

Palisafe™

Class 1a GRP Composite security and
boundary fencing system



Performance Specification

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Foreword

This specification is for Palisafe™ fencing manufactured and marketed by UK Pultrusions Limited. The product has been previously marketed as Polysade and was manufactured by Plura composites Limited until June 2024 when all product rights have been transferred.

This document contains references to testing and drawings produced prior to June 2024 which are still relevant to this specification.

Document layout information

This specification is based upon the layout of British Standard BS 1722-12:2016 and it came into effect on 1 June 2024. It was prepared by Graeme Pringle Technical Director for UK Pultrusions Limited.

Use of this document

It has been assumed in the preparation of this Specification that the execution of its provisions will be entrusted to appropriately qualified and experienced people. At the time of publication two appropriate qualification schemes are available: the Fencing Industry Skills Scheme (FISS) and the Construction Skills Certification Scheme (CSCS). 1) FISS/CSCS maintain a national register for fence installers and operatives. Other schemes might be available.

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1 Scope

In the absence of any published standards for Composite GRP fencing: This specification is based upon BS 1722-12:2016, which specifies requirements for steel palisade fences and gates for general purpose (GP) fences for heights up to 2.4 m, and for security purpose (SP) fences for heights of 3 m and 3.6 m, all with posts at 2.75 m centres. The British Standard also covers fences between 2.4 m and 3 m in height with components constructed to the SP specification.

Please note however that due to the disparity in material properties and post construction; elements of BS 1722-12:2016 do not apply or are not appropriate when considering the performance criteria. This includes weight, deflection, certain key dimensions, material grades and corrosion resistance and these will be noted where applicable. However wherever appropriate; the load resistance requirements under test are still considered applicable. In addition; any features which are considered to be an essential function of the product.

NOTE 1 Where greater resistance against penetration is required for fences below 2.4 m in height, the SP components can be obtained from UK PULTRUSIONS.

NOTE 2 Requirements within the British Standard for the minimum sizes of fence components are based on a design wind loading, q , at right angles to the plane of the fence of 900 N/m² employing a shape factor of 1.9 on the net area presented to the wind.

NOTE 3 In situations of extreme exposure or abnormal loading, a special appraisal can be undertaken by UK PULTRUSIONS based upon design criteria, which should be provided by the specifier/designer.

NOTE 4 The responsibility for ensuring the final installation meets this specification belongs to the installer. This responsibility can be mitigated by obtaining the following from UK PULTRUSIONS, available upon request and which can be provided at the time of delivery (These are in accordance with Clause 10 of BS 1722-12:2016):

- A. *A certificate of conformity to this specification reference; UKP-PS-001 JUNE 2017*
- B. *A Delivery note which contains: UK PULTRUSIONSs contact details, a contract or order number, the date of delivery and the purchasers contact details*

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 13706—1:2002 Reinforced plastics composites. Specifications for pultruded profiles. Designation

BS EN 13707—2:2002 Reinforced plastics composites. Specifications for pultruded profiles. Method of test and general requirements

BS EN 13707—3:2002 Reinforced plastics composites. Specifications for pultruded profiles.

BS 907, *Specification for dial gauges for linear measurement*²⁾

BS 3692:2014, *ISO metric precision hexagon bolts, screws and nuts – Specification*

BS 3693, *Recommendations for design of scales and indexes on analogue indicating instruments*

BS 4320, *Specification for metal washers for general engineering purposes – Metric series*

BS 4484-1, *Specification for measuring instruments for constructional works – Part 1: Metric graduation and figuring of instruments for linear measurement*

BS 7371-3, *Coatings on metal fasteners – Part 3: Specification for electroplated zinc coatings*

BS 7371-6, *Coatings on metal fasteners – Part 6: Specification for hot dipped galvanized coatings*

BS 8500-1:2015+A1:2016, *Concrete – Complementary British Standard to BS EN 206 – Part 1: Method of specifying and guidance for the specifier*

BS 8500-2:2015+A1:2016, *Concrete – Complementary British Standard to BS EN 206 – Part 2: Specification for constituent materials and concrete*

BS EN 1011-1, *Welding – Recommendations for welding of metallic materials – Part 1: General guidance for arc*

BS EN 1011-2, *Welding – Recommendations for welding of metallic materials – Part 2: Arc welding of ferritic steels*

BS EN 12620, *Aggregates for concrete*

BS EN ISO 376, *Metallic materials – Calibration of force-proving instruments used for the verification of uniaxial testing machines*

BS EN ISO 1461:2009, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

BS EN ISO 7500-1:2015, *Metallic materials – Calibration and verification of static uniaxial testing machines – Part 1: Tension/compression testing machines –*

Calibration and verification of the force-measuring system

BS 476-7: 1997 Class 2, *Classification of spread of flame*

Section 1: Product Details

3 Dimensions and general characteristics

3.1 Dimensions and tolerances

For other heights of GP fences, unless stated, the specification for the nearest fence height given in Table 1 shall be used.

NOTE Dimensions for components are shown in Table 1, Table 2 and Table 4.

For other heights of SP fences, unless stated, the specification for the nearest fence height given in Table 2 shall be used.

