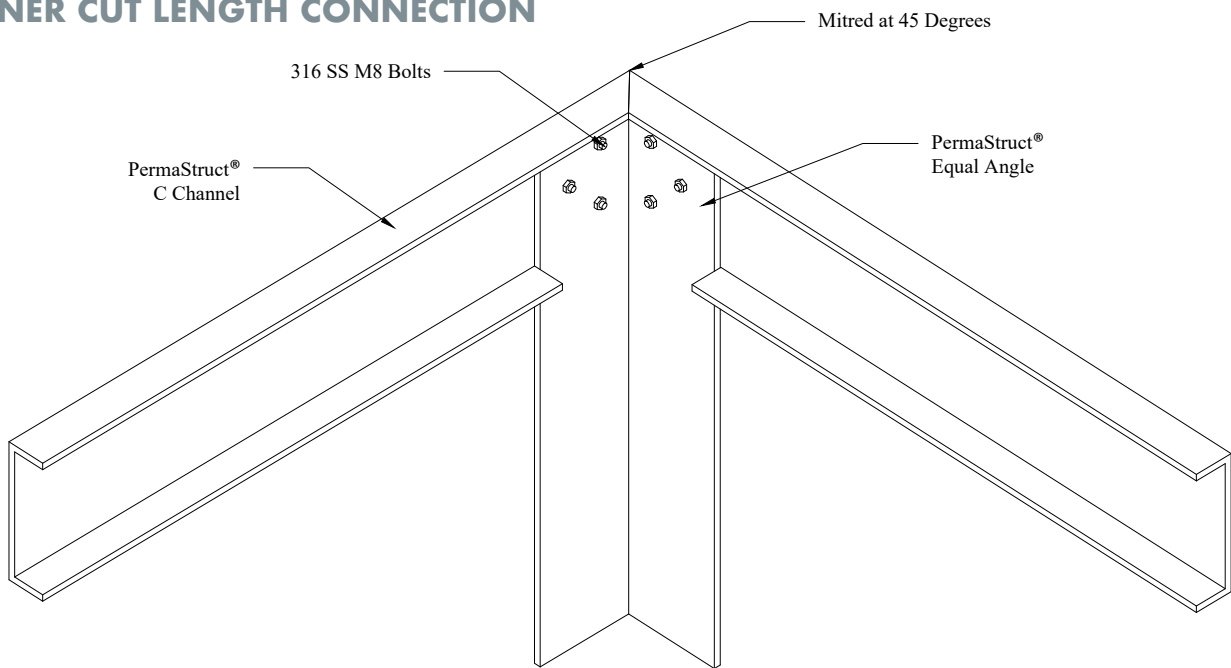
PermaStruct® FRP Profiles can be connected in various ways to suit different structures, with the following technical drawings outlining the common connections. Please Note: All bolts are to be arranged asymmetrically with a minimum edge distance of 25mm unless otherwise stated.

### CORNER CONNECTION



No. of Bolts	Plate Thickness	Shear Capacity (KN)	Tear Capacity (KN)	Crushing Capacity (KN)
3	12.7 mm	21	56	67
	9.5 mm	21	42	50

### CORNER CUT LENGTH CONNECTION

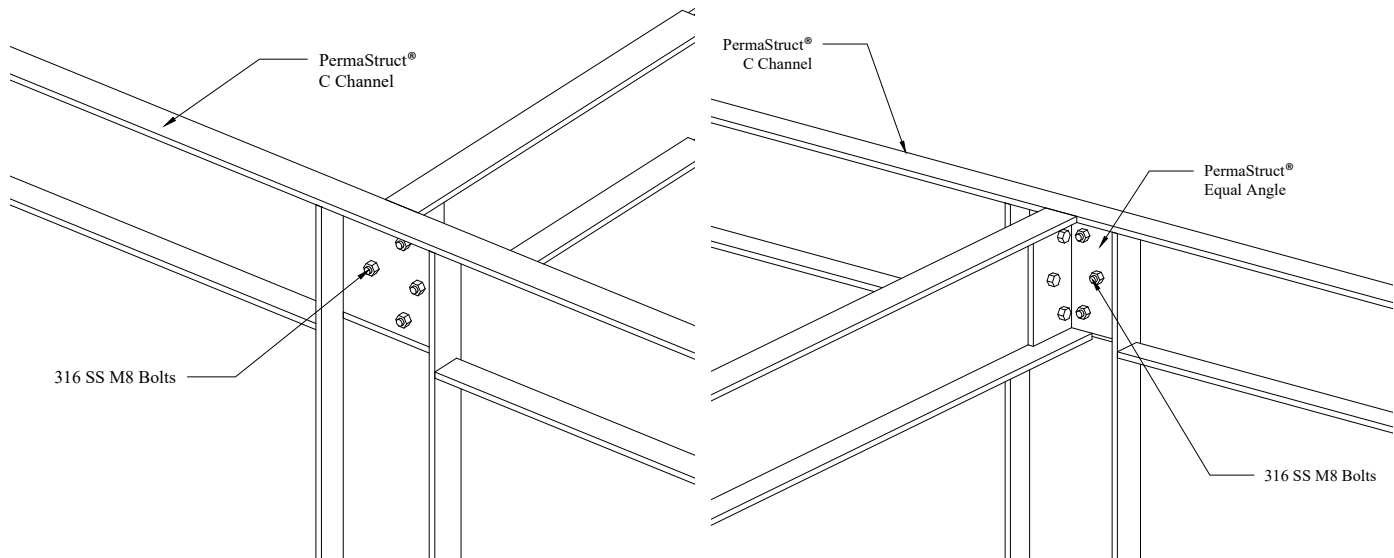


No. of Bolts	Plate Thickness	Shear Capacity (KN)	Tear Capacity (KN)	Crushing Capacity (KN)
3	12.7 mm	21	56	67
	9.5 mm	21	42	50

# 1. PERMASTRUCT FRP PROFILES

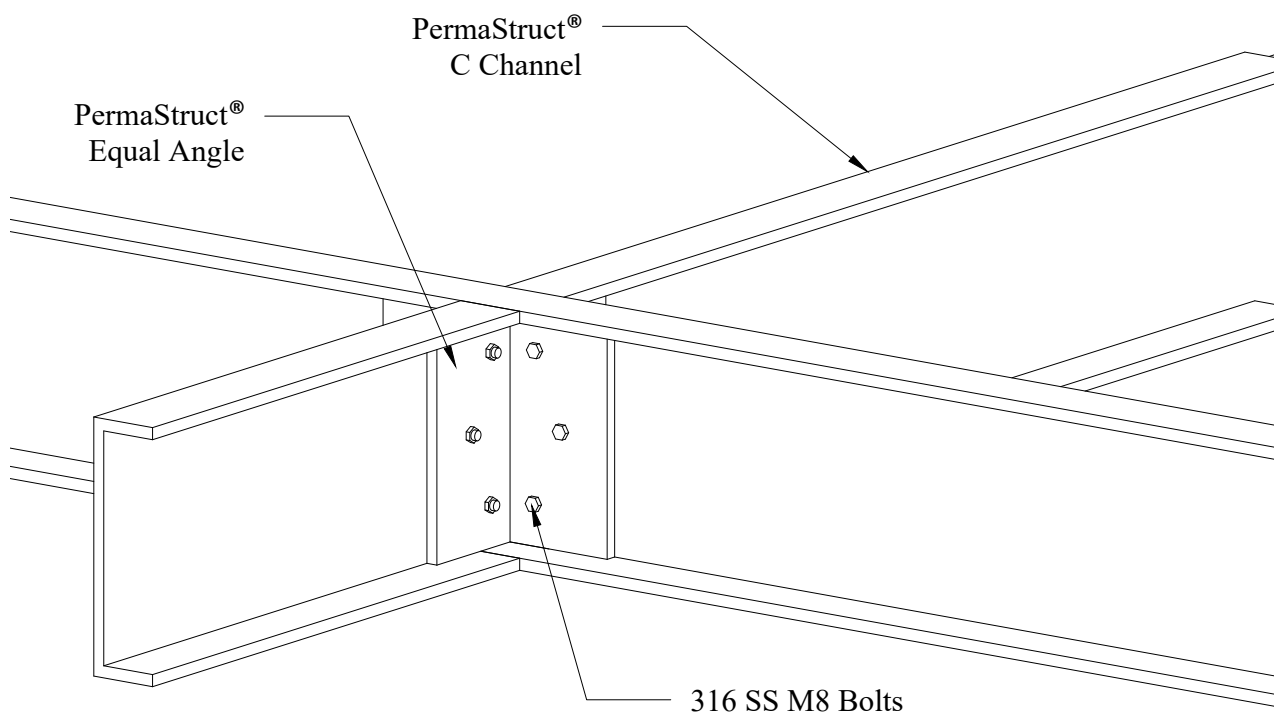
## CONNECTION DETAILS

### 3 WAY BEAM COLUMN CONNECTION



No. of Bolts	Plate Thickness	Shear Capacity (KN)	Tear Capacity (KN)	Crushing Capacity (KN)
4	9.5 mm	29	56	67

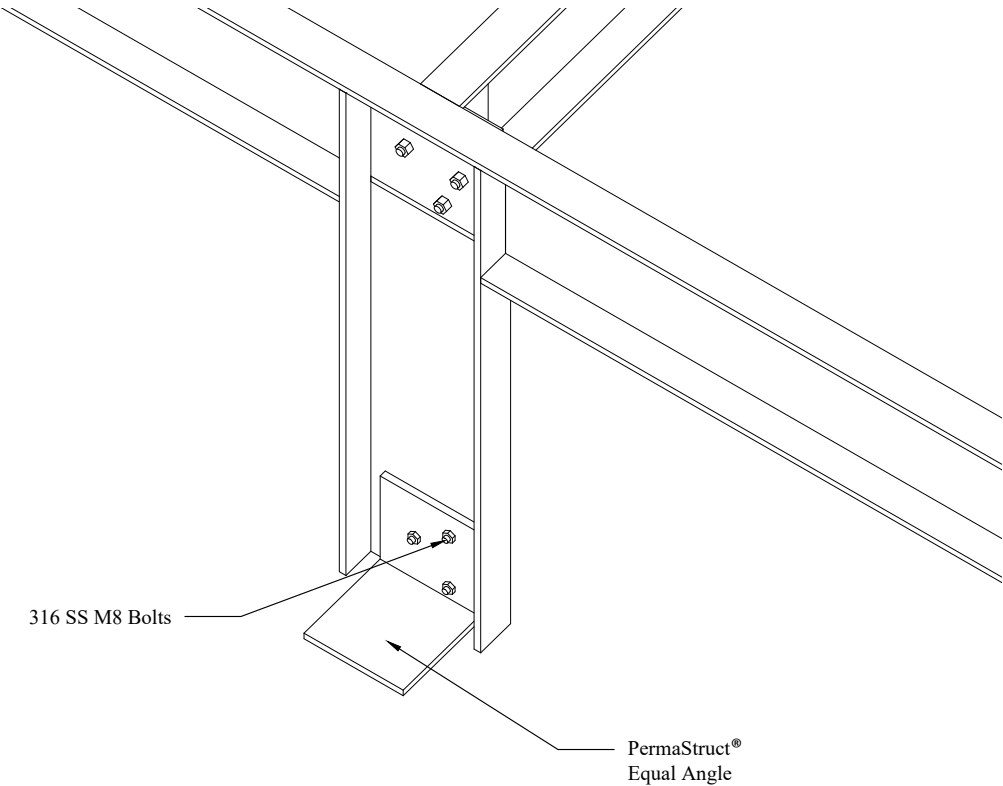
### 4 WAY BEAM COLUMN CONNECTION



No. of Bolts	Plate Thickness	Shear Capacity (KN)	Tear Capacity (KN)	Crushing Capacity (KN)
4	9.5 mm	29	56	67

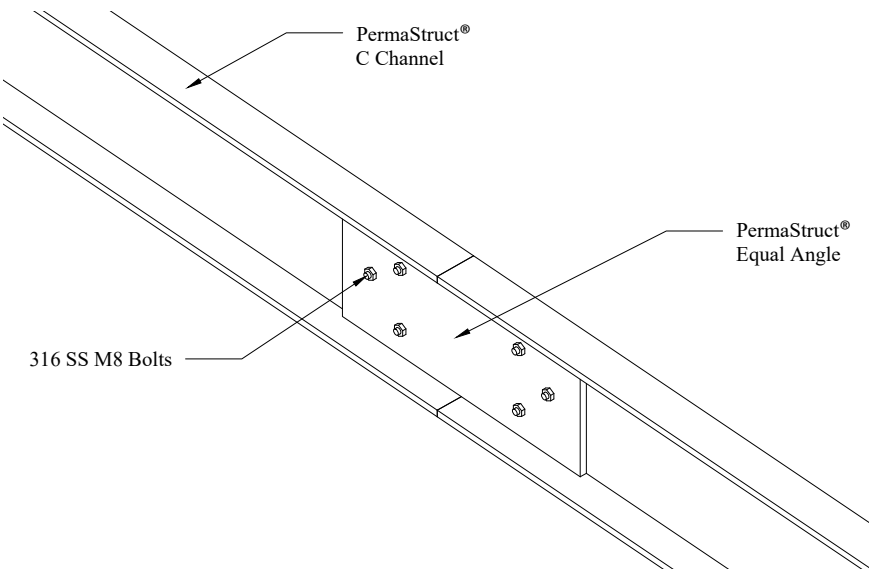
CONNECTION DETAILS

CHANNEL TO GROUND CONNECTION



No. of Bolts	Plate Thickness	Shear Capacity (KN)	Tear Capacity (KN)	Crushing Capacity (KN)
4	9.5 mm	29	56	67

CHANNEL PLATE CONNECTION



No. of Bolts	Plate Thickness	Shear Capacity (KN)	Tear Capacity (KN)	Crushing Capacity (KN)
3	12.7 mm	21	56	67
	9.5 mm	21	42	50



VOLUME 2

# PermaStruct® Staircases



## 2. PERMASTRUCT STAIRCASES

PermaStruct® Staircases can be custom built to your specifications and are manufactured from PermaStruct® FRP Profiles.

### MATERIAL COMPONENTS STRUCTURAL FRAMEWORK

The material properties of PermaStruct® FRP Profiles are detailed in Appendix 1. For the loading capabilities of PermaStruct® FRP Profiles please refer to Appendix 7.

The main PermaStruct® FRP Profiles used for the structural framework include the following:

Profile	Dimensions (mm)	Use
PermaStruct® FRP C Channel	203 x 56 x 9.5mm	Stringers & Primary Beams (Bearers)
PermaStruct® FRP Equal Angle	152 x 152 x 12.7mm	Columns & Connection Brackets
PermaStruct® FRP Box	50 x 50 x 6.4mm	Square Handrails, Secondary Beams (Joists) & Connection Brackets
PermaStruct® FRP Equal Angle	50 x 50 x 6.4mm	Stair Tread Brackets
PermaStruct® FRP Kick Rail	150 x 3mm	Kick Rail

### STRUCTURAL LANDING / STAIR TREADS

The Landing Decks and Stair Treads of PermaStruct® Staircase are manufactured from PermaStruct® FRP Grating. PermaStruct® FRP Grating is available in a range of mesh sizes and thicknesses, please refer to the material properties in Appendix 2 and loading capabilities in Appendix 7.





## 2. PERMASTRUCT STAIRCASES

### DESIGN CONSIDERATIONS

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#### STRUCTURAL FRAMEWORK

PermaStruct® C Channel 203 x 56 x 9.5mm is used for all primary beams and stringers. These are to be checked for both ultimate limit state (ULS) and serviceability limit state (SLS), with load factors to be used are in accordance with AS 1170.0. At spans where the deflection at  $L/300$  is excessive, columns are to be added.

Beam spacing and sub-frame layout for landings should be designed based on a maximum Live Load from PermaStruct® FRP Profile Load Table, see Appendix 6. It is also important to consider the effect of long term deflection due to creep for structures with high importance levels i.e. use a creep factor of 1.2 where appropriate. Overall framework is to be also checked to comply with wind loading as per AS 1170.2 if the PermaStruct® Staircase is exposed to external environments.

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#### STRUCTURAL LANDING

All Landings for PermaStruct® Staircases are connected and designed to satisfy the minimum imposed loadings as follows:

- A uniformly distributed superimposed live loading of 2.5 KPA
- A concentrated loading applied through a 100 x 100 mm pad of not less than 1.1 KN at any point

Other specific load requirements should be designed in accordance with AS1170.1.

All PermaStruct® FRP Grating used on landings should span one-way and beam arrangements should be made to suit a 'one-way spanning slab' condition. All PermaStruct® FRP Grating should be designed based on Ultimate Limit State (ULS) for UDL and Point Load and checked against a maximum deflection of 5mm for Serviceability Limit State (SLS), see the PermaStruct® FRP Grating Load Table in Appendix 5. This is a necessary measure as it allows for lack of significant stiffness of FRP material.

Kick Rails are required for landings where a person has access to the area beneath the landing. For overall structure max deflection  $L/100$  or 4mm.

---

#### HANDRAIL

Handrails for PermaStruct® Staircases can be either square or round. Square handrails may vary in the following profile sizes 50x50mm, 64x64mm, 102x102mm SHS, however, are all 6.4mm thick. All round handrails will have a 7mm thick, 50 mm OD Tube.

All PermaStruct® Handrails and Connectors have been tested for Ultimate Limit State and Serviceability Limit State as per AS1657 Appendix B 4.4 and have been accredited by National Association of Testing Authorities, Australia (NATA).

## 2. PERMASTRUCT STAIRCASES

### CONNECTION DETAILS

PermaStruct® Staircases have different profile connections with varying fixing requirements, from a fixed to pinned support, bolted to pot riveted joists, and mitred to non-mitred ends. These connections have a major influence on the strength of the overall structure.

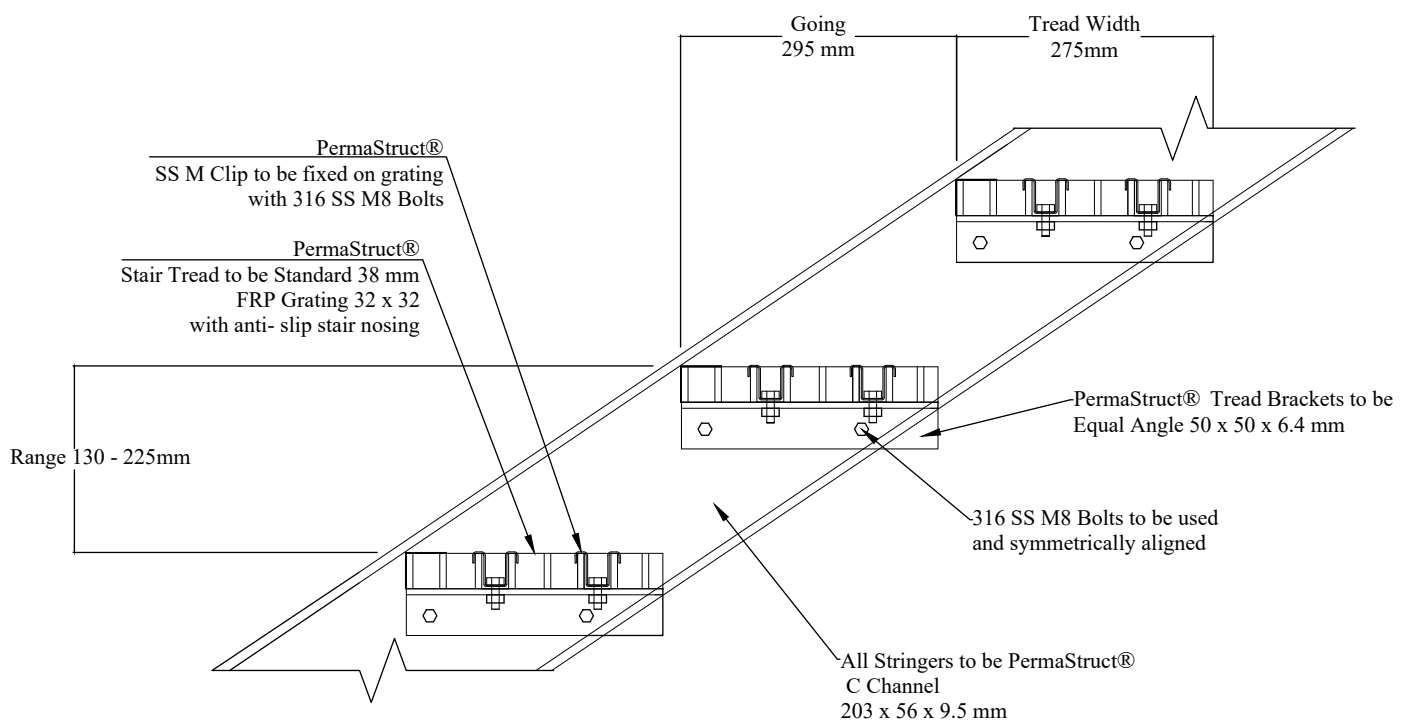
### STAIR TREAD CONNECTION

All Risers and Goings have been designed to comply with AS 1657, with the following considerations:

- Stair Tread loading and self weight should be distributed to stringers.
- Moment Connections should be designed as pinned supports.
- Stairways shouldn't be less than 600 mm wide, measured between the inside edges of the stringer.
- The slope of the staircase i.e. stringer angle should not exceed 45 degrees and a 30 – 38 degrees.
- The number of stair risers should be not less than two and not greater than 18.
- The surface of every tread should extend across the full width of the stairway and the tread surface should be slip-resistant.
- All risers and goings should have uniform dimensions with a permissible tolerance of +/- 5 mm.
- Stair Nosing should be designed such that the edge of the tread is clearly visible against the background.

#### Please Note:

- All Goings to range from 215 to 355mm
- Goings = Tread Width + Tread Gap (20mm)
- Tread Gap < 30mm
- All Risers and Goings to satisfy  $540 \leq (2R+G) \leq 700$
- Minimum Allowable Tread Width = 185mm
- All Bolts to have a minimum edge distance of 25mm.





## 2. PERMASTRUCT STAIRCASES

### CONNECTION DETAILS

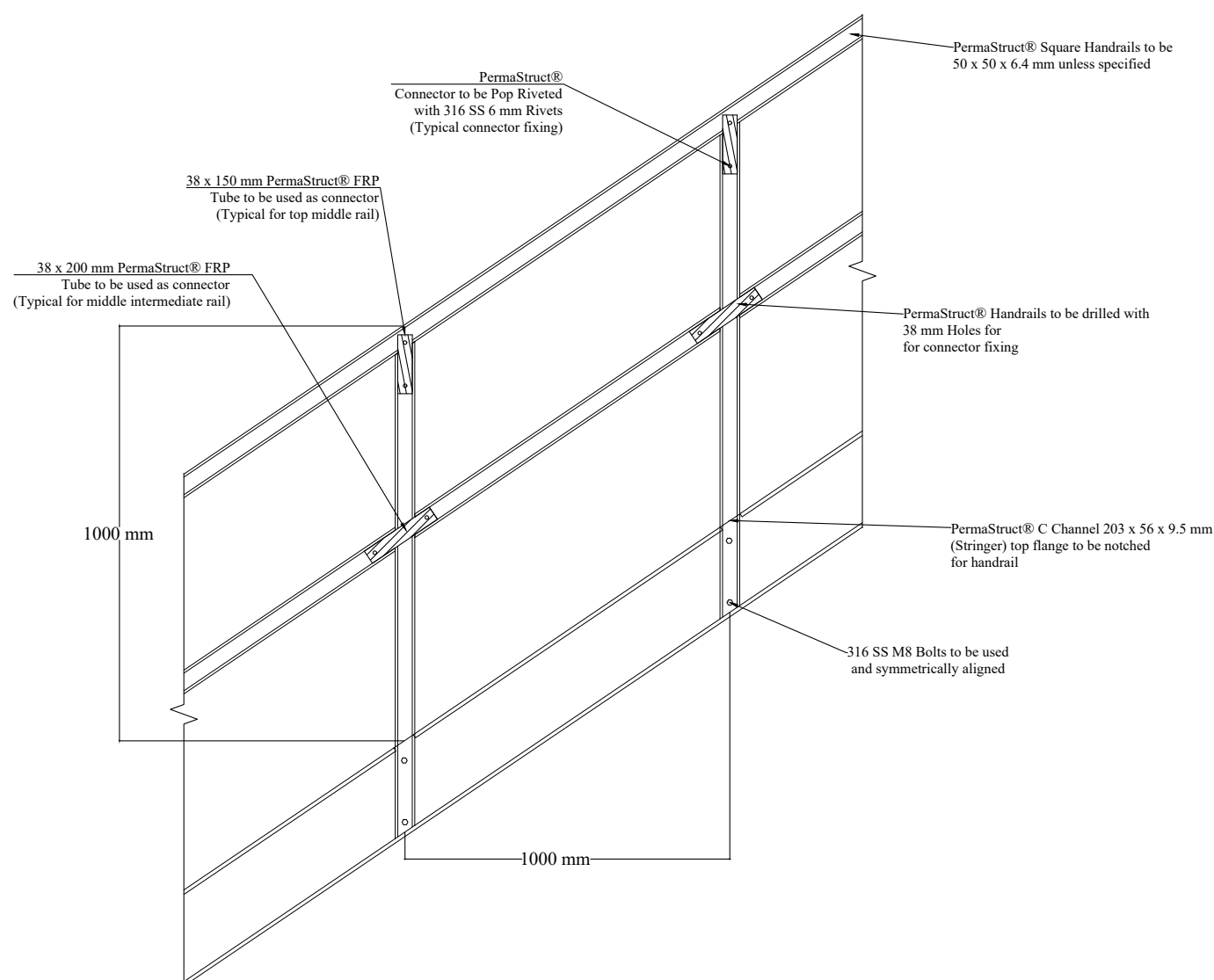
#### HANDRAIL CONNECTION

All exposed sides of the PermaStruct® Staircase must be fitted with handrails. At least one of the top, intermediate or bottom rails shall be continuous between the stair and flight landings, and should have no obstruction that will lead to a breaking in the handhold. PermaStruct® Staircases therefore have a continuous top rail.

All connections from stringer to landing shall be a pinned connection, while connections to the ground may be considered fixed. It is recommended that a pinned connection is used for structural analysis, due to the ease of the materials ability to rotate compared to a steel welded plate connection. All bolts should maintain a minimum edge distance of 25 mm. Notching of stringer will affect stringer strength, but not to the degree that would lead to potential failure, under standard walkway load cases.

#### Please Note:

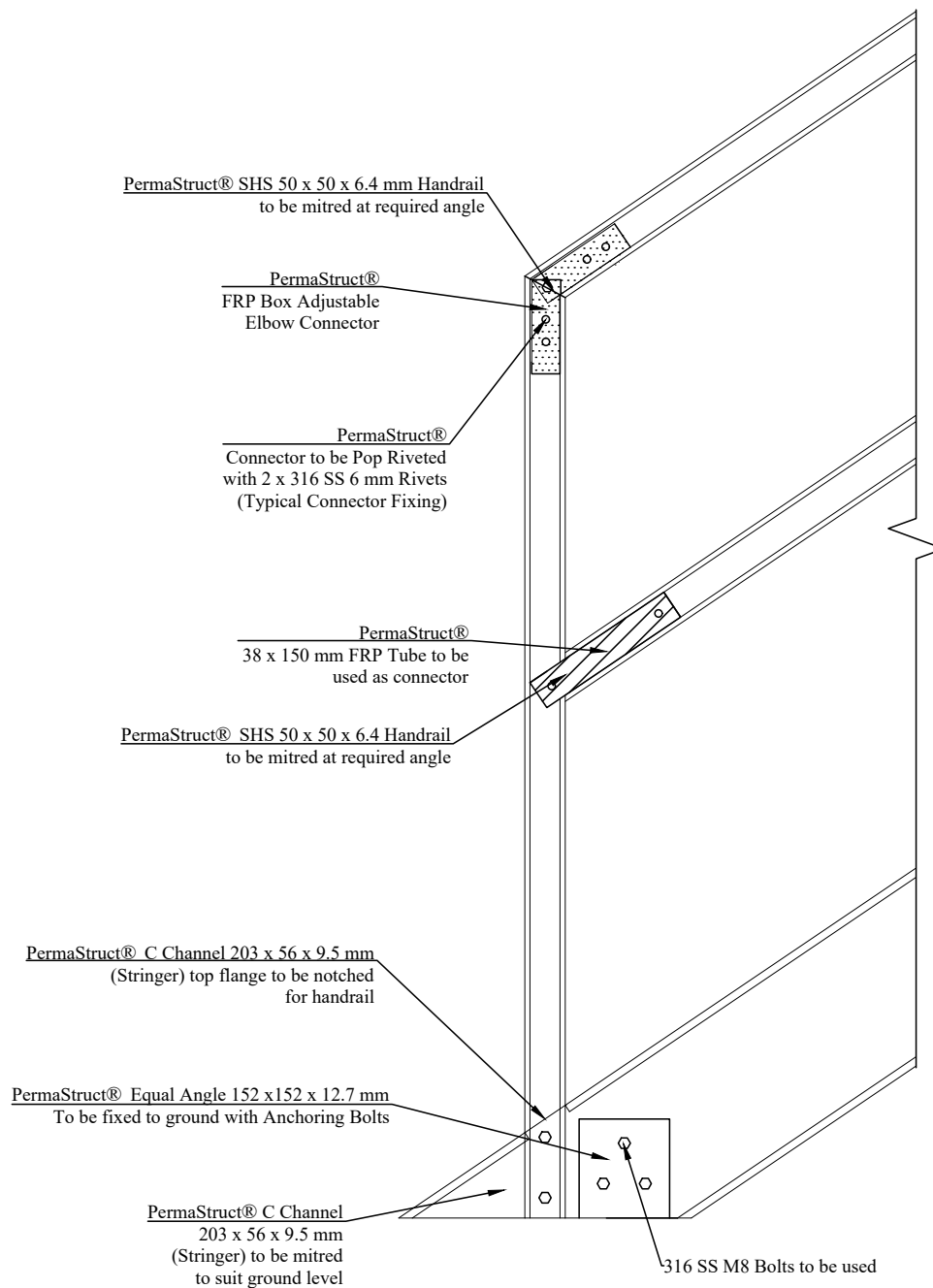
- All 316 SS M8 Bolts to be fixed with a minimum edge distance of 25mm
- All Handrail to be spaced 1000mm wide and 1000mm above deck level unless specified
- Top handrail to be continuous while middle handrail to be mitred every 1000mm at required angle.



## 2. PERMASTRUCT STAIRCASES

### CONNECTION DETAILS

#### INCLINED HANDRAIL CONNECTION (START)

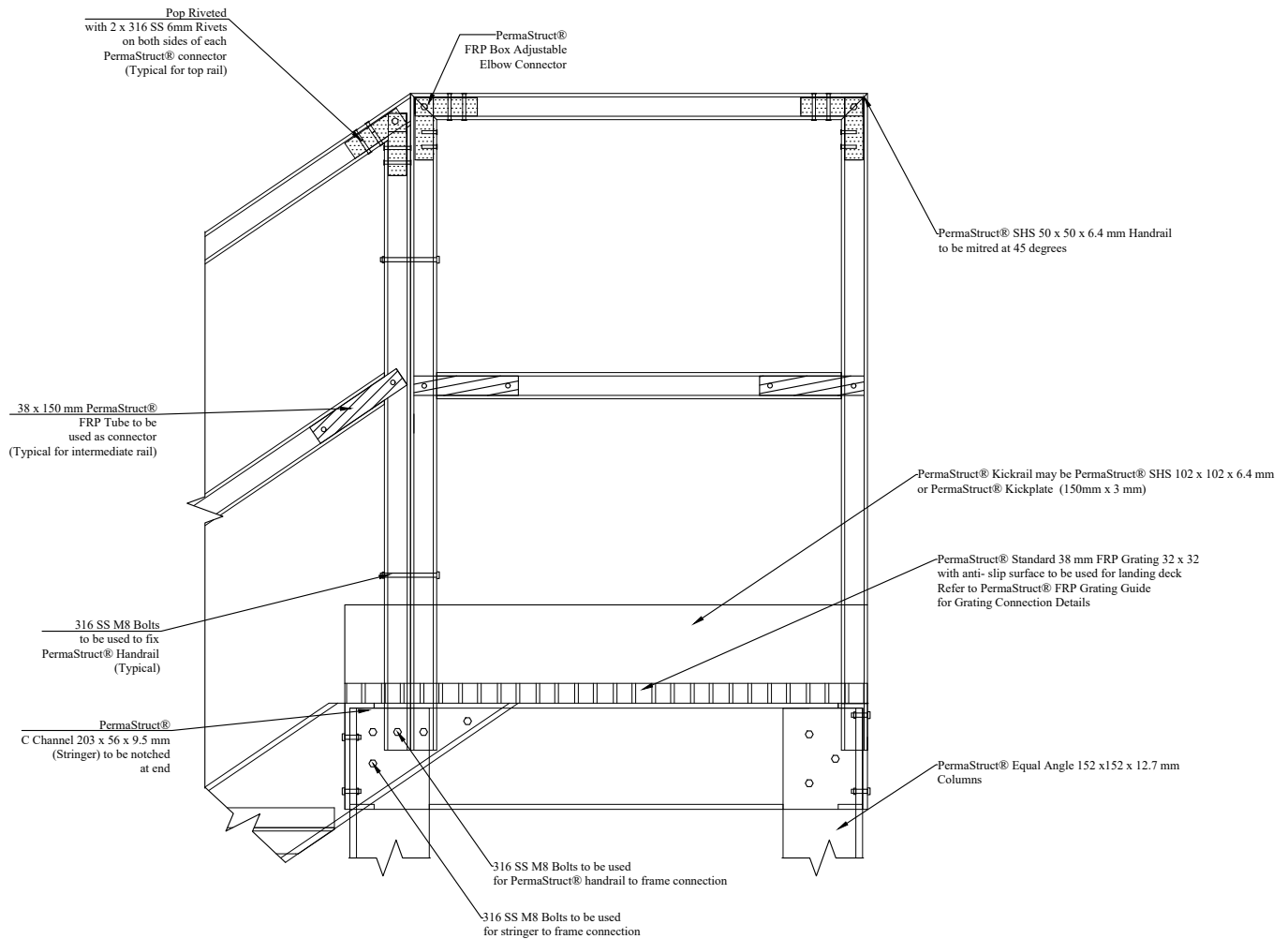




## 2. PERMASTRUCT STAIRCASES

### CONNECTION DETAILS

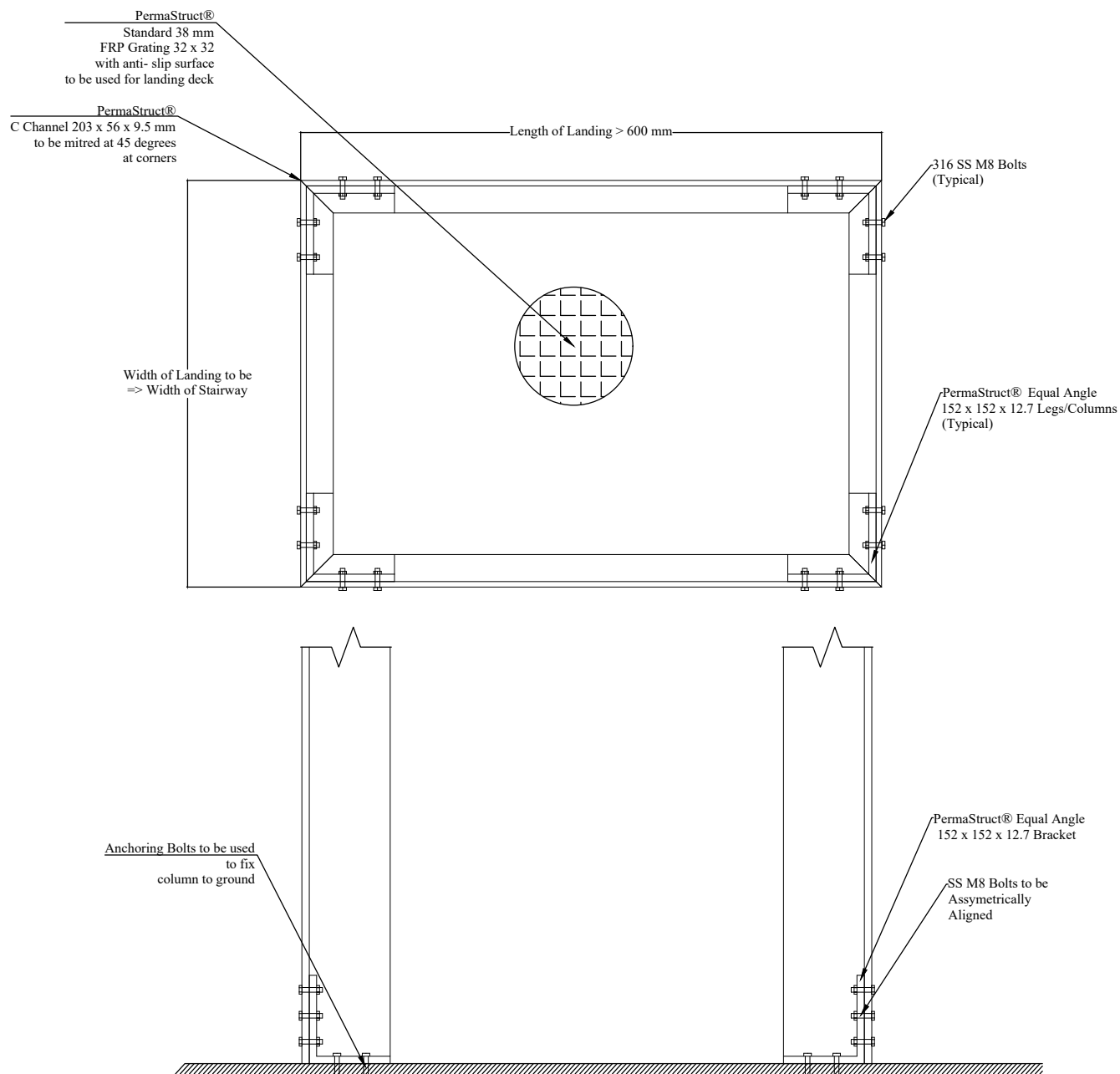
#### INCLINED HANDRAIL CONNECTION (END)



## 2. PERMASTRUCT STAIRCASES

### CONNECTION DETAILS

#### LANDING CONNECTION



VOLUME 3

# PermaStruct® Boardwalks





# 3.1. PERMASTRUCT RAPIDDECK

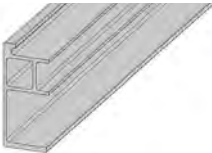
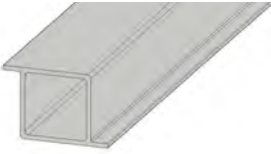

PermaStruct® has developed a fully engineered and certified, modular FRP Boardwalk System called PermaStruct® RapidDeck. This system consists of a slip-walking surface, supported by a durable lightweight composite sub-frame.