Table 1 Dimensions for general purpose (GP) fences with posts at 2.7 m centres

British Standard type reference	Fence Height Above ground m	Dimensions					
		Posts	Rails (horizontal)		Pales (maximum gap between pales, face-to-view, 89mm)		
		Embedded Length ^{A)} mm	Length ^{B)} m	Typical connector bolt diameter mm	Oversail		Typical bolt diameter pale to rail ^{D)} mm
					Top mm	Bottom mm	
GP 11 Not covered in BS 1722-12:2016	1.10	525	2.60	10	225	150	6
GP 12 Not covered in BS 1722-12:2016	1.20	525	2.60	10	225	150	6
GP 15	1.50	525	2.60	10	225	150	6
GP 18	1.80	525	2.60	10	225	150	6
GP 21	2.10	625	2.60	10	275	200	6
GP 24	2.40	725	2.60	10 ^{C)}	300	210	6
GP 27 Not covered in BS 1722-12:2016	2.70	825	2.40 ^{E)}	10 ^{C)}	300	210	6

A) The embedded length is derived from the formula:

$$L = \frac{FH}{3} - 75$$

B) BS 1722-12:2016 states the centres between posts should be 2.75m which results in a rail length of 2.72m. This is based upon the steel posts being I beams. The Palisafe™ Composite GRP system employs a square BOXpost™ which is larger than the I beams employed by steel systems. This in turn means; in order to keep the correct pale spacing the rail length needs to be shorter than defined in the Standard.

C) Due to the light weight (not light duty) nature of composite GRP fence systems when compared with steel lighter duty fixings can be employed on taller sizes (10mm vs 12mm).

D) Not specified in BS 1722-12:2016, but again due to the lightweight (not light duty) nature of composite GRP these fixings do not need to be to the same gauge as for holding steel pales.

E) As Palisafe™ fence is supplied as a pre-assembled panel system; for heights over 2.4 m; panels are not as wide in order to be able to be delivered on standard transport, which is only available up to 2.4 metres wide; thus any single dimension is restricted to 2.4 metres.

Table 2 Dimensions for security purpose (SP) fences with posts at 2.7 m centres

British Standard type reference	Fence Height Above ground	Dimensions					
		Posts	Rails (horizontal)		Pales (maximum gap between pales, face-to-view, 89mm)		
		Embedded Length ^{A)}	Length ^{B)}	Typical connector bolt diameter	Oversail		Typical bolt diameter pale to rail ^{D)}
	m	mm	m	mm	Top	Bottom	mm
					mm	mm	
SP 30	3.0	925	2.00	10	475	380	6
SP 36	3.60	1125	1.5	10 ^{C)}	650	550	6

A) The embedded length is derived from the formula:

$$L = \frac{FH}{3} - 75$$

B) BS 1722-12:2016 states the centres between posts should be 2.75m which results in a rail length of 2.72m. This is based upon the steel posts being I beams. The Palisafe™ Composite GRP system employs a square BOXpost™ which is larger than the I beams employed by steel systems. This in turn means; in order to keep the correct pale spacing the rail length needs to be shorter than defined in the Standard.

In addition (and in this case) as Palisafe™ fence is supplied as a pre-assembled panel system; for the taller SP types, panels are not as wide in order to reduce the weight to a manageable level for manual handling. Also standard transport is only available up to 2.4 metres wide and so any single dimension is restricted to 2.4 metres.

C) Due to the light weight (not light duty) nature of composite GRP fence systems when compared with steel lighter duty fixings can be employed on taller sizes (10mm vs 12mm).

D) Not specified in BS 1722-12:2016, but again due to the lightweight (not light duty) nature of composite GRP these fixings do not need to be to the same gauge as for holding steel pales.

3.2 Characteristics of pales

When tested in accordance with Test A Flexural strength of pales; pales shall conform to the load/ deflection as follows:

- a) for SP fencing, as per BS 1722-12:2016 under test the load shall be 3.5 kN the maximum deflection at the middle of the span under a test load shall be 3.5 kN shall not exceed 24 mm ^{A)} (Steel is 10mm) ; and
- b) for GP fencing, the maximum deflection at the middle of the span under a test load of 2.5 kN shall not exceed 15 mm ^{A)} (Steel is 8mm).

Pales shall also be capable of withstanding the loading for the pale to fence rail assembly in **5.2**.

Pales shall be manufactured from Composite GRP to Grade E17 referenced within the standards in **4.1**.

^{A)} As BS 1722-12:2016 is designed for steel which, reaches it's permanent set at much lower levels than GRP, the maximum deflection allowable has to be set at numbers much lower than for GRP. To balance this there is zero permanent set allowable with the GRP after the load is removed.

3.3 Characteristics of posts

When tested in accordance with Test B Flexural strength of posts; posts shall conform to the load deflection as follows:

- a) for GP fencing posts, the maximum deflection at the middle of the 2 500 mm span under a test load of 10 kN shall not exceed 16 mm ^{A)} (Steel is also 16mm); and
- b) for SP fencing posts, the maximum deflection at the middle of the 2 500 mm span under a test load of 20 kN shall not exceed 32 mm ^{A)} (Steel is 9mm).

The test load shall be applied to the post at right angles to the plane of the fence.

Posts shall be provided at a maximum of 2.7 m centres.

Posts shall be manufactured from Composite GRP to Grade E23 referenced within the standards in **4.1**.

^{A)} As BS 1722-12:2016 is designed for steel which, reaches it's permanent set at much lower levels than GRP, the maximum deflection allowable has to be set at numbers much lower than for GRP. To balance this there is zero permanent set allowable with the GRP after the load is removed.

^{B)} As the Palisafe™ is a pale pass through system; the rail is tested with the pale slots made into it.

4 Materials

4.1 Glass Re-enforced Polyester Resin (GRP)

All GRP components conform to BS EN 13706 which defines the minimum mechanical properties in each of two grades E17 and E23.