## MATERIAL COMPONENTS

### STRUCTURAL FRAMEWORK

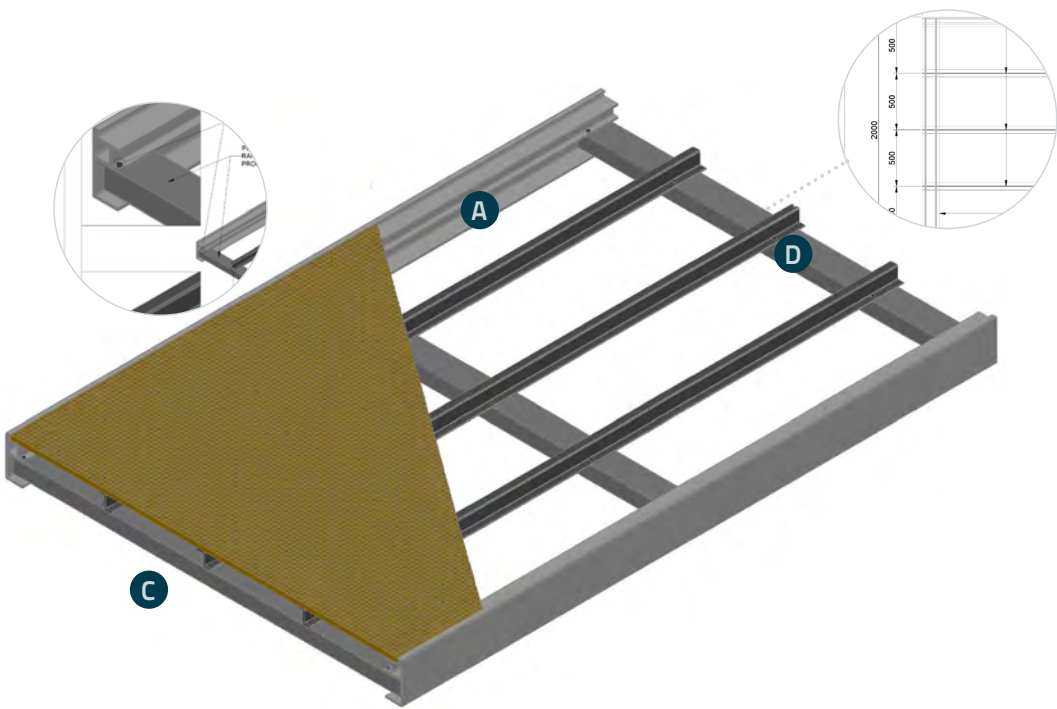
The structural framework of PermaStruct® RapidDeck is built from custom PermaStruct® FRP Profiles, please see Appendix 3 for more information.

The PermaStruct® FRP Profiles used for the structural frame include the following:

#	Component	Profile
A	PermaStruct® RapidDeck Sub-Frame Profile #301 Channel	
C	PermaStruct® RapidDeck Sub-Frame Profile #302 Bearer	
D	PermaStruct® RapidDeck Sub-Frame Profile #303 Joist	

### RAPIDDECK DECKING

PermaStruct® RapidDeck has a range of different options that can be used for its decking, this includes PermaStruct® FRP Grating and PermaTimber®WPC Decking. Please refer to the material properties in Appendix 2 and Appendix 4 for more information.



## 3.1. PERMASTRUCT RAPIDDECK

### DESIGN CONSIDERATIONS

#### STRUCTURAL FRAMEWORK

PermaStruct® RapidDeck has already been fully engineered and certified as a single module for both 3KPa and 5Kpa design live loads. The standard RapidDeck module of 3.2m by 2.3m was modeled as a rigid frame structure with SPACEGASS and all the maximum allowable stresses checked for ultimate limit state (ULS) and appropriate deflections checked for serviceability limit state (SLS). For widths greater than 2.3m wide, multiple modified modules will be fixed back to back along the required width of the boardwalk. The profile spacing of Profile C and D, were then determined from the engineered module and were found to be as below:

Design Live Load	RapidDeck Load Spacing	
	Profile C	Profile D (Joists)
3 kPa	1066mm	640mm
5 kPa	575mm	575mm

#### BOARDWALK DECKING

PermaStruct® Rapid Deck's recommended decking options would be a PermaStruct® 21mm Micro or Mini Mesh, or a PermaTimber® 146 Decking. Other decking options would require Rapid Deck Profile D to be spaced accordingly to suit the maximum span of the deck. (Refer load tables in appendix for other options). Please note that all grating and decking on boardwalks should span one-way and beam arrangements should be made to suit a 'one-way spanning slab' condition. All grating should be designed based on Ultimate Limit State (ULS) for UDL and Point Load and checked against a maximum deflection of 5mm from the Perma Grating Load Tables for serviceability limit state (SLS). This is a necessary measure taken to allow for lack of significant stiffness of FRP material. PermaTimber® Decking should be checked for the maximum distance each board can span against the design loading. The maximum span should be taken as the most critical value from bending, deflection and shear strength. Kick rails are required on the edge of the boardwalk if there is no permanent structure within 10 mm of the edge or if a person has access to the area below the boardwalk. The Recommended Kick Rail profile for PermaStruct® RapidDeck is a PermaStruct® 102 x 102 x 6.4 SHS Box

#### HANDRAIL

Handrails for PermaStruct® RapidDeck may be either square or round (square is recommended). Square handrail may vary in profile sizes; 50 x 50, 64 x 64, 76x76, 102 x 102 SHS, However will be all 6.4 mm thick. Round handrail will have a 7mm thick 50 mm OD Tube. All handrails and connectors have been tested for Ultimate Limit State and Serviceability Limit State as per AS1657 Appendix B 4.4 and have been accredited by National Association of Testing Authorities, Australia (NATA). It is important to note that the use of a RapidDeck Boardwalk determines the height and number of rails required for a Handrail. According to Australian Design Standards AS 1657 and AS5100, all handrails are to be at least 1 m high with two rails spaced at a maximum of 400 mm for pedestrian access only, and at least 1.4 m high with three rails also spaced at a maximum of 400 mm for shared access i.e. Cyclists and Pedestrians use.

# 3.1. PERMASTRUCT RAPIDDECK

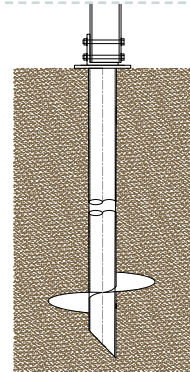
## DESIGN CONSIDERATIONS

### FOOTINGS

PermaStruct® Rapid Deck can be designed to suit different footing options depending on the project site's topography, terrain, soil types etc. (Please note that the type of footing to be used will depend on the geotechnical report for the project)

#### Screw Piles

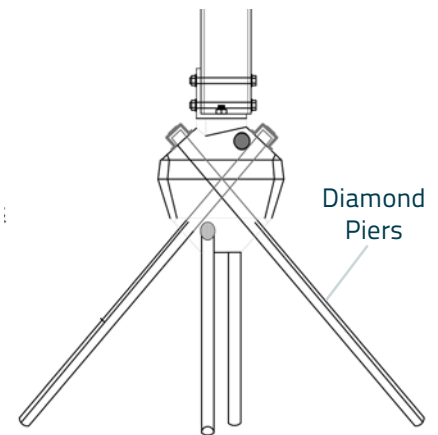
Screw Piles can be installed quickly with minimal noise and vibration. They are wound into the ground. Screw Piles are made of circular hollow steel sections that are spiraled, essentially forming a large screw. As the pile, reaches the required depth, it remains permanently in place, and is normally filled with concrete. This piling system offers minimal environmental impact and its ease of manufacturing makes it the preferred option with PermaStruct® RapidDeck.



#### Diamond Piers

Diamond Piers are a concrete, pre-engineered and low footprint foundation system and are the recommended footing option for PermaStruct® RapidDeck. The revolutionary design uses piles that go deep into the ground providing great support through the concrete pier.

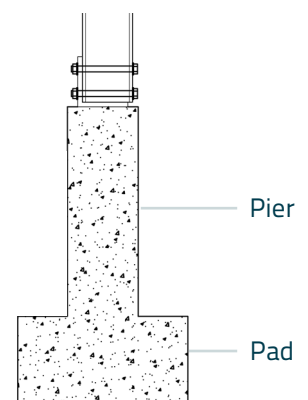
As little to no excavation is required, there is no need to use heavy machinery, which reduces noise on-site and environmental damage during installation. Ideal for sites with difficult access, Diamond Piers can be hand carried in and fixed allowing a structure to be easily removed or relocated if necessary.



#### Piers Foundation

A Pier foundation consists of a collection of large diameter cylindrical columns to support the superstructure and transfer large super imposed loads below.

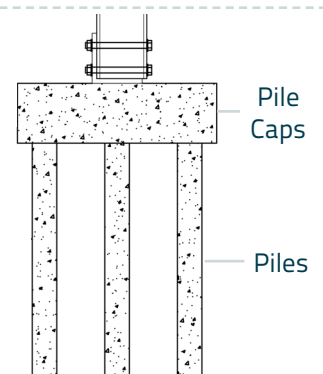
This method is easy and requires less amount of materials and labor than traditional methods. This makes it an efficient and effective foundation for PermaStruct® Rapid Deck as it causes less disruption to the soil environment. This method also allows engineers to easily modify existing designs.



#### Pile Cap Foundation

A pile foundation is mainly used for extreme cases , where the load needs to be transferred to deeper soil/rock with higher bearing capacity due to the surface soil having a low bearing capacity.

Pile foundations are suitable for sites where the loading is significant, and the shallow soil is not as supportive. Pile Cap Foundations are normally only used for bigger projects.



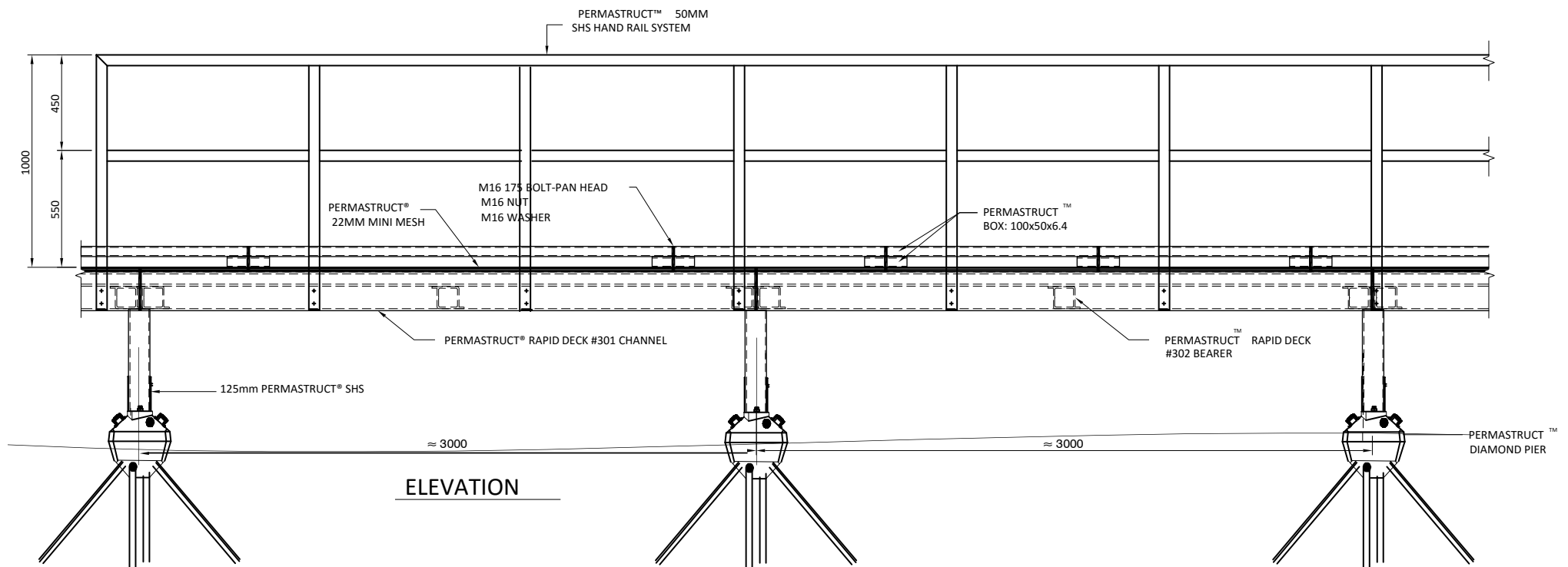


## 3.1. PERMASTRUCT RAPIDDECK

### CONNECTION DETAILS

PermaStruct® Rapid Deck Boardwalks have the following general connections with standard column sizes and diamond piers used. Please Note: These connection drawings are for general reference only.

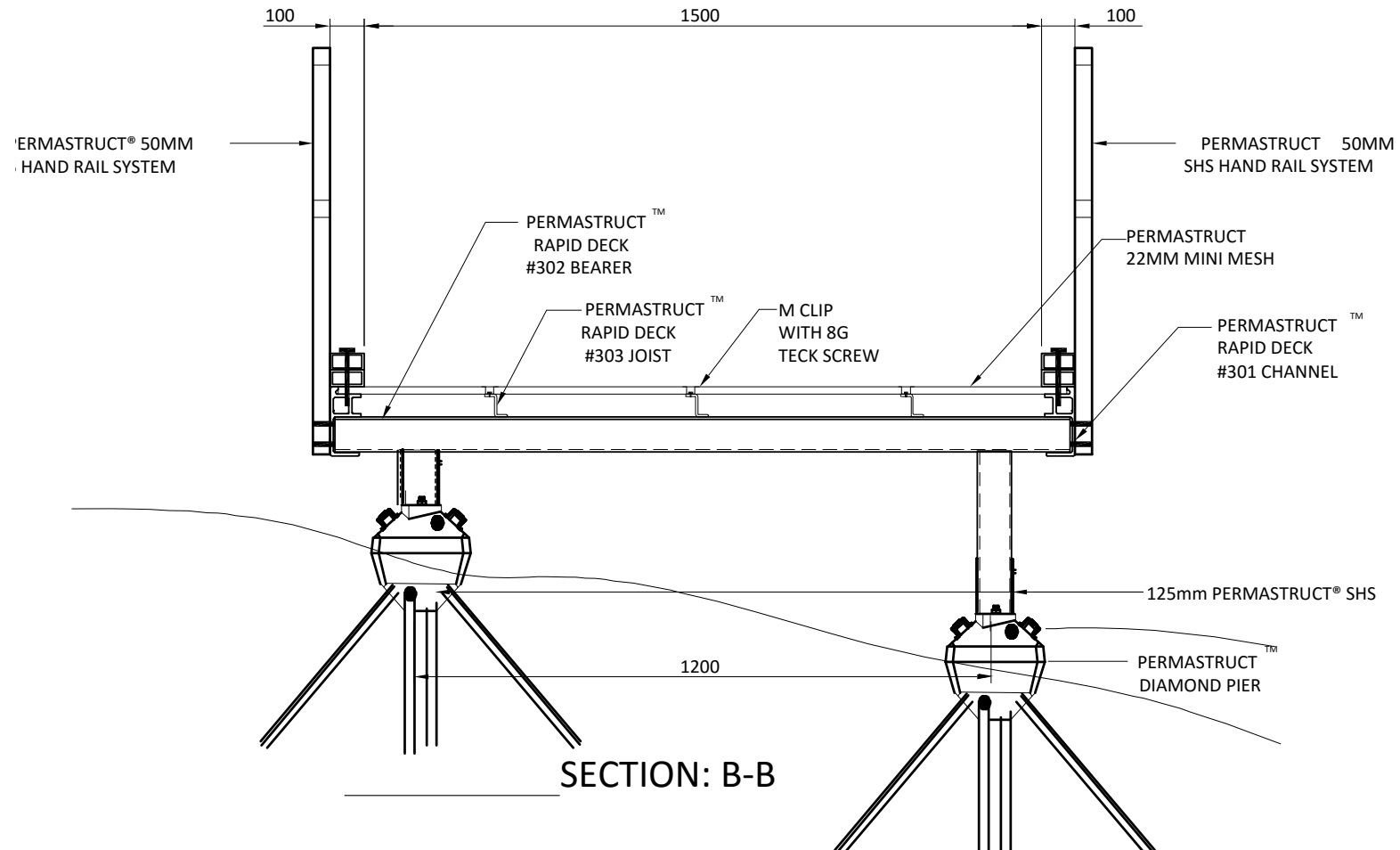
### GENERAL CONNECTIONS



## 3.1. PERMASTRUCT RAPIDDECK

### CONNECTION DETAILS

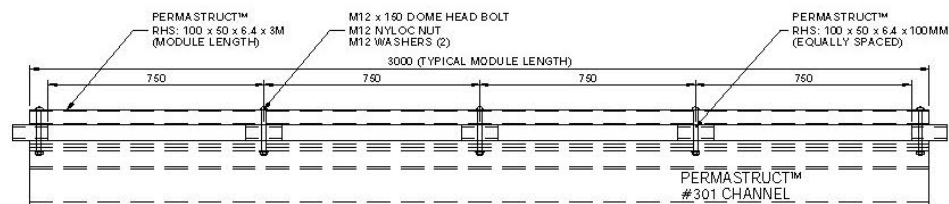
#### GENERAL CONNECTIONS



# 3.1. PERMASTRUCT RAPIDDECK

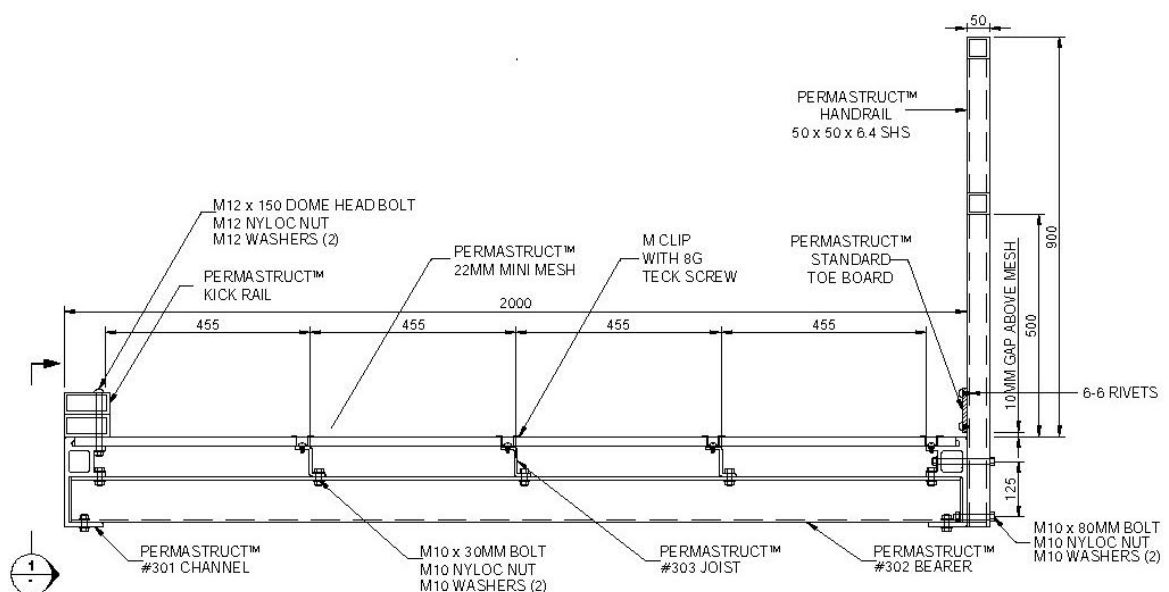
## CONNECTION DETAILS

### GENERAL CONNECTIONS



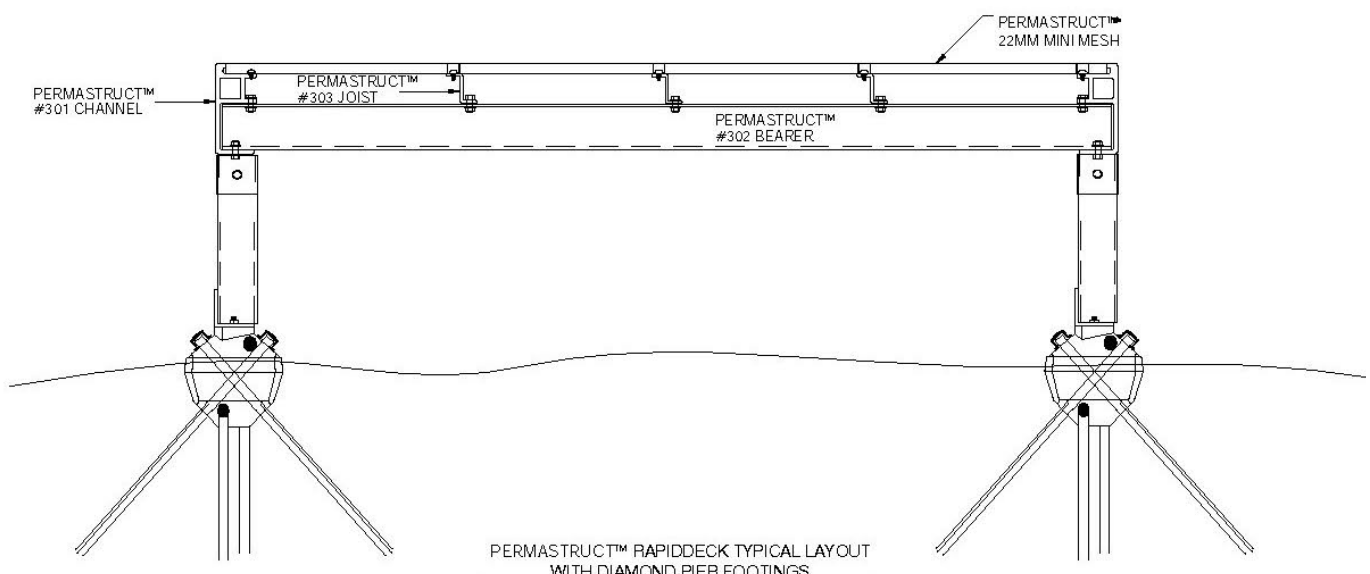
SECTION  
SOLENTS

PERMASTRUCT™ KICK RAIL SYSTEM



PERMASTRUCT™ 50MM SHS HANDRAIL SYSTEM

INCLUDES OPTION FOR TOE BOARD AND KICK RAIL  
(SCALE: NTS)