The standard applies solely to pultruded profiles for “structural purposes”, which according to the standard are defined as “where the load-bearing characteristic is the major criterion of design and where the product is part of a load-bearing system”.

The standard specifies the minimum requirements for the quality, tolerances, strength, stiffness and surface of structural profiles.

Table 3 Mechanical properties

Characteristic properties			Minimum requirements	
Property	Unit	Test method	E23	E17
Modulus of elasticity	GPa	Annex D, EN 13706-2:2002	23	17
Tensile modulus-longitudinal	GPa	EN ISO 527-4	23	17
Tensile modulus-transverse	GPa	EN ISO 527-4	7	5
Tensile strength-longitudinal	MPa	EN ISO 527-4	240	170
Tensile strength-transverse	MPa	EN ISO 527-4	50	30
Pin bearing strength-longitudinal	MPa	Annex E, EN 13706-2:2002	150	90
Pin bearing strength– transverse	MPa	Annex E, EN 13706-2:2002	70	50
Bending strength-longitudinal	MPa	EN ISO 14125	240	170
Bending strength-transverse	MPa	EN ISO 14125	100	70
Shear strength-longitudinal	MPa	EN ISO 14130	25	15

NOTE Where applicable, the use of higher strength or more enhanced grades than those shown is permissible, provided they meet the necessary requirements as in the standards listed in this table.

4.1.1 UV Properties

Palisafe™ fencing is manufactured using Isophthalic Polyester Resin, which has a good resistance to UV. Additionally; additives and pigments which also contain ultraviolet light absorbers and inhibitors greatly increase the performance versus long term sunlight exposure.

Polyester synthetic veils are also applied to the outside of the profiles used in order to encapsulate the E-glass fibres and provide a resin rich surface, which limits the potential for glass show through (a common issue with earlier and aged GRP components installed outdoors).

Results have shown that UV degradation does not affect the modulus of elasticity of the profiles and so has limited effect on the mechanical properties of the fencing over time.

Fading of the resin colour will occur although the extent of this is dependent upon the level and intensity of sunlight exposure. Further surface coating can be applied to significantly limit this effect should this be required, this should be specified by the designer / client.

4.1.2 Fire Resistance Properties

Palisafe™ fencing conforms with BS 476-7: 1997 Class 2 as standard. Material can be formulated to produce a higher class if required.

Palisafe™ material will not melt and will not fuel a fire.

4.2 Steel

Steel components (other than in fixings & gate fittings) are used only in bolt down feet for hard areas and/or in a post repair jointer and conform to the applicable material standard listed in Table 4.

The steel grade(s) employed shall be specified on the basis of the mechanical properties, formability and weldability required.

Table 4 Steel Grades

Material	Dimensional standard	Material standard	Material grade
Flat plate	BS EN 100058:2003	BS EN 10025-2:2004	S235JR
Square hollow sections	BS EN 10210-2:2006	BS EN 10210-1:2006	S235JRH
	BS EN 10219-2:2006	BS EN 10219-1:2006	S235JRH

4.3 Bolts, nuts and washers

All bolts and nuts shall conform to BS 3692.

Bolts shall be strength grade 4.6 for GP fences and strength grade 8.8 for SP fences. Panel fixing bolts shall be cup square headed. Bolts for pales shall have special formed heads to suit pale profiles and shall be tamper resistant, i.e. not easily removed using typical tools.

Nuts shall conform to BS 3692:2014, strength grade 4 and shall be tamper resistant.

Washers, if specified, shall conform to BS 4320.

The corrosion protection to be applied to the bolts, nuts and washers shall be selected from the following options:

- a) galvanizing in accordance with BS EN ISO 1461 or BS 7371-6;
- b) zinc electroplating in accordance with BS 7371-3; and
- c) other proprietary treatments with corrosion resistance properties equal to or greater than b).

4.4 Cold swaged pin and collar fixings

Cold swaged collar grooved or grooved fasteners shall conform to BS 7805-1, and shall be formed from carbon boron steel conforming to BS EN 10263-1, BS EN 10263-2, BS EN 10263-3 and BS EN 10263-4, or equivalent, having a minimum tensile strength of 850 N/mm². They shall have a suitably formed head and shall be provided with a ductile flanged collar.

NOTE Head types differ between manufacturers.

The tensile strength of cold swaged pin and collar fixings shall be determined in accordance with Test D.

The corrosion protection to be applied to the cold swaged pin and collar fixings shall be selected from the following options:

- a) galvanizing in accordance with BS EN ISO 1461 or BS 7371-6;
- b) zinc electroplating in accordance with BS 7371-3; and/or
- c) other proprietary treatments with corrosion resistance properties equal to or greater than b).

5 Construction of the fence

5.1 Pales

Pales are fixed to the horizontal rails such that the maximum gap between, face-to-view, is:

- a) 89 mm for GP fences; and
- b) 86 mm for SP fences.

The clear distance between pales and adjacent posts should not exceed the spacing between pales on adjacent fencing.

For both the GP and SP fences, pales pass through a CNC machined slot in the horizontal rails and are then secured to the rails at every intersection by use of a shear nut or cold swaged pin and collar fixings.

The heads of all fastenings have the minimum possible projection beyond the face of the pale to minimize tampering and footholds.

The pass through pale design provides protection against pale removal even in the event of direct impact attack on the fastener head.

The tolerance on the length of the pale shall be ± 5 mm.

NOTE 1 Special gradient pale and rail fixings are available to deal with slopes.