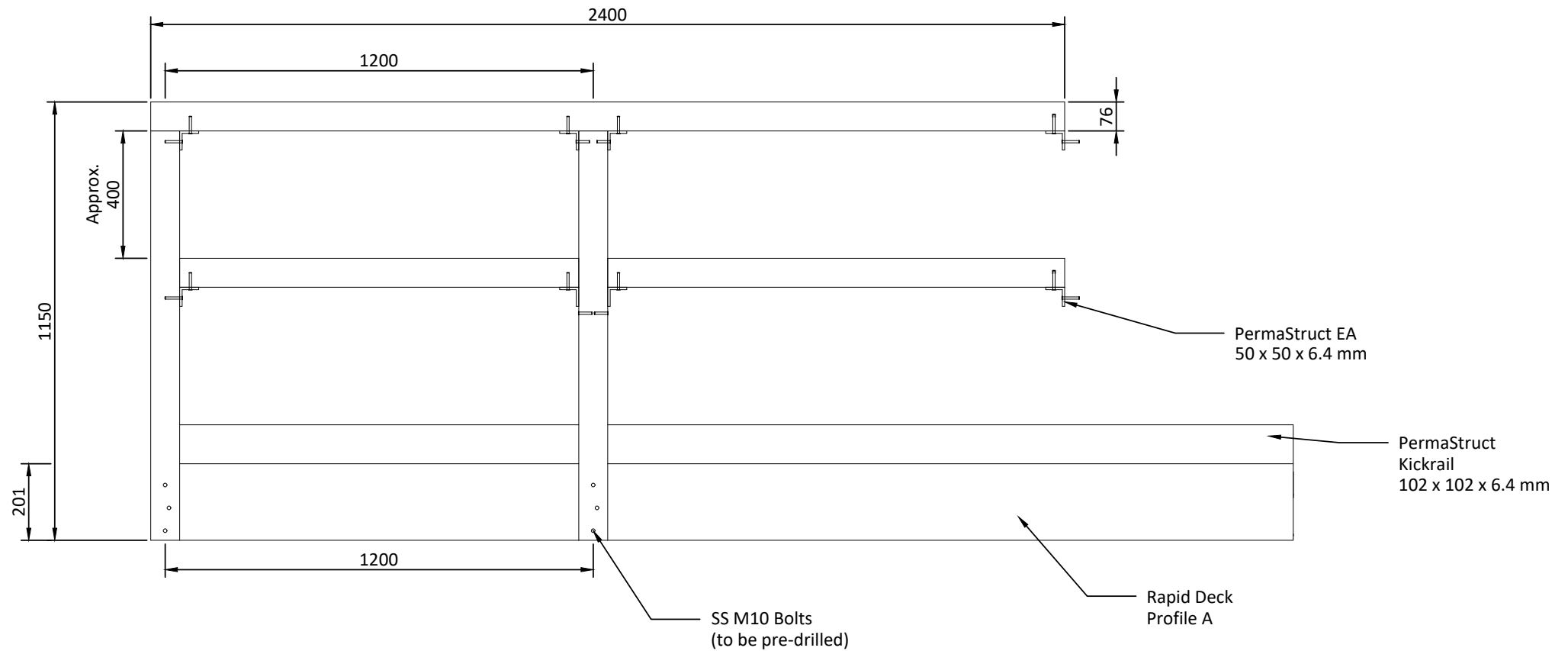




## 3.1. PERMASTRUCT RAPIDDECK

### CONNECTION DETAILS

#### HANDRAIL CONNECTION - PEDESTRIAN ACCESS

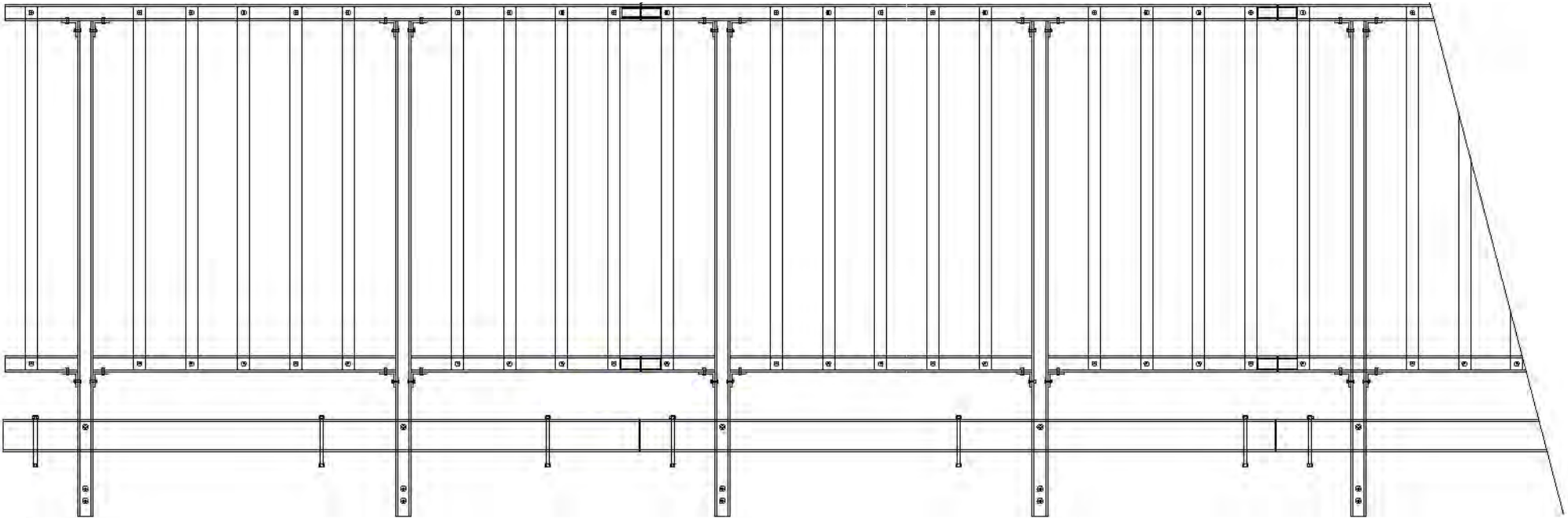


## 3.1. PERMASTRUCT RAPIDDECK

### CONNECTION DETAILS

#### HANDRAIL CONNECTION - SHARED ACCESS

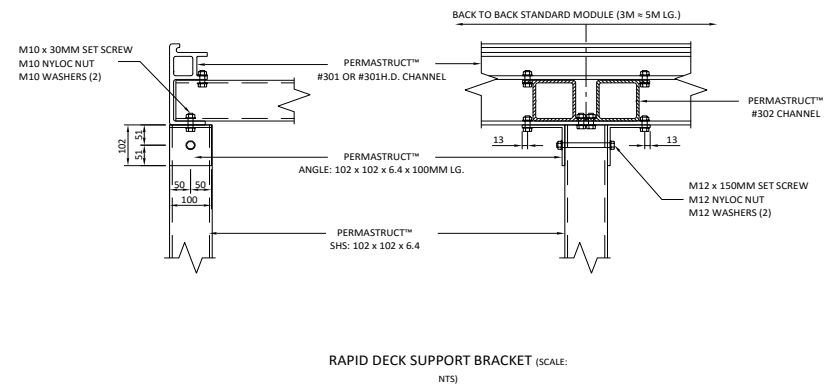
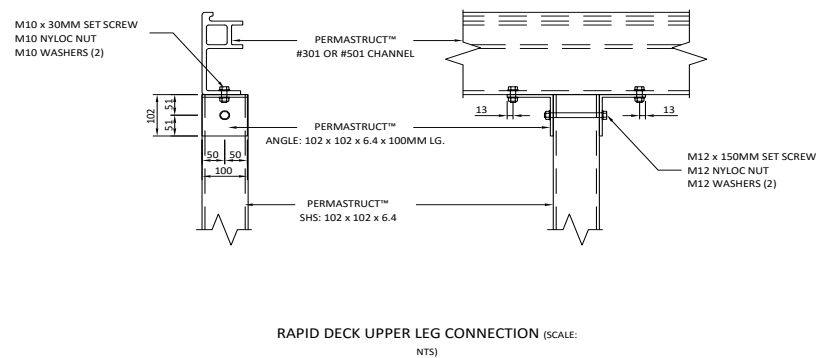
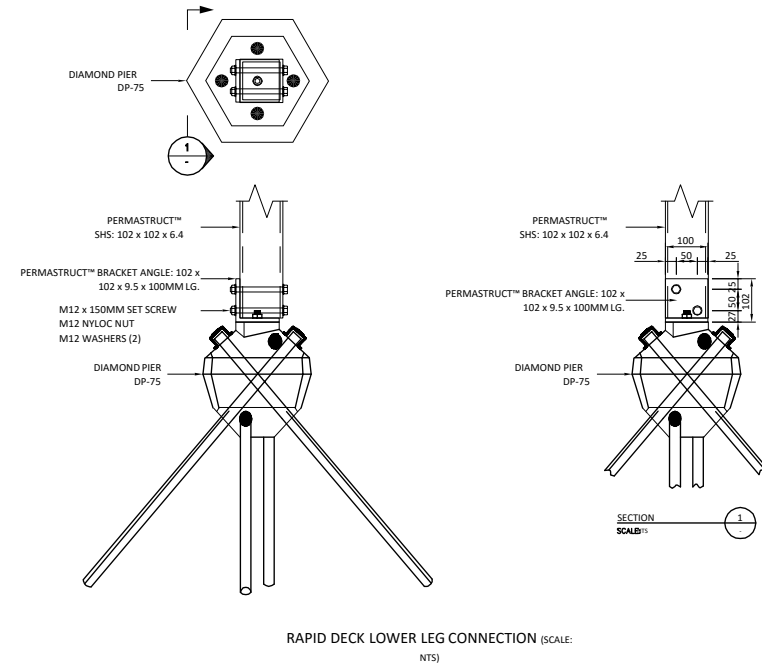
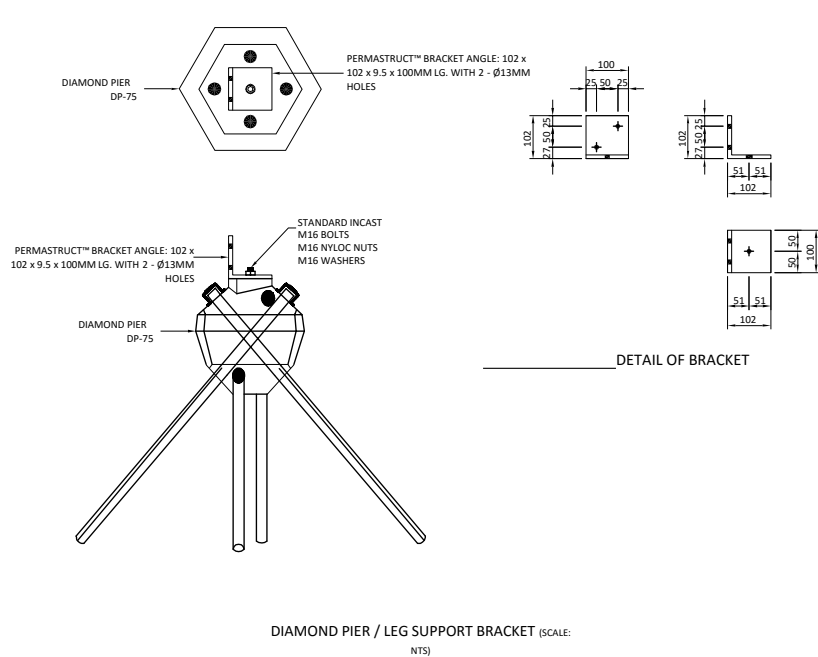
38mm CHS balustrade at 150mm spacing with 60 x 6.4 SHS vertical stanchions.



# 3.1. PERMASTRUCT RAPIDDECK

## CONNECTION DETAILS

### FOOTING CONNECTIONS





## 3.2. PERMASTRUCT BOARDWALKS

Constructed from high-quality PermaStruct® FRP, PermaStruct® Boardwalks provide a low maintenance and durable alternative to traditional materials. Custom designed to suit any environment or application, a variety of textures, materials and colours are available.

### MATERIAL COMPONENTS

#### STRUCTURAL FRAMEWORK

The structural framework of PermaStruct® Boardwalks are built from custom PermaStruct® FRP Profiles, please see Appendix 1 for more information.

The main PermaStruct® FRP Profiles used for the structural frame include the following:

Profile	Dimensions (mm)	Use
PermaStruct® FRP C Channel	203 x 56 x 9.5mm	Primary Beams (Main Boardwalk Frame)
PermaStruct® FRP Equal Angle	152 x 152 x 12.7mm	Columns & Connection Brackets
PermaStruct® FRP Box	102 x 102 x 6.4mm	Square Handrails, Secondary Beams (Joists), Columns & Kick Rail
PermaStruct® FRP Box	50 x 50 x 6.4mm	Square Handrails
PermaStruct® FRP Kick Rail	150 x 3mm	Kick Rail

#### BOARDWALK DECKING

PermaStruct® Boardwalks have a range of different options that can be used for its decking, this includes PermaStruct® FRP Grating and PermaTimber®WPC Decking. Please refer to the material properties in Appendix 2 and Appendix 4 for more information.



## 3.2. PERMASTRUCT BOARDWALKS

### DESIGN CONSIDERATIONS

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#### STRUCTURAL FRAMEWORK

PermaStruct® C Channel 203 x 56 x 9.5mm is used for all primary beams and are to be checked for both ultimate limit state (ULS) and serviceability limit state (SLS). Load factors to be used are in accordance with AS 1170.0. At spans where the deflection at 1% deflection is excessive, columns are required to be added.

Beam spacing and subframe layout for PermaStruct® Boardwalks should be designed based on maximum Live Load from the PermaStruct® FRP Profile Load Tables, see Appendix 6. It is also important to consider the effect of long term deflection due to creep for structures with high importance levels i.e. use a creep factor of 1.2 where appropriate. Overall framework is to be also checked to comply with wind loading as per AS 1170.2. Joists should be spaced to suit the maximum span of the selected boardwalk decking.

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#### BOARDWALK DECKING

All PermaStruct® Boardwalks are to be designed to suit standard Pedestrian Loading of 3 or 5 KPA, with other specific load requirements to be designed in accordance with AS1170.1.

All PermaStruct® FRP Grating and PermaTimber® WPC Decking used on boardwalks should span one-way and beam arrangements should be made to suit a 'one-way spanning slab' condition.

All PermaStruct® Grating should be designed based on Ultimate Limit State (ULS) for UDL and Point Load and checked against a max deflection of 5mm for Serviceability Limit State (SLS). This is a necessary measure taken to allow for lack of significant stiffness of FRP material.

All PermaTimber® WPC Decking should be checked for the maximum distance each board can span against the design loading. The maximum span should be taken as the most critical value from bending, deflection and shear strength.

Kick rails are required on the edge of the boardwalk if there is no permanent structure within 10 mm of the edge or if a person has access to the area below the boardwalk. The Kick rail profile may either be either a PermaStruct® 102 x 102 x 6.4 SHS Box or a PermaStruct® Kick Rail 150 x 3 mm plate.

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#### HANDRAIL

Square handrail may vary in the following profile sizes 50x50mm, 64x64mm, 102x102mm SHS, however, are all 6.4mm thick. Round handrail will have a 7mm thick, 50 mm OD Tube.

All PermaStruct® Handrails and Connectors have been tested for Ultimate Limit State and Serviceability Limit State as per AS1657 Appendix B 4.4 and have been accredited by National Association of Testing Authorities, Australia (NATA).

## 3.2. PERMASTRUCT BOARDWALKS

### CONNECTION DETAILS

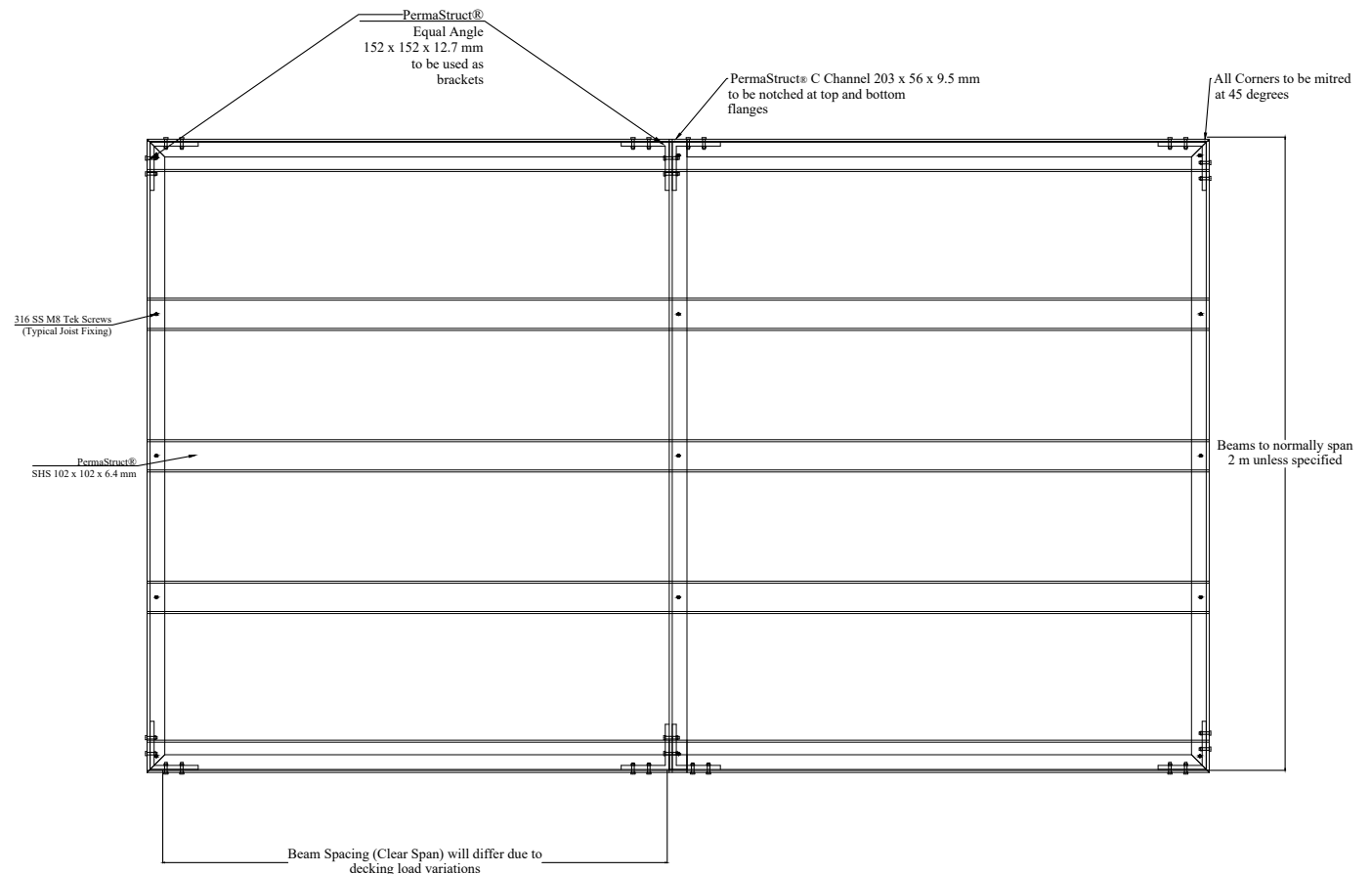
PermaStruct® Boardwalks have different profile connections that have varying fixing requirements from a fixed to pinned support, bolted to screwed, and mitred to non-mitred ends. These connections have a major influence on the strength of the overall structure.

#### BOARDWALK FRAME CONNECTION

PermaStruct® Boardwalk Frames consist of an equal angle bracket plate fixed inside PermaStruct® C Channel with Stainless Steel M8 Bolts. Bolt fixings should satisfy a 25mm minimum edge distance and be arranged asymmetrically to allow for the fibre to resist shearing and splitting if possible failure occurs. Beam Spacing's should be determined based on the design load required. If the PermaStruct® Boardwalk needs to span more than 2m wide, a stronger PermaStruct® FRP Beam may be required to replace the PermaStruct® C Channel. All corners are to be mitred at 45 degrees and beam flanges notched at certain connection points. PermaStruct® 102 x 102 x 6.4 mm Joists will be fixed to the bottom flange of the PermaStruct® C Channel with 8 gauge tek screws.

#### Please Note:

- PermaStruct® C Channel 203 x 56 x 9.5mm to be used for the main frame.
- Leg / Column locations will be installed at every T Junction to mitigate deflection
- SS M8 Bolts to be used for fixings and location and length may differ upon external structures e.g. handrail, columns etc.



## 3.2. PERMASTRUCT BOARDWALKS

### CONNECTION DETAILS

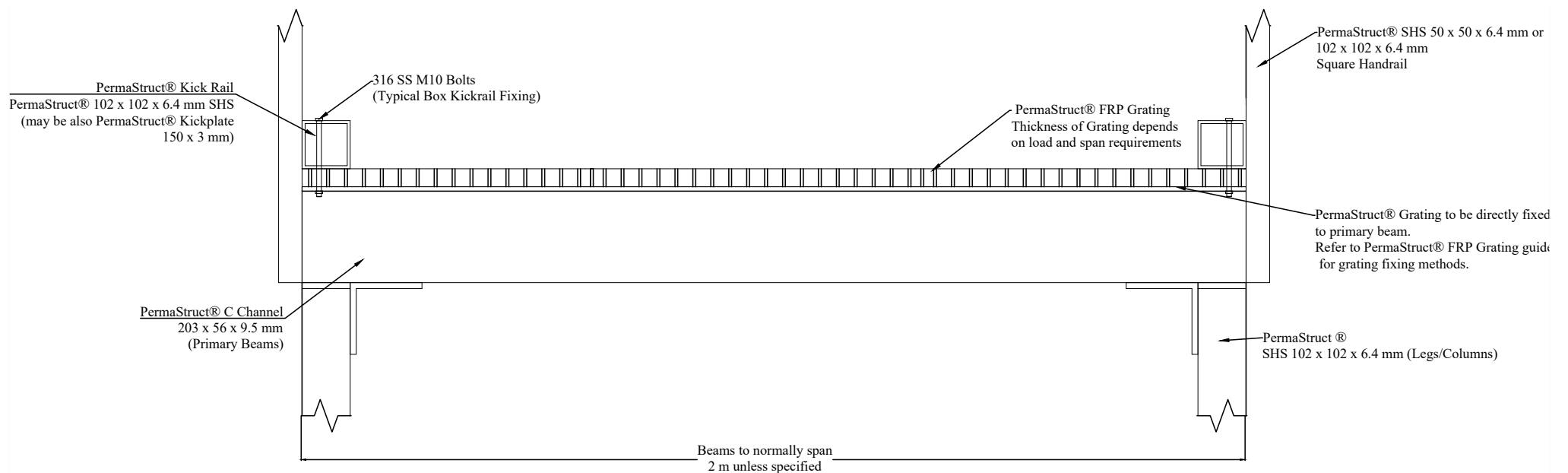
#### BOARDWALK DECK CONNECTION (FRP)

If PermaStruct® FRP Grating is used as the decking joists are not required for support, as the grating panels are strong enough to span most required lengths. PermaStruct® FRP Grating should be fixed straight through to the PermaStruct® C Channel with fixing clips. The PermaStruct® FRP Grating used will depend on the required design load, span the grating should have to take, and the grating load bar sizes and thicknesses.

#### Please Note:

Primary Beams to span whole width of Boardwalk unless heavy load requirements are required.

Legs/Columns to generally PermaStruct® SHS 102 x 102 x 6.4mm but may change due to load and leg/column height variations.





## 3.2. PERMASTRUCT BOARDWALKS

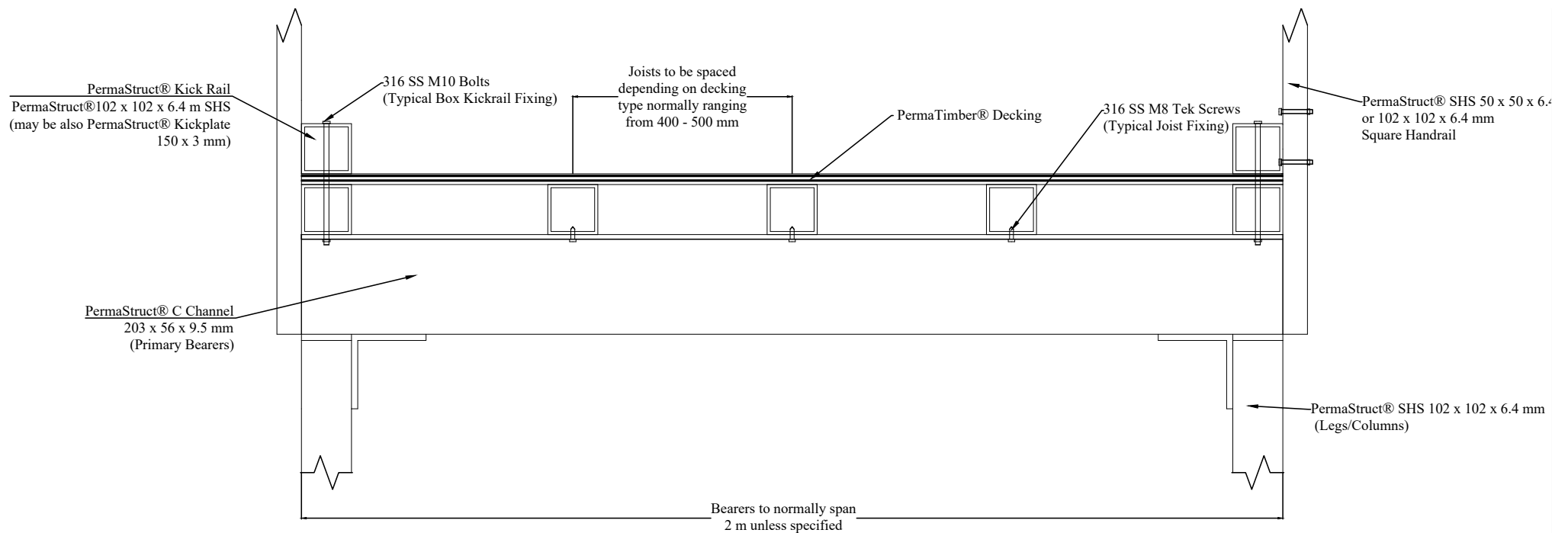
### CONNECTION DETAILS

#### BOARDWALK DECK CONNECTION (WPC)

PermaTimber® WPC Decking will require joists for support, as the decking boards are not strong enough to span the whole width of the PermaStruct® Boardwalk. PermaTimber® WPC Decking Boards are fixed together with clips and fixed with screws to the joists (refer to the PermaTimber® WPC Decking Install Guide). The required decking profile to use depends on the design load, joist spacing and aesthetic requirements.

#### Please Note:

- Joist to be generally 50 x 50 x 6.4mm unless specified
- Primary Bearer to span whole width of boardwalk unless heavy load requirements are required
- Legs/columns to be generally 102 x 102 x 6.4mm but may change due to load and column height variations

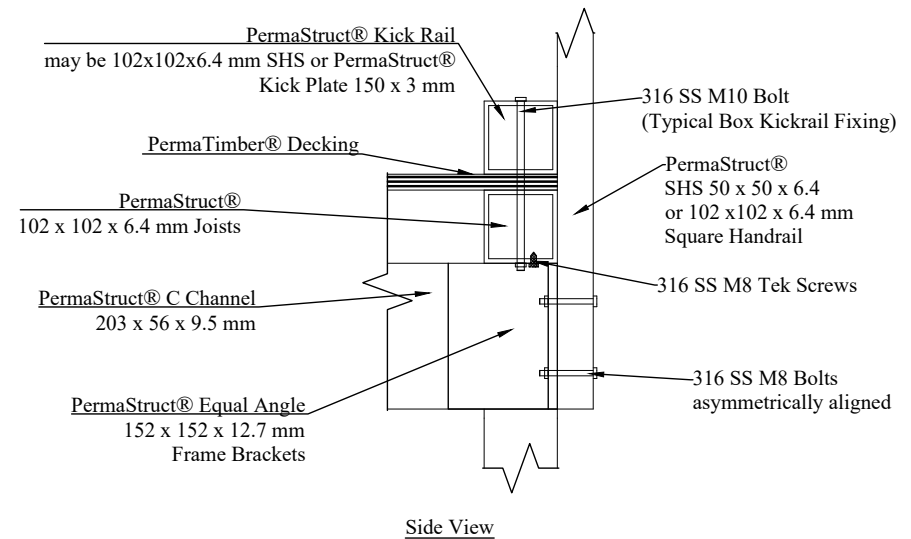
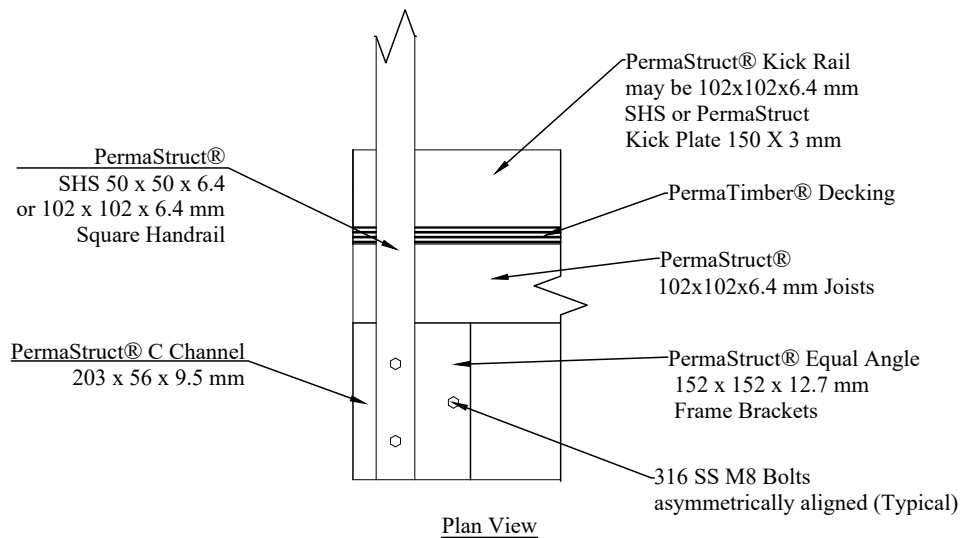


## 3.2. PERMASTRUCT BOARDWALKS

### CONNECTION DETAILS

#### HANDRAIL / KICK RAIL FRAME CONNECTION

PermaStruct® Kick Rail Box, PermaTimber® Decking and PermaStruct® Joists are all connected with stainless steel M10 Bolts. PermaStruct® Square Handrails are fixed to the outside of the PermaStruct® Boardwalk Frame with stainless steel M8 Bolts. If a PermaStruct® Kick Rail Plate is used, then an M8 bolt will fix the kick rail to the square handrail.

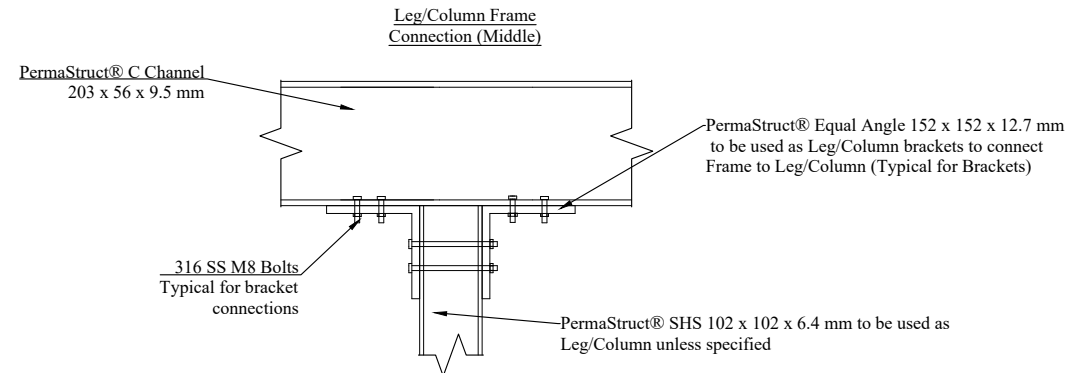
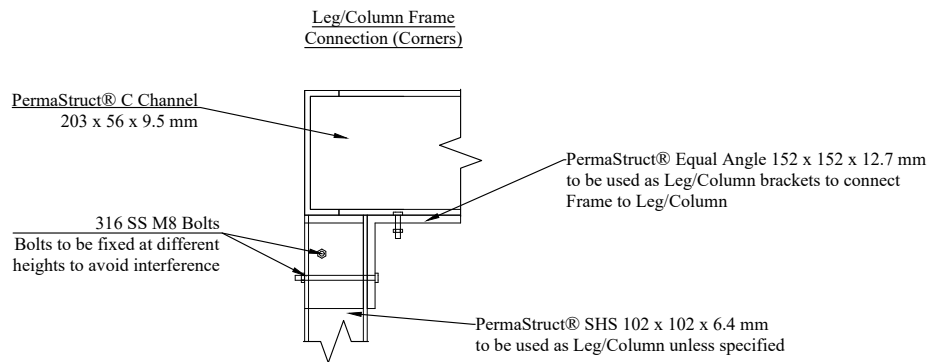


## 3.2. PERMASTRUCT BOARDWALKS

### CONNECTION DETAILS

#### BEAM COLUMN / LEG CONNECTION

PermaStruct® Boardwalk frames to column connections will depend on the type and section of column used. A PermaStruct® SHS 102 x 102 x 6.4mm Box Section is normally recommended for a column. If the Box columns are connected to the PermaStruct® C Channel frame, with equal angle brackets stainless steel M8 Bolts are to be used. At the corner connections, it is important that the M8 Bolts are fixed at different heights to avoid any potential interference. If another section is required to be used for the column, then the connection detail will vary (further info available if required upon request).



VOLUME 4

# PermaStruct® Ladders





## 4. PERMASTRUCT LADDERS

PermaStruct® Ladders & Cages are the perfect solution for submerged, semi-submerged and caustic environments, thanks to their superior non-corrosive properties.

### MATERIAL COMPONENTS

The main framework of PermaStruct® Ladders are built from PermaStruct® FRP Profiles, please see Appendix 1 for more information.

### DESIGN CONSIDERATIONS

#### STRUCTURAL DESIGN

PermaStruct® Ladders can be designed to Ultimate Limit State to withstand a concentrated live loading to rungs of not less than 1.5 kN for each 3m of vertical height within the same ladder flight. For Serviceability Limit State, PermaStruct® Ladders can be made to resist the lesser deflection of 40mm or  $L/100$ , where the ladder is supported in a horizontal position and loaded at mid span. PermaStruct® Ladder Rungs have been designed to withstand a point load of 1.5kN at the centre of its span.

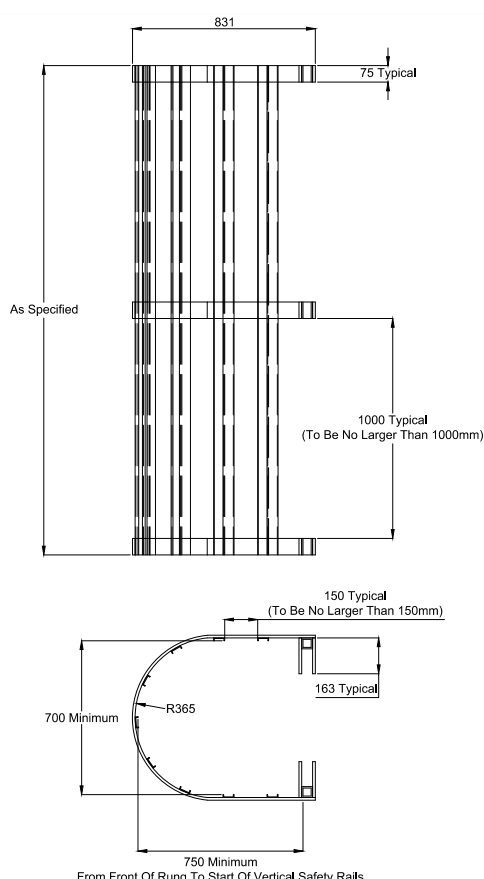
PermaStruct® Ladders can be designed based on the following options:

- Ladder stiles may be spaced anywhere between 375 mm and 525 mm.
- Ladder rungs can be spaced between 250 mm to 300 mm for ladders longer than 1 m, and any even spacing less than 300 mm for ladders less than or equal to 1 m long.