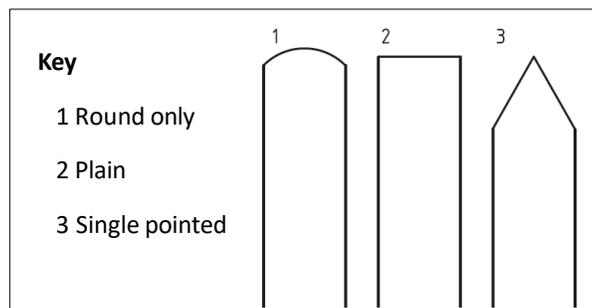
NOTE 3 The shape of the tops of the pales should be specified by the purchaser.

The shape of the tops of the pales should be selected from the basic shapes as shown in Figure 1. Pointed head pales are not recommended for use on fences less than 2.1 m high adjacent to public thoroughfares.

For SP fences, pale top shapes 1 and 2 should not be used (see Figure 1) unless some form of topping is also specified (see 6.4).

NOTE 4 Figure 1 illustrates typical angle pale top shapes.

Figure 1 **Typical pale top shapes**



5.2 Pale to rail fixing

All samples tested for the pale to rail fixing assembly withstand the following loadings when tested in accordance with Test D:

- a) for GP fences: 10 kN; and
- b) for SP fences: 18 kN.

5.3 Posts

Posts should be installed at a maximum of 2.7 m centres.

All posts are capped off at the top with a cap that does not protrude beyond the outer 100mm x 100mm size of the post.

Where posts are required at different centres, the centres should be specified by the client and all components will be purpose designed.

Posts should be embedded in concrete foundations to the minimum depths given in Table 1 and Table 2. 100mm diameter securing holes in opposing sides at the bottom of the BOXpost™ are in place so the concrete surround can be worked into the post base.

Where removable lengths of palisade fence are required, the construction details or design criteria for the removable posts and their foundations should be specified; See the removable insert in 9. Options and accessories to assist with this.

5.4 Stays

If stays are necessary to withstand abnormal loading or site conditions, the design criteria or constructional details of the stays should be specified between UK PULTRUSIONS and the client.

NOTE 1 The fences specified by BS 1722-12:2016 are designed to be used without stays.

NOTE 2 All SP fences in Palisafe™ have anti burrowing measures as laid out in 6.2

5.5 Rails

Fences have a minimum of two horizontal rails.

NOTE For SP fences, additional rails can be added by agreement between the purchaser and UK PULTRUSIONS (see Clause 6).

Each rail is secured to posts with connector plates or fish plates bolted to the vertical leg(s) of the rail.

NOTE 1 For SP fences; BS 1722-12:2016 calls for fish plates or connector plates to be fitted to the web of the post. Due to the BOXpost™ nature of the Palisafe™ system; this is not possible; as the fishtail passes through two walls in the Palisafe™ system; this is already inherently stronger and more secure than standard GP steel systems.

The diameter of the bolts is as given in Table 1 and Table 2.

NOTE 2 BS 1722-12:2016 calls for provision to be made for thermal expansion by providing slotted holes at the rail to plate connection. As thermal expansion of composite material is minimal when compared to steel this is not applicable.

Plates are a minimum of 6 mm thick, and of sufficient sizing to give a minimum distance of 9 mm to the edge of the hole.

Connector plates or fish plates are not connected to the post but instead pass through the twin walls of the BOXposts™. This can be enhanced by provision of a security bolt which passes through the BOXpost™ perpendicular to the connector plate. It passes through the two walls of the BOXpost™ and through the connector plate within the post. This then complies with 5.6 a) & c) within the BS 1722-12:2016 standard but is an option only and requires specification by the client.

5.6 Post to rail connections

Each rail is secured to posts with connector plates or fish plates bolted to the front vertical leg of the rail. As the Palisafe™ fishtail is made from extra thick GRP plate which passes through two walls of the BOXpost™; for SP fences, there is no requirement for the fish plate or a connector plate to be fitted to the web of the post. The diameter of the bolts shall be as given in Table 1 and Table 2.

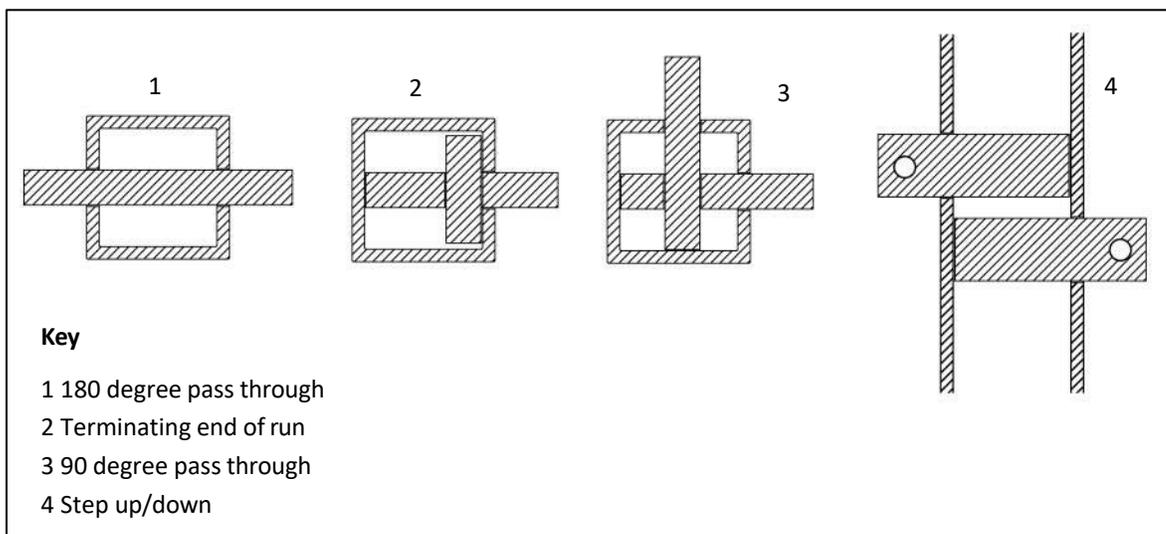
There is no provision required for thermal expansion as GRP is not affected like steel. Slotted holes are provided at the rail to plate connection to allow for an easier site fix. Plates are a minimum of 8 mm thick, and of sufficient sizing to give a minimum distance of 9 mm to the edge of the hole.