#### ACCESSORIES

PermaStruct® Ladders can be made to suit both fixed and mobile conditions. For conditions where the ladder is to be fixed to the ground, a PermaStruct® Square Base Foot is used.

For cases, where the ladder is to be mobile on the ground, but still attached to an external structure i.e. wall or platform, PermaStruct® Ladder L Shaped Brackets are used. PermaStruct® Ladders that are more than 6m long from the ground, require a PermaStruct® Ladder Cage to be fixed.



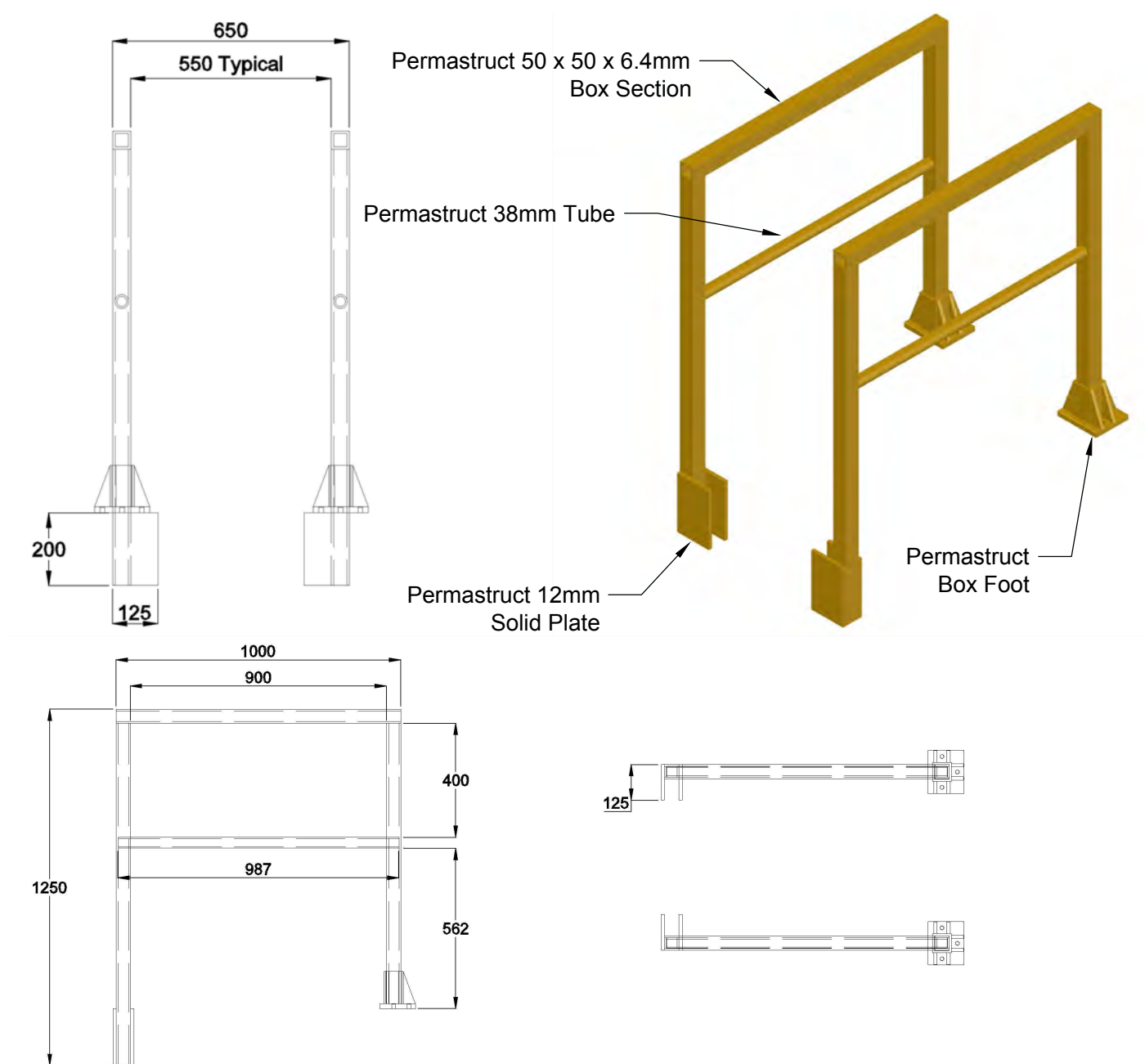
## 4. PERMASTRUCT LADDERS

### DESIGN CONSIDERATIONS

#### ACCESSORIES

For PermaStruct® Ladders that require a step through, the ladder stiles shall not extend more than 1 m above the top landing. The width of the step through may range from 525 mm to 675 mm. The extended stiles that form the step through, will be designed to withstand a maximum deflection of  $L/50$  where  $L$  is the length of the extended step through stile. The extended stiles should also be able to resist a force of 600 N acting outwards at 90 degrees to the ladder slope.

The maximum lateral deflection of the extended stiles shall be limited to  $L/15$ , where again,  $L$  is the length of the extended stiles. The extended stiles should also be able to resist a lateral force of 350N acting laterally to the plane of the ladder and positioned at the top of the extended stiles. All hand clearances around the stiles shall be maintained at 50 mm, except at points where a ladder cage or bracket is attached.



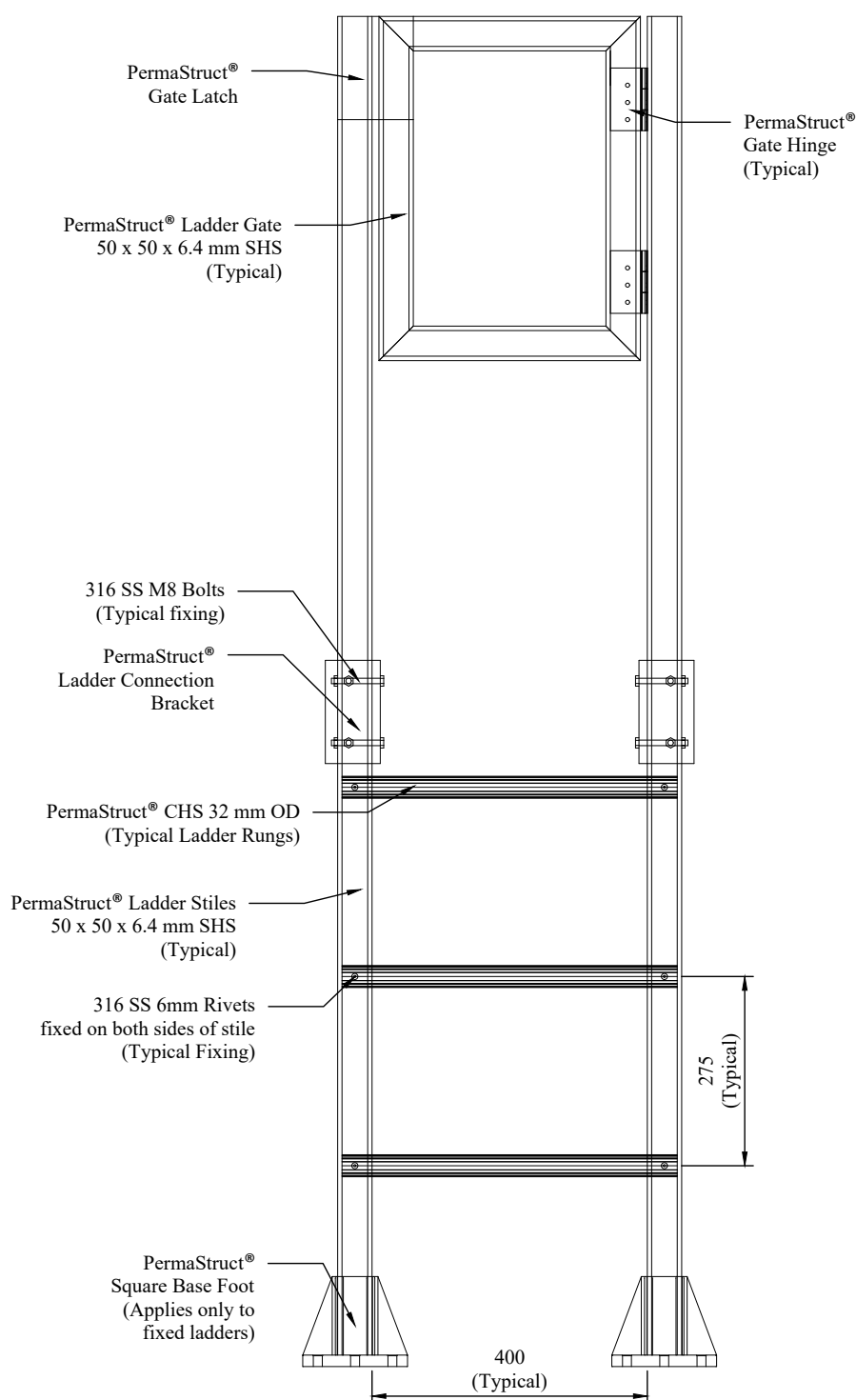
## 4. PERMASTRUCT LADDERS

### DESIGN CONSIDERATIONS

#### ACCESSORIES

PermaStruct® Ladders fixed to platforms or adjacent structures, may also have a PermaStruct® Gate attached to the top of ladder stiles. All PermaStruct® Ladders for this condition will all have ladder brackets used for fixing the platform. For cases, where a stronger fixing to external structures is required, inclined PermaStruct® Equal Angles may also be used.

PermaStruct® Gates consist of four 50 x 50 x 6.4 mm box mitred and pop riveted together, with an FRP Plate used as a latch. PermaStruct® Gates are fixed onto the ladder stiles with a stainless steel hinge.



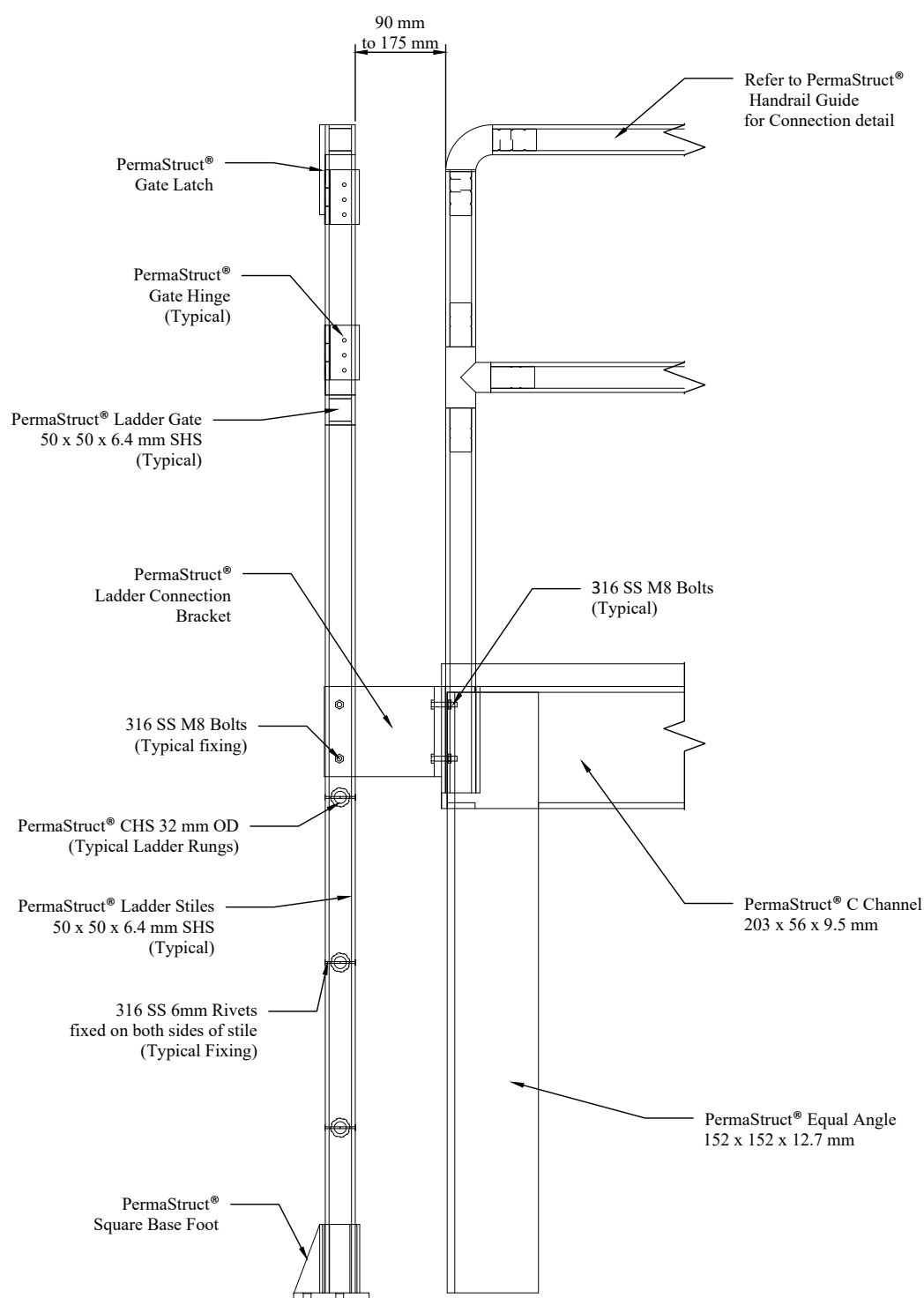
## 4. PERMASTRUCT LADDERS

### CONNECTION DETAILS

PermaStruct® Ladders may be connected to platforms or external landings either at the middle of the external structure, or at the edge. There is a variation in connection detail for PermaStruct® Ladders that are required to be fixed onto the ground to that are required to be mobile.

#### LADDER PLATFORM CONNECTION (FIXED)

PermaStruct® Ladders have to maintain a gap between 90mm to 175mm to the platform handrail. PermaStruct® Ladder Brackets are connected to the frame of the platform, with 316 SS M8 Bolts arranged symmetrically. Ladder Rungs are fixed to stiles by pop rivets on either side, with the PermaStruct® Square Base Foot either glued in or bolted to the stiles.



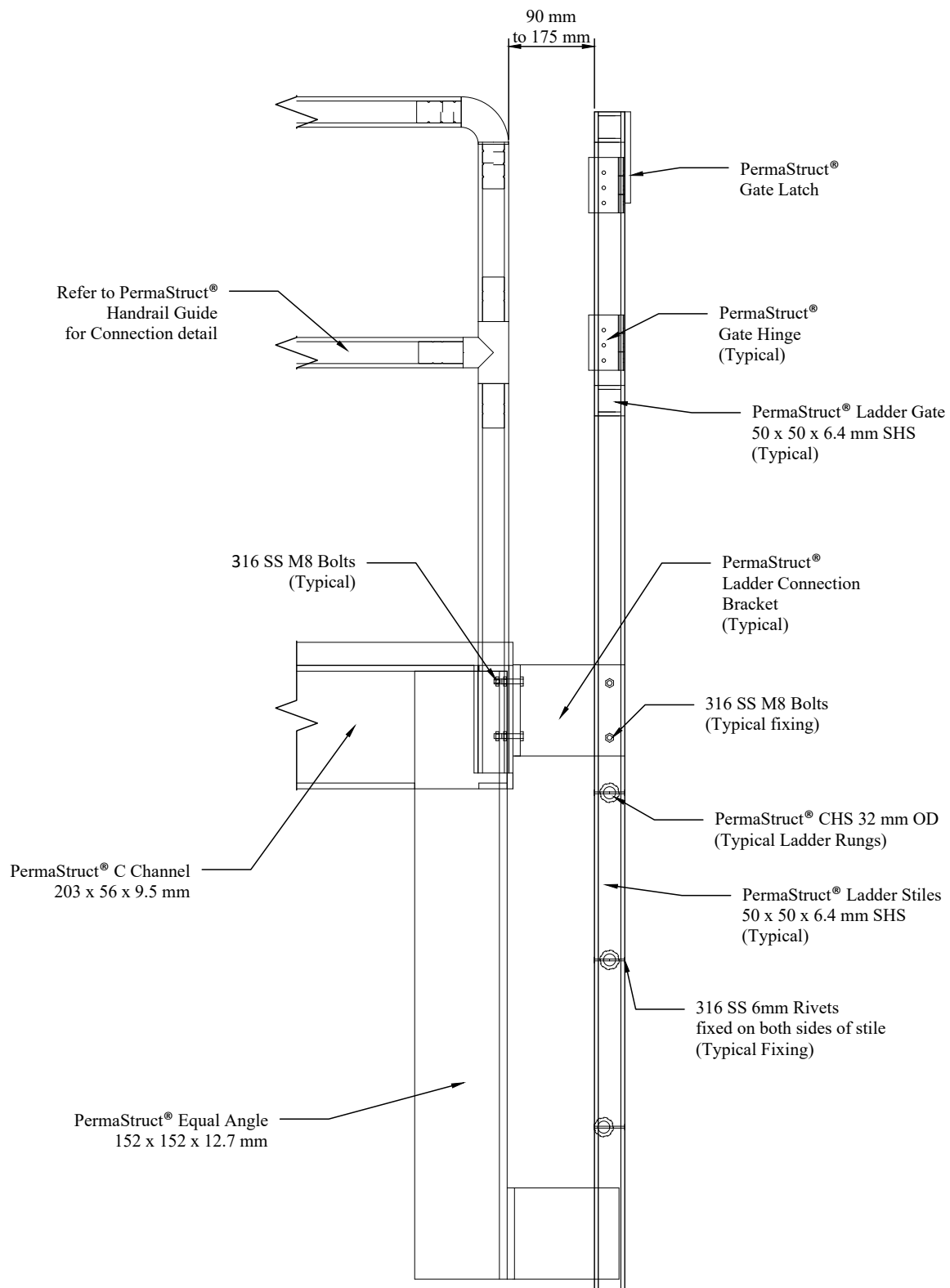


## 4. PERMASTRUCT LADDERS

### CONNECTION DETAILS

#### LADDER PLATFORM CONNECTION (MOBILE)

PermaStruct® Ladders that are designed for mobility, are similar to that of a fixed connection, with the main difference being the lack of any PermaStruct® Square Base Foot, with a PermaStruct® Ladder Bracket connected to one side of the adjacent platform. This type of connection allows for the ladders to be fixed only to the side platform i.e. to the columns. If a connection to the centre of the platform is required, then additional inclined PermaStruct® Equal Angles may be used.