Connector plates or fish plates are connected to the post by passing through pre-machined slots in two walls of the BOXpost™.

This can be enhanced by provision of a security bolt which passes through the BOXpost™ perpendicular to the connector plate. It passes through the two walls of the BOXpost™ and through the connector plate within the post.

NOTE: Standard posts are 'pass through' in line run and have slots top and bottom on opposing faces to accept the fishtail. The client must specify at time of order; any posts which are required on a corner or end of run as these will be either machined on perpendicular or a single face(s).

Figure 2 Fishtail configurations



5.7 Intermediate supports

Where appropriate, intermediate supports will be provided to the lower structural rail in order to prevent the rail deflecting in excess of 10 mm (at any point) under the weight of the fence.

As Palisafe™ is much lighter than the steel alternative; this measure will only be required in minimal cases.

5.8 Protective treatment

Composite GRP material will not corrode and so the measures contained within Section 1 5.8 of BS 1722-12:2016 for protective treatment are not applicable.

All profiles used within the fencing are produced using UV stable materials (see 4.1.1).

6 Security purpose (SP) fences

6.1 General

Additional security measures will be taken for all SP fences.

NOTE These measures are optional for GP fences.

6.2 Burrowing

If burrowing is possible, one of the following measures should be specified under BS 1722-12:2016:

- a) a concrete sill shall be provided in accordance with **9.1.3**;
- b) pales shall be extended by 150 mm and embedded in the concrete sill as in a); or
- c) pales shall be extended by 350 mm and buried in the ground.** ^{A)}

^{A)} By far the simplest and most practical approach with Palisafe™ is c) Composite GRP is non-corrosive and therefore has a design life in excess of 60 years even if c) is undertaken. Buried pales will not corrode and this eliminates the need for wet-trades on site.

6.3 Increased resistance to penetration

To increase resistance to pale removal, and if the pales are not buried or set in concrete in accordance with **6.2**, an additional rail can be attached to the lower part of each pale. This additional rail will be fixed to the pales 100 mm from the bottom of the pale.

NOTE To increase resistance to penetration additional rails can be added, for example, at waist height, by agreement with the designer.

6.4 Topping

If required, further security against climbing shall be provided by fixing a spiked topping, barbed wire entanglement or barbed tape concertina to the pales.

Such toppings shall be fitted as close to the top of the pales as possible or, in the case of barbed coils, the wire shall sit within the oversail.

NOTE The use of such toppings on SP fences is highly recommended. However, the use of barbed tape concertina is not recommended for fences below 3 m in height as the bottom of the coil should not be less than 2.5 m above ground level.

7 Maintenance, renovation and repair of composite GRP fences

The fence should be inspected after installation and on a regular basis as part of any standard asset maintenance program. If damage is found; depending upon the nature; the following actions should be taken:

7.1 Damage to the structure (for example from being hit by a vehicle or similar)

In the unlikely event that a part of the fence becomes damaged during installation the damaged part must be removed and replaced to keep the integrity of the system. This is the same if damage occurs post installation.

7.2 Deep scratches

These may be more noticeable on darker colours of Black or Dark Green.

Use the UK PULTRUSIONS Palisafe™ Fence Smart Paint Scratch Repair Remover touch up pen, available in standard colours of Black, Holly Green and Blue.

Full instructions are supplied with the pen.

This paint has been specially chosen as it perfectly compliments the composite GRP materials used, requires minimum preparation, will NOT delaminate or flake and will match the design life of the fencing product.

NOTE On White and Standard Grey fences these will not be noticeable.

7.3 Surface/Superficial scratches

These can be removed by use of a proprietary 'Back to Black' type cleaner.

7.4 General cleaning

It is safe to use any standard soap and water and/or jet washing to clean Palisafe™ fencing.

8 Construction of gates

8.1 General

Gates provide a comparable degree of security to the adjacent fencing. The overall height of the gates when fixed is not less than the adjacent fencing height. The top and bottom rails of the gates are set at the same level as the fence rails.

The gates are designed so that the distance from the bottom edge of the gate pales to the surface of the road/path/ground does not exceed 70 mm when the gate is in the closed position.

The spacing of pales on the gates is the same as that used on the fencing. The clear distance between the vertical framing of the gates and adjacent posts or pales is not greater than the clear distance between pales on the adjacent fencing.

All gate frames are produced from box section the size for which is given in Table 5. Joints for the gate frame are internally re-enforced with in-house produced Polyurethane angle blocks, which are bonded into the box section joints and are then bolted through as a secondary fix.

NOTE 1 As composite GRP materials are much lighter than steel; this results in a lighter gate and as such the gate frame box sections can be a lighter gauge than those set out for steel with BS 1722-12:2016 (This is allowable within the standard if agreed by the client).

NOTE 2 The section sizes for gate frames are given in Table 5.

To provide rigidity and to limit deflection and sag in service:

A) As per BS 1722-12:2016 'Where pales are not welded they shall be attached by the same method as fence pales'. As such all pales are of the same 'pass thru' and bolted nature as for the fence panels; &

B) To further improve rigidity; rear mounted corner frame fillets can be added on larger spanning gates (1.5m plus) or if requested by the client.

As is required by BS 1722-12:2016:

The methods in A) and B) affords the same resistance to penetration as the fence.

There are no footholds between the top and bottom horizontal rails of the gate.

Cross-bracing is not used.

Table 5 **Frame sizes for individual gate leaf widths (pairs or singles)**

Fence height m	Typical frame sizes for individual gate leaf widths		
	<1.5m mm	>1.5m <2.0m mm	>2.0m <3.0m mm
1.1	50x50x5	50x50x5	50x50x5
1.2	50x50x5	50x50x5	50x50x5
1.5	50x50x5	50x50x5	50x50x5
1.8	50x50x5	50x50x5	50x50x5
2.1	50x50x5	50x50x5	50x50x5
2.4	50x50x5	50x50x5	50x50x5
2.7	50x50x5	50x50x5	75x75x6
3.0	50x50x6	50x50x6	75x75x6
3.6	50x50x6	75x75x6	75x75x6

NOTE Where the clear opening of a gateway is critical this should be specified by the client

8.2 Hinges

8.2.1 Hinges general

Due to the lightweight nature of composite GRP fencing and gates, Palisafe™ pedestrian access gates can feature 'Self closing' hinges in addition the traditional 'Pin and eyebolt' hinges.

8.2.2 Hinge safety

Gates are designed such that failure of a single hinge does not allow the gate to fall.

Hinges and gate posts are designed to take the full load of the gate plus an allowance for superimposed vertical loads equal to 100 kg applied at the nose of the gate without deflection in any position detrimental to its operation.

Each hinge mechanism is designed to bear a load equal to 3.5 times the weight of the finished gate leaf.

NOTE 1 Typical dimensions of hinge components are given in Table 6.

NOTE 2 As with other parts of the Composite GRP system; the gates are much lighter than steel and therefore fixing components can be of lighter gauge.

Table 6 Fitting requirements for gates

Fence height	Fitting schedule category		
	For single gates	For pairs of gates	
	0.9m to 1.2m wide	4m to 5.8m wide	>5.8m wide
1.1m to 2.1m	A	B	C
2.4m to 2.7m	A	C	E
3.0m to 3.6m	C	E	E

Table 7 Typical minimum dimensions for gate fittings

Description	Dimensions			
	Schedule A mm	Schedule B mm	Schedule C mm	Schedule E mm
Hinge pins diameter	N/A	20	30	By special design only
Pivot bolt diameter	N/A	20	30	
Gate eye bolt:				
Eye thickness	N/A	20	30	
Bolt diameter	N/A	20	30	
Lugs:				
Single	N/A	20	30	
Double	N/A	20	20	
Backing plate thickness	10	12	12	
Bolt diameter for connecting backing plate to gate posts	4 x 16	4 x 20	4 x 20	
Drop bolt diameter	20	22	22	
Locking bar	50 x 10	50 x 10	50 x 10	
Self Closing Hinges	Truclose Series 3 Heavy Duty Standard	N/A	N/A	
Slam plate	6	8	8	

8.2.3 Hinges and security

Hinges used are designed so that it is impossible to remove the gates by lifting at the hinges when they are in the shut and locked position. The hinges are provided with a simple and easily applied system of adjustment for the correction of sag, settlement or misalignment during installation and service.

NOTE 1 See Figure 3 for an example of a hinge eyebolt fitted to composite GRP post and gate frame.

NOTE 2 See Figure 4 for an example of a Truclose Heavy duty Standard hinge.

Figure 3 Example of a hinge eyebolt

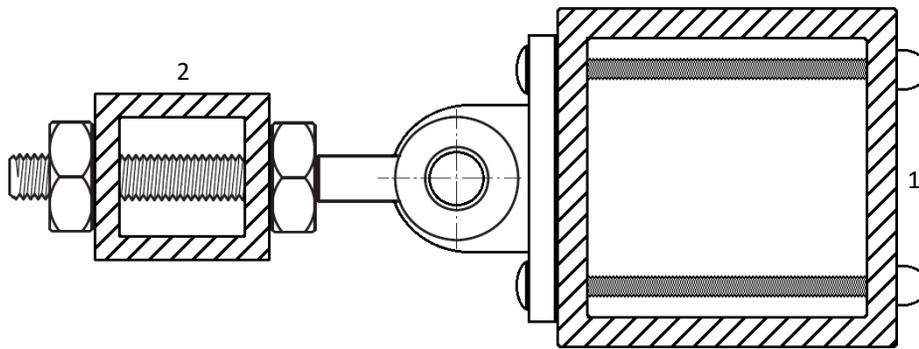
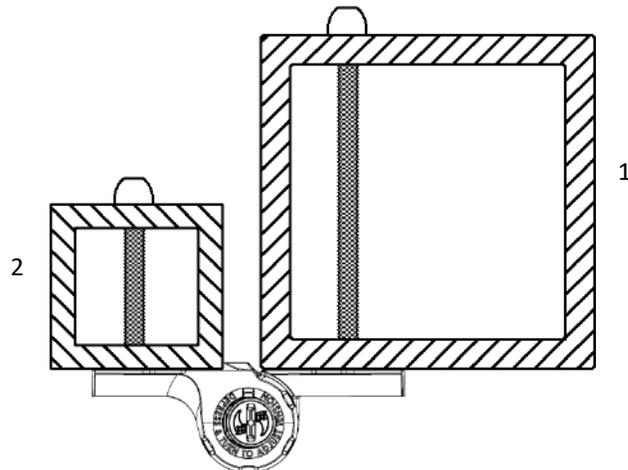