VOLUME 5

# PermaStruct® Jetties





## 5. PERMASTRUCT JETTIES

**PermaStruct® FRP is the ideal choice for large-scale and commercial marine applications. It is exceptionally strong and long-lasting, whilst also providing non-slip safety for users.**

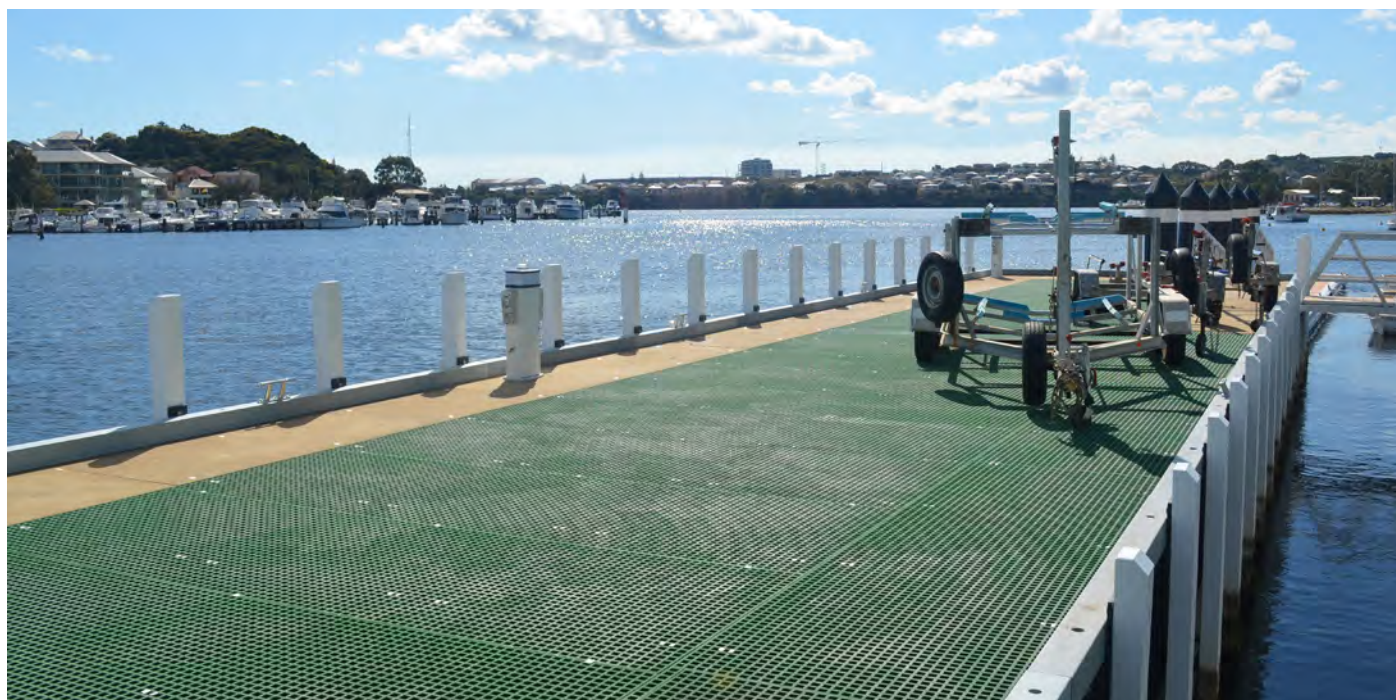
### MATERIAL COMPONENTS

The main framework of PermaStruct® FRP Jetties are built from PermaStruct® FRP Profiles, please see Appendix 1 for more information.

PermaStruct® Jetties consist of the following typical components:

Profile	Dimensions (mm)	Use
PermaStruct® FRP Channel	203 x 56 x 9.5mm	Joists, Primary Beams & Main Frame
PermaStruct® FRP Equal Angle	152 x 152 x 12.7mm	Connection Brackets
PermaStruct® FRP I Beam	203 x 203 x 9.5mm	Primary Beam
PermaStruct® FRP Grating & PermaTimber® WPC Decking	-	Decking Options for PermaStruct® Jetties
PermaStruct® FRP Box	50 x 50 x 6.4mm	Handrails
PermaStruct® FRP Box	102 x 102 x 6.4mm	Kick Rail
PermaStruct® FRP Kick Rail	150 x 3mm	Kick Rail

Please Note: Perma Composites® supplies Piles for Jetties for only special cases.



# 5. PERMASTRUCT JETTIES

## DESIGN CONSIDERATIONS

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### STRUCTURAL DESIGN

PermaStruct® Jetties are designed as a level walkway such that the walking surface does not exceed a slope of 3 degrees in any direction. PermaStruct® Jetties all have a minimum width of 600mm. All PermaStruct® Jetties are designed to suit a superimposed live loading of 2.5 KPA and a concentrated loading of 1.1 KN through a 100 x 100 mm pad. All other load requirements will be designed to suit on a design to design basis.

PermaStruct® I Beams are used for all primary beams. This is due to PermaStruct® I Beams, being less prone to deflection than other profiles. These are to be checked for both ultimate limit state (ULS) and serviceability limit state (SLS). Load factors to be used are in accordance with AS 1170.0. It is also important to also consider the effect of long term deflection for i.e. creep has when checking for serviceability and the appropriate creep factor to use (i.e. 1.2). Overall framework is to be also checked to comply with wind loading as per AS 1170.2. Joists should be spaced to suit the maximum span of the selected jetty decking.

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### JETTY DECKING

All PermaStruct® FRP Grating and PermaTimber® WPC Decking on PermaStruct® Jetties should span one-way and beam arrangements should be made to suit a 'one-way spanning slab' condition.

All PermaStruct® FRP Grating should be designed based on Ultimate Limit State (ULS) for UDL and Point Load and checked against a max deflection of 5mm from PermaStruct® FRP Grating Load Table, for Serviceability Limit State (SLS) see Appendix 7. This is a necessary measure taken to allow for lack of significant stiffness of FRP material.

PermaTimber® Decking should be checked for the maximum distance each board can span against the design loading. The maximum span should be taken as the most critical value from bending, deflection and shear strength.

Kick rails are required on the edge of all PermaStruct® Jetties as there is normally no permanent structure within 10 mm of the edge. The Kick rail profile may either be either a PermaStruct® 102 x 102 x 6.4 SHS Box or a PermaStruct® Kick Rail 150 x 3 mm plate.

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### HANDRAIL

Square handrail may vary in profile sizes; 50 x 50, 64 x 64, 102 x 102 SHS, However will be all 6.4 mm thick. Round handrail will have a 7mm thick 50 mm OD Tube.

All handrails and connectors have been tested for Ultimate Limit State and Serviceability Limit State as per AS1657 Appendix B 4.4 and have been accredited by National Association of Testing Authorities, Australia (NATA).

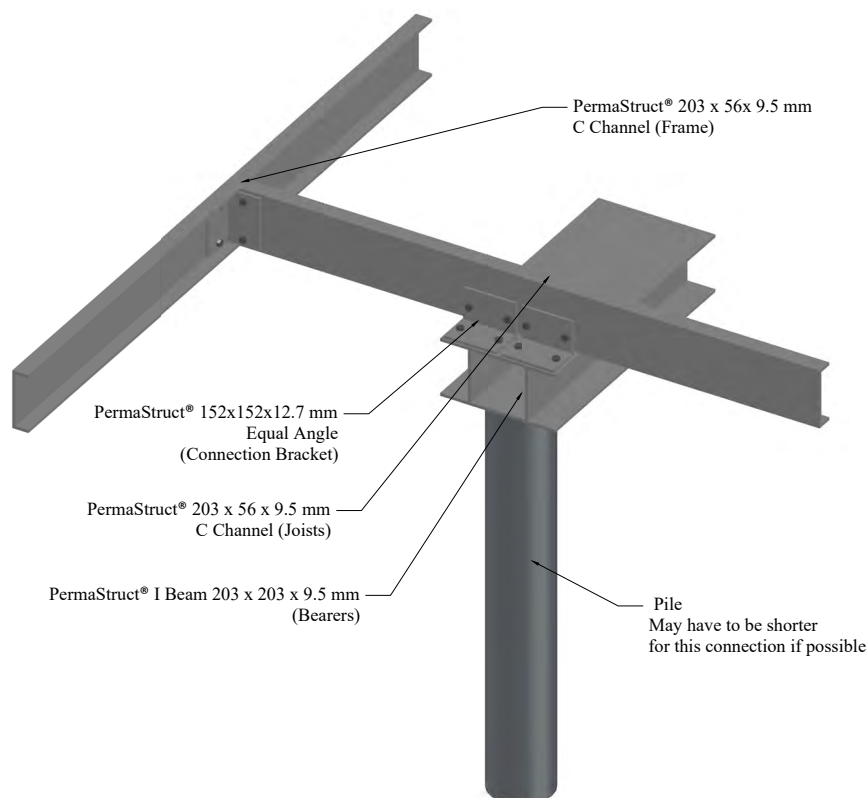
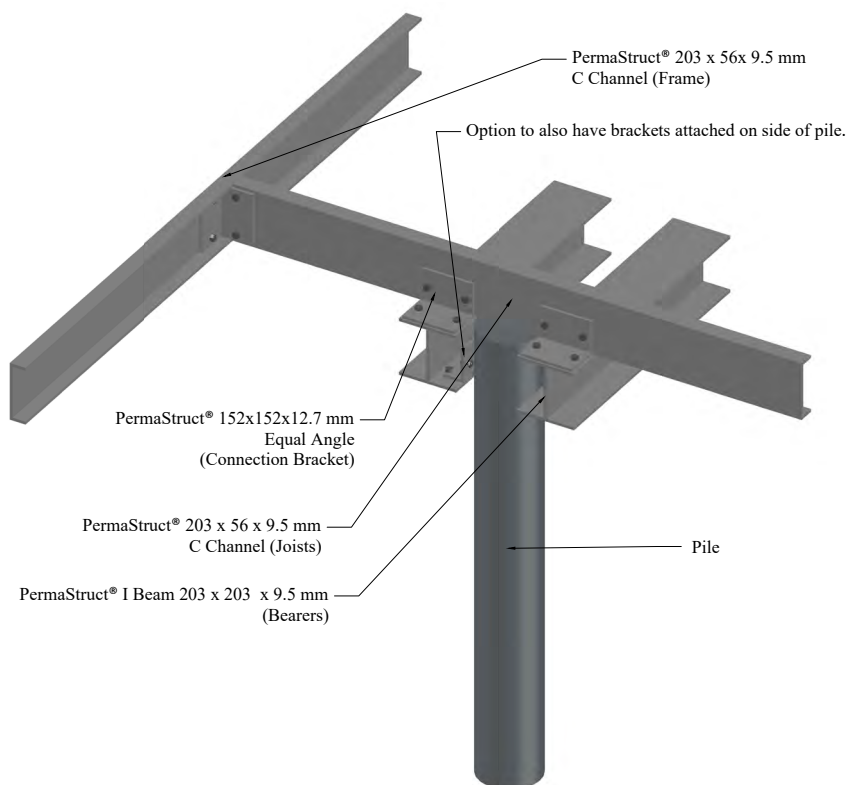


# 5. PERMASTRUCT JETTIES

## CONNECTION DETAILS

### BEAM TO PIER CONNECTION

PermaStruct® Jetties do not have general connections, as connections vary from project to project. For this reason, it is difficult to provide connection details for PermaStruct® Jetties. However, with that in mind, they are still a few connection methods illustrated below that have been used in previous projects.



# Appendix



## APPENDIX 1: Material Properties of PermaStruct® FRP Profiles

Property	Value
Instantaneous Modulus of Elasticity	14500 Mpa
Tensile Strength	207 Mpa
Compressive Strength	207 Mpa
Flexural Strength	207 Mpa
Shear Strength	31 Mpa
Allowable Shear at WLL	10.3 Mpa with FOS 3
Density	1938 kg/m <sup>3</sup>
Design Creep Factor	1.2

## APPENDIX 2: Material Properties of PermaStruct® FRP Grating

Property	Test Method	Value
Grit Finishes	DIN 51130	R13
Tensile Strength	ASTM D638	220 MPa
Modulus of Elasticity	ASTM D638	13 - 15 GPa
Flexural Strength	ASTM D790	280 - 380 MPa
Compressive Strength	ASTM D695	158 MPa
Voltage Breakdown	ASTM D149	5 - 10 KV/mm
Density (Specific Gravity)	ISO 1183	1.7 - 1.8 Kg/dm <sup>3</sup>
Thermal Expansion Factor	ISO 11359	cm/cm/C°
Water Absorption Rate	ASTM 570	0.4 - 0.7%
Operating Temperature	-	60 - 90 C°
Flammability Resistance	ASTM E84	< 25
Weatherability	ISO 4892-2	-

## APPENDIX 3: Material Properties of PermaStruct® FRP RapidDeck Profiles

Property	Value
Resin	ISO or Vinyl Ester
Flexural Strength, Fy (Lengthwise / Crosswise)	302 Mpa / 76 Mpa
Young's Modulus, E	18600 MPa
Shear Strength, G	24.5 Mpa

## APPENDIX 4: Material Properties of PermaTimber® WPC Decking

Property	Value
Instantaneous Modulus of Elasticity	5114 Mpa
Static Bending Strength	40.77 Mpa
Density	1400 kg/m <sup>3</sup>

## APPENDIX 5: PermaTimber® WPC Decking Spans

Profile	Commercial Span
146 Heavy Grain Decking	400mm
225 Decking	600mm
295 Decking	500mm

All PermaTimber® decking can span the maximum recommended joist spacing's of 450mm and 600mm as per the Building Code of Australia (BCA 2016) .Please contact us directly for more details on specific load requirements.



# APPENDIX 6: PERMASTRUCT FRP PROFILE LOAD TABLE

## General Notes:

The following load tables are based on short term loads only. The effect of long term deflections i.e. creep have not been considered. The tables therefore show the maximum uniform distributed loads recommended for each profile at various spans.

## How to Use Load Table

- Identify your desired KPA LOAD Rating. (e.g. 3KPA or 5KPA)
- Work out the Maximum UDL LOAD acting on a beam using below equation:

$$\text{Max UDL (Kg/m)} = \frac{(\text{KPA Load} \times \text{Beam Spacing (in m)} \times 1000)}{9.81}$$

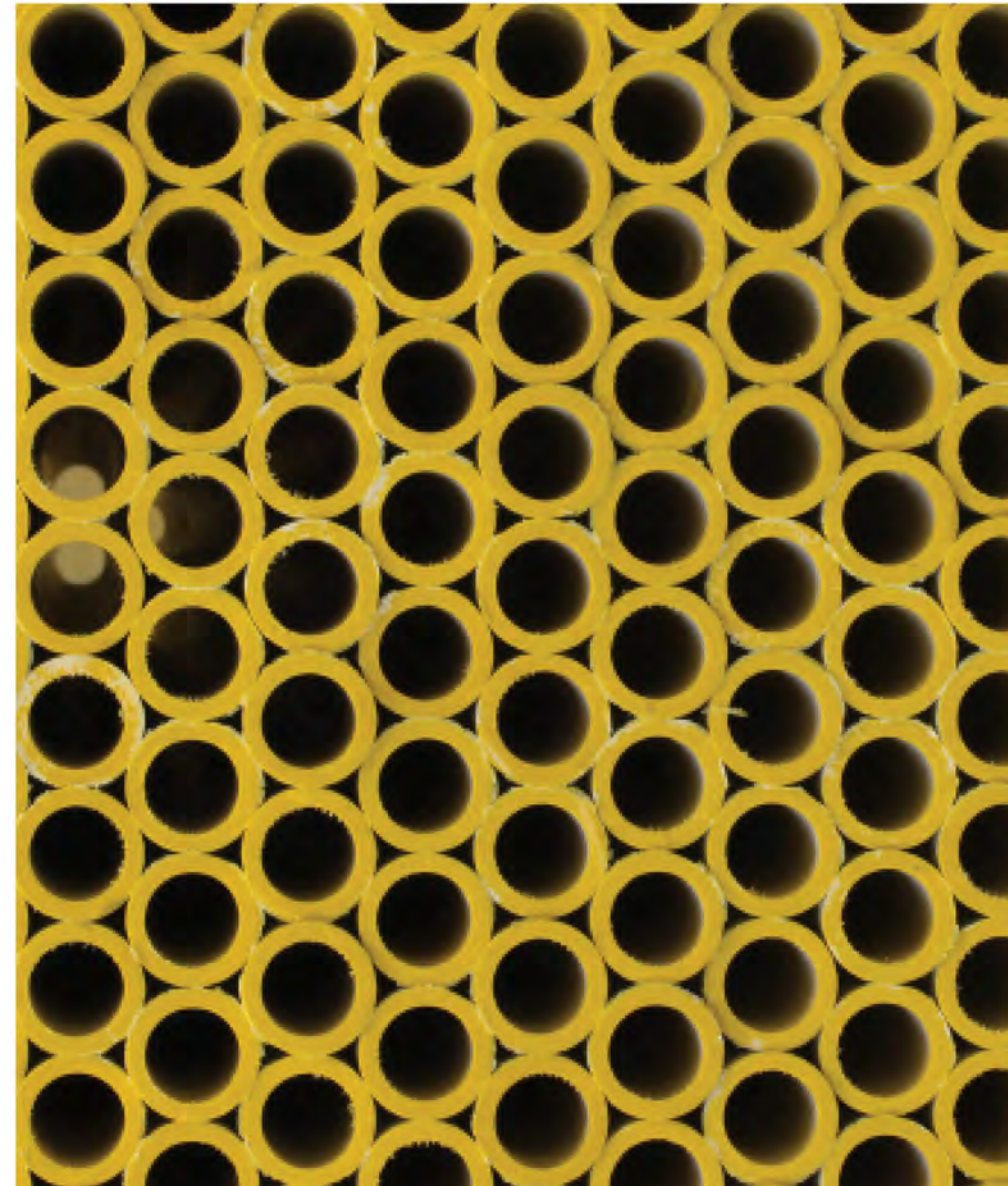
- Compare above value with similar load table value to choose appropriate profile and recommended span.

## NB:

These load table values do not have ULS and SLS safety factors applied and appropriate Limit States need to be applied during engineering design.

## Definitions:

- **Uniformly Distributed Load (UDL)** is a load that is distributed or spreads across the whole region of an element, such as a beam or slab.
- **Point Load** is an equivalent load applied to a single point, which you can determine by calculating the total load over the object's surface or length and attributing the entire load to its centre.
- **1 KPA** equals approximately 100kg per m<sup>2</sup>
- **Ultimate Limit State (ULS)** is the design for the safety of a structure and its users by limiting the stress that materials experience.
- **Serviceability Limit State (SLS)** identifies a civil engineering structure which fails to meet technical requirements for use even though it may be strong enough to remain standing.



## DISCLAIMER

This table is made available for Perma Composites® for informative and educational purposes only, as well as provide a general understanding of the products. It is NOT for providing specific engineering counsel. By using the following table, any misinterpretation of information, is not to be held against Perma Composites®. This table is not a substitution for professional engineering advice, and Perma Composites® should be contacted directly if any advice is required.