Figure 4 Example of Truclose Heavy duty hinge

Key	
1	Post
2	Gate frame



8.3 Drop bolts and slam plates

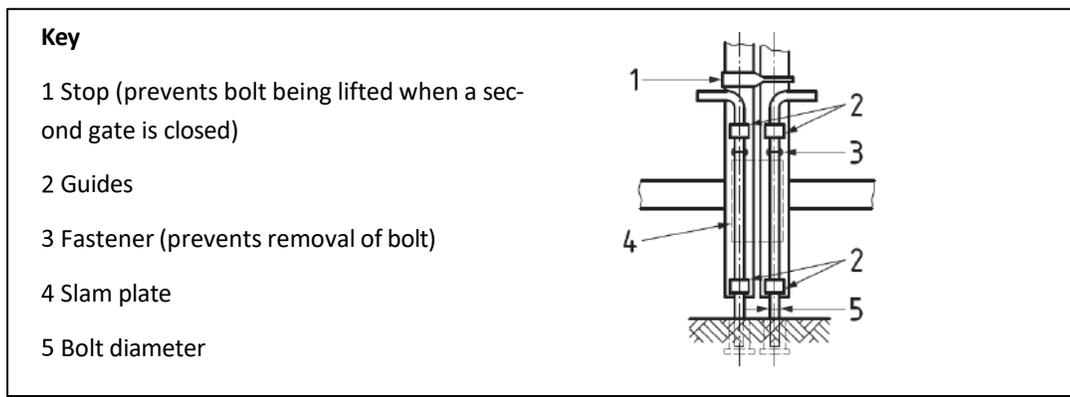
NOTE 1 Typical dimensions for drop bolt and slam plate are shown in Table 7.

Mild steel (low carbon steel) drop bolts are fitted to all gate frames (and therefore to each leaf of a double gate) so that they cannot be removed.

Corresponding sleeves to receive the bolts should be set securely in the ground and concreted in to enable the gate to be secured in both the closed and opened position. The last closing leaf of double gates incorporates a stop that prevents one drop bolt being lifted when the gates are closed. Double gates are provided with slam plates top and bottom on the first closing leaf.

NOTE 2 See Figure 5 for an example of a drop bolt arrangement.

Figure 5 Example of a drop down bolt arrangement



8.4 Locking devices

NOTE 1 Drop bolt sizes are shown in Table 7.

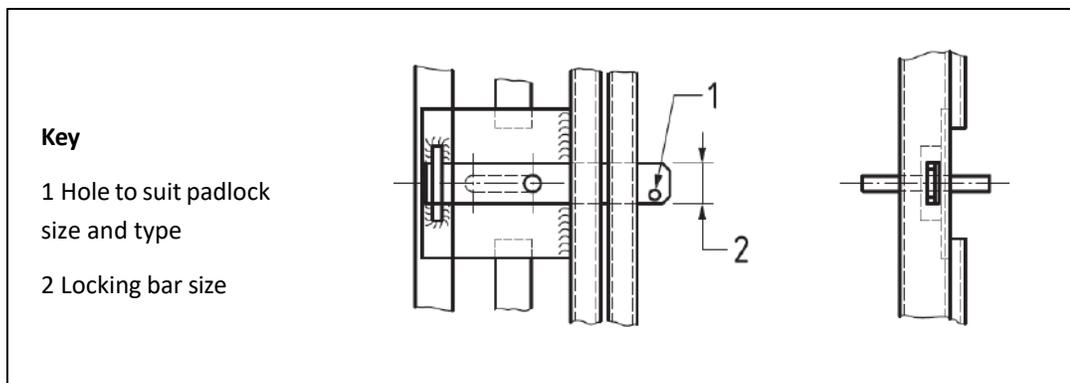
Double gates are fitted with a sliding horizontal locking bar section, secured to a locking plate which in turn is secured to the gate frame at approximately mid-height (but not exceeding 1.5 m) to ensure that the locking bar passes through both of the meeting stiles so that the two gate leaves are firmly held in the shut position.

Locking bars are holed to receive a padlock or the locking plate is prepared for alternative locking devices where specified by the designer.

Locking devices on SP gates do not form a foothold or climbing aid on the face of the gate.

NOTE 2 See Figure 6 for an example of a locking bar arrangement.

Figure 6 Example of a drop down bolt arrangement



8.5 Gate posts

Hinges and gate posts are designed to take the full load of the gate plus an allowance for superimposed vertical loads equal to 100 kg applied at the nose of the gate without deflection in any position detrimental to its operation.

NOTE 1 Typical dimensions for gate posts are shown in Table 8 and Table 9.

NOTE 2 In calculating the dimensions, it has been assumed that the major axis of the post is perpendicular to the line of the fence.

9 Options and accessories

Along with the standard fence and gate system, a range of options and accessories are available to assist with installation and / or maintenance of the Palisafe™.