# APPENDIX 6: PERMASTRUCT FRP PROFILE LOAD TABLE

## PermaStruct® FRP C Channel

Dimensions (mm)			Weight/W	Area/A	I value/I	Neutral Axis	Section Modulus/Z	Span (mm)																											
Depth	Width	Thickness	Kg/m	mm2	mm4 x 1E-3	mm	mm3 (min) x 1E-3	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000							
								Maximum Uniformly Distributed Load (UDL) (Short Term) Kg/m																											
44	28	3.0	0.5	282	84	22	4	30	15	9	6	4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
50	30	5.0	1.0	500	179	25	7	63	32	19	12	8	6	4	3	2	2	-	-	-	-	-	-	-	-	-	-	-							
52	30	5.0	1.0	510	197	26	8	69	36	21	13	9	6	4	3	3	2	2	-	-	-	-	-	-	-	-	-	-							
70	30	4.0	0.9	488	341	35	10	120	62	36	22	15	11	8	6	4	4	3	2	2	2	-	-	-	-	-	-	-							
80	29	3.0	0.8	392	350	40	9	123	63	36	23	15	11	8	6	5	4	3	2	2	2	-	-	-	-	-	-	-							
80	28	3.0	0.8	390	350	40	9	123	63	37	23	15	11	8	6	5	4	3	2	2	2	-	-	-	-	-	-	-							
60	50	5.0	1.5	750	431	30	14	152	78	45	28	19	13	10	7	6	4	4	3	2	2	2	-	-	-	-	-	-							
84	30	5.5	1.4	732	688	42	16	242	124	72	45	30	21	16	12	9	7	6	5	4	3	3	2	2	2	-	-	-							
89	38	4.4	1.3	680	780	44	18	275	141	81	51	34	24	18	13	10	8	6	5	4	4	3	3	2	2	2	-	-							
89	38	4.8	1.4	741	841	44	19	296	152	88	55	37	26	19	14	11	9	7	6	5	4	3	3	2	2	2	2	-							
90	45	5.0	1.6	850	1027	45	23	362	185	107	68	45	32	23	17	13	11	8	7	6	5	4	3	3	3	2	2	2							
100	35	5.0	1.6	800	1094	50	22	385	197	114	72	48	34	25	19	14	11	9	7	6	5	4	4	3	3	2	2	2							
102	35	4.8	1.5	780	1110	51	22	391	200	116	73	49	34	25	19	14	11	9	7	6	5	4	4	3	3	2	2	2							
100	30	6.0	1.7	888	1137	50	23	401	205	119	75	50	35	26	19	15	12	9	8	6	5	4	4	3	3	2	2	2							
102	29	6.4	1.8	927	1196	51	24	421	216	125	79	53	37	27	20	16	12	10	8	7	5	5	4	3	3	3	2	2							
102	35	8.0	2.4	1245	1648	51	32	580	297	172	108	73	51	37	28	21	17	14	11	9	8	6	5	5	4	3	3	3							
100	50	6.0	2.2	1128	1668	50	33	588	301	174	110	73	52	38	28	22	17	14	11	9	8	6	5	5	4	4	3	3							
140	45	5.0	2.1	1100	2967	70	42	941	535	310	195	131	92	67	50	39	30	24	20	16	14	11	10	8	7	6	5	5							
150	38	6.0	2.5	1284	3679	75	49	1167	664	384	242	162	114	83	62	48	38	30	25	20	17	14	12	10	9	8	7	6							
150	50	6.0	2.8	1428	4426	75	59	1170	798	462	291	195	137	100	75	58	45	36	30	24	20	17	15	12	11	9	8	7							
152	41	6.4	2.7	1411	4240	76	56	1195	765	443	279	187	131	96	72	55	44	35	28	23	19	16	14	12	10	9	8	7							
152	42	6.4	2.8	1420	4289	76	56	1209	774	448	282	189	133	97	73	56	44	35	29	24	20	17	14	12	10	9	8	7							
110	60	10.0	4.1	2100	3618	55	66	1274	653	378	238	159	112	82	61	47	37	30	24	20	17	14	12	10	9	8	7	6							
150	40	10.0	4.1	2100	5758	75	77	1825	1039	601	378	254	178	130	98	75	59	47	38	32	26	22	19	16	14	12	11	9							
152	40	10.9	4.4	2291	6354	76	84	2015	1146	663	418	280	197	143	108	83	65	52	42	35	29	25	21	18	15	13	12	10							
203	56	9.5	5.4	2812	14899	102	147	2362	2016	1555	979	656	461	336	252	194	153	122	100	82	68	58	49	42	36	32	28	24							
200	50	10.0	5.4	2800	13893	100	139	2447	2005	1450	913	612	430	313	235	181	143	114	93	76	64	54	46	39	34	29	26	23							
200	60	10.0	5.8	3000	15700	100	157	2489	1982	1639	1032	691	486	354	266	205	161	129	105	86	72	61	52	44	38	33	29	26							
240	70	10.0	7.0	3600	27400	120	228	2896	2471	2002	1801	1207	847	618	464	358	281	225	183	151	126	106	90	77	67	58	51	45							
340	70	10.0	8.9	4600	65433	170	385	3458	2951	2732	2366	2161	1821	1475	1108	854	672	538	437	360	300	253	215	184	159	139	121	107							
250	70	12.0	8.5	4392	35354	125	283	3736	2870	2583	2208	1557	1093	797	599	461	363	290	236	195	162	137	116	100	86	75	66	58							

# APPENDIX 6: PERMASTRUCT FRP PROFILE LOAD TABLE

## PermaStruct® FRP I & H Beam

Dimensions (mm)			Weight/W	Area/A	I value/I	Neutral Axis	Section Modulus/Z	Span (mm)																											
Depth	Width	Thickness	Kg/m	mm2	mm4 x 1E-3	mm	mm3 (min) x 1E-3	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000							
								Maximum Uniformly Distributed Load (UDL) (Short Term) Kg/m																											
51	51	4.2	1.2	605	259	25	10	91	47	27	17	11	8	6	4	3	3	2	2	-	-	-	-	-	-	-	-	-							
76	76	6.2	2.6	1337	1284	38	34	452	232	134	84	57	40	29	22	17	13	11	9	7	6	5	4	4	3	3	2	2							
150	75	6.0	3.3	1728	5982	75	80	1159	971	624	393	263	185	135	101	78	61	49	40	33	27	23	20	17	15	13	11	10							
152	76	6.4	3.6	1855	6607	76	87	1280	1072	690	434	291	204	149	112	86	68	54	44	36	30	26	22	19	16	14	12	11							
150	100	8.0	5.2	2672	9678	75	129	1534	1309	1010	636	426	299	218	164	126	99	80	65	53	44	37	32	27	24	20	18	16							
152	76	9.4	5.2	2675	9162	76	120	1937	1487	956	602	403	283	207	155	120	94	75	61	50	42	35	30	26	22	19	17	15							
202	101	10.0	7.4	3840	23657	101	234	2500	2134	1852	1555	1042	732	533	401	309	243	194	158	130	109	91	78	67	58	50	44	39							
152	152	12.7	10.6	5484	21106	76	277	2602	2094	1763	1387	929	653	476	358	275	217	173	141	116	97	82	69	59	51	45	39	34							
203	203	12.7	14.4	7418	52785	102	520	3719	2856	2479	2082	1860	1633	1190	894	689	542	434	353	291	242	204	174	149	129	112	98	86							
250	125	12.0	11.1	5712	54062	125	432	3809	2925	2539	2310	2024	1672	1219	916	705	555	444	361	298	248	209	178	152	132	114	100	88							
240	220	13.0	16.5	8502	84384	120	703	3789	2985	2591	2447	2186	1919	1679	1401	1079	849	680	552	455	379	319	272	233	201	175	153	135							

Web Reinforced



# APPENDIX 6: PERMASTRUCT FRP PROFILE LOAD TABLE

## PermaStruct® FRP Square Hollow Section

Dimensions (mm)			Weight/W	Area/A	I value/I	Neutral Axis	Section Modulus/Z	Span (mm)																											
Depth	Width	Thickness	kg/m	mm2	mm4 x 1E-3	mm	mm3 (min) x 1E-3	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000							
								Maximum Uniformly Distributed Load (UDL) (Short Term) Kg/m																											
25	25	3.0	0.5	269	23	13	2	8	4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
25	25	3.2	0.6	284	24	13	2	8	4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
36	36	3.0	0.8	396	72	18	4	26	13	8	5	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
38	38	2.5	0.7	355	75	19	4	26	14	8	5	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
38	38	3.2	0.9	444	91	19	5	32	16	10	6	4	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-							
38	38	4.0	1.1	544	106	19	6	37	19	11	7	5	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-							
41	41	4.2	1.2	625	146	21	7	51	26	15	10	6	5	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-							
50	50	5.0	1.7	900	308	25	12	108	55	32	20	14	10	7	5	4	3	3	2	2	-	-	-	-	-	-	-	-							
51	51	5.0	1.8	916	324	25	13	114	58	34	21	14	10	7	5	4	3	3	2	2	-	-	-	-	-	-	-	-							
60	62	5.2	2.1	1075	576	30	19	203	104	60	38	25	18	13	10	8	6	5	4	3	3	2	2	2	-	-	-	-							
62	62	6.3	2.7	1409	743	31	24	262	134	78	49	33	23	17	13	10	8	6	5	4	3	3	2	2	2	2	-	-							
64	64	6.4	2.9	1475	825	32	26	291	149	86	54	36	26	19	14	11	8	7	6	5	4	3	3	2	2	2	2	-							
70	70	5.0	2.5	1300	921	35	26	324	166	96	61	41	28	21	16	12	9	8	6	5	4	4	3	3	2	2	2	2							
75	75	6.0	3.2	1656	1324	38	35	466	239	138	87	58	41	30	22	17	14	11	9	7	6	5	4	4	3	3	2	2							
90	90	4.0	2.7	1376	1700	45	38	479	307	177	112	75	53	38	29	22	17	14	11	9	8	7	6	5	4	4	3	3							
76	76	6.4	3.4	1774	1455	38	38	512	262	152	96	64	45	33	25	19	15	12	10	8	7	6	5	4	4	3	3	2							
80	80	6.0	3.4	1776	1632	40	41	575	294	170	107	72	50	37	28	21	17	13	11	9	7	6	5	5	4	3	3	3							
75	75	9.0	4.6	2376	1757	38	47	619	317	183	115	77	54	40	30	23	18	14	12	10	8	7	6	5	4	4	3	3							
102	102	6.4	4.7	2419	3675	51	72	841	663	384	242	162	114	83	62	48	38	30	25	20	17	14	12	10	9	8	7	6							
100	100	8.0	5.7	2944	4184	50	84	1032	755	437	275	184	129	94	71	55	43	34	28	23	19	16	14	12	10	9	8	7							
120	120	8.0	6.9	3584	7531	60	126	1194	1019	786	495	332	233	170	128	98	77	62	50	41	35	29	25	21	18	16	14	12							
150	150	8.0	11.9	6152	17727	75	236	1561	1119	1018	874	781	548	400	300	231	182	146	118	98	81	69	58	50	43	38	33	29							

Fillet Edge

Web Reinforced

# APPENDIX 6: PERMASTRUCT FRP PROFILE LOAD TABLE

## PermaStruct® FRP Rectangle Hollow Section

Dimensions (mm)			Weight/W	Area/A	I value/I	Neutral Axis	Section Modulus/Z	Span (mm)																											
Depth	Width	Thickness	kg/m	mm2	mm4 x 1E-3	mm	mm3 (min) x 1E-3	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000							
								Maximum Uniformly Distributed Load (UDL) (Short Term) Kg/m																											
25	38	2.5	0.6	290	27	13	2	10	5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
24	62	2.5	0.8	407	40	12	3	14	7	4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
25	50	4.0	1.0	536	48	13	4	17	9	5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
26	70	3.0	1.0	540	60	13	5	21	11	6	4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
25	85	3.0	1.2	624	66	13	5	23	12	7	4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
34	58	3.0	1.0	516	95	17	6	33	17	10	6	4	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-							
32	52	5.0	1.4	740	105	16	7	37	19	11	7	5	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-							
50	80	5.0	2.3	1200	460	25	18	162	83	48	30	20	14	10	8	6	5	4	3	3	2	2	2	-	-	-	-	-							
60	116	4.0	2.6	1344	823	30	27	290	148	86	54	36	25	19	14	11	8	7	5	5	4	3	3	2	2	2	2	-							
62	223	4.0	4.3	2216	1608	31	52	340	290	168	106	71	50	36	27	21	16	13	11	9	7	6	5	5	4	3	3	3							
70	231	4.0	4.5	2344	2174	35	62	383	314	227	143	96	67	49	37	28	22	18	15	12	10	8	7	6	5	5	4	4							
89	261	4.0	5.3	2736	4129	45	93	509	410	345	271	182	128	93	70	54	42	34	28	23	19	16	14	12	10	9	8	7							
92	118	4.8	3.7	1920	2601	46	56	596	469	271	171	115	80	59	44	34	27	21	17	14	12	10	9	7	6	6	5	4							
60	200	8.0	7.6	3904	2294	30	76	646	414	239	151	101	71	52	39	30	24	19	15	13	11	9	8	6	6	5	4	4							
120	170	5.0	5.4	2800	6733	60	112	830	688	562	443	297	208	152	114	88	69	55	45	37	31	26	22	19	16	14	12	11							
100	153	6.0	5.6	2886	4729	50	95	833	640	494	311	208	146	107	80	62	49	39	32	26	22	18	16	13	12	10	9	8							
100	150	8.0	7.3	3744	5881	50	118	1036	849	614	387	259	182	133	100	77	60	48	39	32	27	23	19	17	14	12	11	10							
101	191	9.5	10.1	5187	8496	51	168	1197	996	887	558	374	263	192	144	111	87	70	57	47	39	33	28	24	21	18	16	14							
152	229	6.0	8.6	4428	17475	76	229	1231	946	821	747	616	540	394	296	228	179	144	117	96	80	68	57	49	43	37	32	29							
102	152	9.5	8.7	4465	7054	51	139	1243	1018	736	464	311	218	159	120	92	72	58	47	39	32	27	23	20	17	15	13	12							



# APPENDIX 6: PERMASTRUCT FRP PROFILE LOAD TABLE

## PermaStruct® FRP Equal Angle

Dimensions (mm)			Weight/W	Area/A	I value/I	Neutral Axis	Section Modulus/Z	Span (mm)																											
Depth	Width	Thickness	kg/m	mm2	mm4 x 1E-3	mm	mm3 (min) x 1E-3	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000	4250	4500	4750	5000	5250	5500	5750	6000							
								Maximum Uniformly Distributed Load (UDL) (Short Term) Kg/m																											
29	29	4.0	0.4	216	17	9	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
40	40	4.0	0.6	304	46	11	4	6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
50	50	5.0	0.9	475	113	14	8	14	7	4	3	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
51	51	6.4	1.2	605	145	15	10	18	9	5	3	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
60	60	8.0	1.7	896	297	18	17	37	19	11	7	5	4	4	3	2	2	-	-	-	-	-	-	-	-	-	-	-							
75	75	4.0	1.1	584	325	20	16	41	21	12	8	5	5	4	3	3	2	2	-	-	-	-	-	-	-	-	-	-							
75	75	6.0	1.7	864	469	21	22	59	30	17	11	7	7	6	5	4	3	2	2	2	-	-	-	-	-	-	-	-							
76	76	6.4	1.8	927	518	21	24	65	33	19	12	8	8	7	5	4	3	3	2	2	-	-	-	-	-	-	-	-							
75	75	8.0	2.2	1136	602	22	28	75	39	22	14	9	9	8	6	5	4	3	2	2	2	-	-	-	-	-	-	-							
76	76	9.5	2.6	1354	725	22	32	91	46	27	17	11	11	10	7	6	4	4	3	2	2	2	-	-	-	-	-	-							
80	80	8.0	2.4	1216	737	23	32	92	47	27	17	12	11	10	7	6	4	4	3	2	2	2	-	-	-	-	-	-							
102	102	6.4	2.4	1250	1265	28	46	158	81	47	30	20	18	17	13	10	8	6	5	4	3	3	2	2	2	2	-	-							
100	100	10.0	3.7	1900	1800	29	63	225	115	67	42	28	26	24	18	14	11	9	7	6	5	4	4	3	3	2	2	2							
102	102	12.7	4.7	2419	2315	30	77	290	148	86	54	36	34	31	23	18	14	11	9	8	6	5	5	4	3	3	3	2							
152	152	9.5	5.5	2812	6404	42	154	802	411	238	150	100	93	86	64	50	39	31	25	21	17	15	12	11	9	8	7	6							
152	152	12.7	7.2	3710	8286	43	194	1038	531	308	194	130	120	111	83	64	50	40	33	27	23	19	16	14	12	10	9	8							

# APPENDIX 7: PERMASTRUCT FRP GRATING LOAD TABLE UDL

## HOW TO USE LOAD TABLE

1. Choose your desired load.
2. Choose your desired span.
3. Read off table across span column and look for corresponding value of deflection value in mm.
4. Compare deflection value with required maximum deflection limit.

If the table does not indicate desired grating product, or cannot satisfy design requirements, please contact us directly for further information.

## DISCLAIMER

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3KPA - 300kg/m <sup>2</sup>								
Grating Type	500mm	600mm	700mm	800mm	900mm	1000mm	1100mm	1200mm
PermaStruct® Standard Mesh Grating (38 x 38, 32 x 32 Hole Size)								
15mm Thick	7.93	-	-	-	-	-	-	-
25mm Thick	0.93	1.89	3.45	5.83	9.28	14.08	-	-
30mm Thick	0.62	1.26	2.29	3.86	6.14	9.30	13.56	-
38mm Thick	0.30	0.59	1.05	1.76	2.78	4.20	6.11	8.60
PermaStruct® Standard Mesh Grating (50 x 50, 42 x 42 Hole Size)								
50mm Thick	0.16	0.31	0.54	0.89	1.39	2.09	3.02	4.23
PermaStruct® Standard Mesh Grating (38 x 38, 26 x 26 Hole Size)								
50mm Thick	0.10	0.19	0.33	0.54	0.85	1.28	1.84	2.59
PermaStruct® Mini Mesh Grating (20 x 20, 40 x 40, 12 x 12 Hole Size)								
21mm Thick	1.30	2.64	4.85	8.23	-	-	-	-
38mm Thick	0.28	0.55	0.99	1.65	2.61	3.94	5.73	8.07
PermaStruct® Micro Mesh Grating (13 x 13, 40 x 40, 8 x 8 Hole Size)								
21mm Thick	1.24	2.54	4.67	7.93	-	-	-	-
38mm Thick	0.21	0.42	0.76	1.27	2.01	3.04	4.41	6.21
PermaSlab Light Solid Top								
35mm Thick (30 + 5mm)	0.29	0.55	0.97	1.59	2.49	3.72	5.37	7.53
41mm Thick (38 + 3mm)	0.18	0.35	0.61	1.01	1.59	2.38	3.43	4.81
PermaSlab Heavy Duty Solid Top								
42mm Thick	0.13	0.23	0.36	0.55	0.81	1.16	1.62	2.20
62mm Thick	0.07	0.12	0.18	0.27	0.39	0.54	0.74	0.99

# APPENDIX 7: PERMASTRUCT FRP GRATING LOAD TABLE UDL

## HOW TO USE LOAD TABLE

1. Choose your desired load.
2. Choose your desired span.
3. Read off table across span column and look for corresponding value of deflection value in mm.
4. Compare deflection value with required maximum deflection limit.

If the table does not indicate desired grating product, or cannot satisfy design requirements, please contact us directly for further information.

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5KPA - 500kg/m <sup>2</sup>								
Grating Type	500mm	600mm	700mm	800mm	900mm	1000mm	1100mm	1200mm
PermaStruct® Standard Mesh Grating (38 x 38, 32 x 32 Hole Size)								
25mm Thick	1.55	3.14	5.75	9.72	-	-	-	-
30mm Thick	1.04	2.10	3.82	6.44	10.23	-	-	-
38mm Thick	0.49	0.98	1.76	2.94	4.64	7.00	10.18	14.33
PermaStruct® Standard Mesh Grating (50 x 50, 42 x 42 Hole Size)								
50mm Thick	0.27	0.51	0.90	1.48	2.32	3.48	5.03	7.05
PermaStruct® Standard Mesh Grating (38 x 38, 26 x 26 Hole Size)								
50mm Thick	0.16	0.31	0.55	0.91	1.42	2.13	3.07	4.31
PermaStruct® Mini Mesh Grating (20 x 20, 40 x 40, 12 x 12 Hole Size)								
21mm Thick	2.16	4.41	8.09	-	-	-	-	-
38mm Thick	0.46	0.91	1.64	2.75	4.35	6.57	9.55	13.45
PermaStruct® Micro Mesh Grating (13 x 13, 40 x 40, 8 x 8 Hole Size)								
21mm Thick	2.07	4.24	7.79	-	-	-	-	-
38mm Thick	0.36	0.71	1.27	2.12	3.35	5.06	7.35	10.36
PermaSlab Light Solid Top								
35mm Thick (30 + 5mm)	0.48	0.92	1.61	2.65	4.15	6.20	8.96	12.55
41mm Thick (38 + 3mm)	0.30	0.58	1.02	1.69	2.64	3.96	5.72	8.02
PermaSlab Heavy Duty Solid Top								
42mm Thick	0.22	0.38	0.60	0.92	1.35	1.94	2.69	3.66
62mm Thick	0.12	0.20	0.31	0.45	0.65	0.90	1.23	1.64



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*Confidence with every step*