9.1 Posts

9.1.1 Bolt down post feet

In areas where it is not possible to bury the base of posts / where the surface is a hard standing, bolt down fence post feet are available. Produced from galvanised steel, feet have an upstand which firmly fits inside of the BOXpost™ along with an external skirt which wraps around the outside. Posts are secured to the feet by bolts supplied with the feet.

Each foot has a base flange with 4 number M10 holes for bolting down.

NOTE Foundation bolts are not provided with the feet. As site conditions can vary; it is the responsibility of the installer / client to specify and source these as appropriate.

9.1.2 Removable posts

Should it be required to remove fence posts for future, temporary access to a part of the site; bolt on galvanised steel inserts, which sit inside the BOXposts™ are available.

The installer shall cut the BOXpost™, circa 100 to 150mm up from the finished ground level and perpendicular to the post. The steel insert then slides down inside the embedded post and is bolted into place. The top part of the post is then inserted over this fitting and bolted into place to create a finished post.

This process can be reversed in future to remove the post and adjacent panels.

NOTE 1 Adjacent panels should be fitted to the fishtails with removable bolts; these will be concealed at the rear on the fence inside the box rail.

NOTE 2 Bolts that secure the post to the steel fitting insert should be removable and utilise a security head to prevent un-authorized access.

9.1.3 Fishtail slots

For changes in the direction of a fence line, BOXpost™ fishtail slots can be machined to take the line at a 30 to 90 degree angle.

In addition slots can be machined into just one post side if the post is terminating a run.

Fishtail caps are available to cover any un-used slots.

9.2 Gradients

Where the fence line will run along a slope; there are two options;

9.2.1 Stepped posts

Fishtail slots can be offset within BOXposts™ to provide a stepped fixing of panels to follow the slope; the degree of slope / fall should be specified by the client at time of enquiry.

NOTE See 5.6 Figure 2 4.

9.2.2 Concertina panels

Panels with oversized slots for pass through rails and with 'loose' shear nut fixings of pale to rail arrangement allow the installer to concertina the panels at time of installation to suit the fall. This is useful if a stepped fence is not required or is the slope fall cannot be pre-determined by the client. A maximum 30cm in 2.7 metre panel fall is achievable.

9.3 Replacement components

Replacements are available for all parts of the Palisafe™ fencing system. These include: Posts,

Post top Caps, Post fishtail caps;

Pales, Rails (pre-slotted to accept pales) & Centre Stays;

Fixings Rail to Fishtail, Fixings Pale to Rail and;

Gates, Gate hinges, Gate locks and catches

9.4 Touch up kits

As detailed in 7.2; Palisafe™ Fence Smart Paint Scratch Repair Remover touch up pens are available in standard colours of Black, Holly Green and Blue.

Full instructions are supplied with the pen.

Section 2: Installation

10 Installation

10.1 Foundation and sills

COMMENTARY ON 9.1

During gate installation, where ground conditions necessitate, a hard threshold should be used to prevent burrowing.

10.1.1 General

Foundations for SP fences and gates used shall be designed to take account of conditions of service if these give rise to loads in excess of the defined wind loads.

Posts for all composite palisade fences shall be set in concrete where appropriate. The presence of any electricity, gas, water or other underground services shall be established prior to commencement of excavation, drilling or installation in the working area.

10.1.2 Holes for fence post foundations

Unless specifically designed foundations are specified by the client, the dimensions in plan of the holes excavated to receive the posts shall conform to Table 9. The hole shall be formed, with vertical sides, to a depth below ground level equal to one third of the height of the fence above ground level.

Table 8 Holes for fence post foundations

Fence height above ground level m	Minimum plan dimensions	
	Square hole mm	Round hole mm
Less than 2.4	350 x 350	450 diameter
2.4	350 x 350	450 diameter
3	450 x 450	600 diameter
3.6	450 x 450	600 diameter

NOTE These foundation sizes are based on the assumption of average ground conditions and wind loading. In abnormal conditions, conditions of extreme exposure or severe conditions of service, special measures might be required.

10.1.3 Concrete sills

Where a concrete sill is specified by the client, it shall be formed of in-situ concrete and shall be continuous between posts under the line of the pales. The sill shall be not less than 125 mm wide x 150 mm deep and cast with the top at, or within, 50 mm of ground level so that the distance between the underside of the pales and the top of the sill does not exceed 50 mm. If shuttering of the side or weathering of the top of the sill is required, this shall be specified.

NOTE As Composite GRP fencing will not corrode; to save 'wet trades' on site it is recommended to specify greater oversail to the bottom of the pales to 350mm and bury the pales into the ground. This as detailed in 6.2 c).

10.1.4 Concrete for post foundations and sills

Concrete for post foundations and sills shall be at least one part cement to ten parts 20 mm all-in ballast conforming to BS EN 12620 mixed with the minimum requisite quantity of clean water, or grade C8/10 or ST2 concrete conforming to BS 8500-1:2015+A1:2016 and BS 8500-2:2015+A1:2016. The concrete shall be placed in position before commencement of the initial set.

10.2 Line

The fence shall follow lines specified by the designer / client. The bottom of the pales shall be not more than 50 mm above mean ground level or concrete sill level.

The presence of any electricity, gas, water or other underground services shall be established prior to commencement of excavation, drilling or installation in the working area.

NOTE Unless otherwise agreed between the client and the installer; (see Annex A) the installation of the fence does not include work required to cut or fill the ground to vary levels, nor does it cover special work to secure culverts, ditches, etc.

10.3 Posts

Posts shall be fixed in a concrete base to the appropriate depth.

NOTE 1 The minimum quantity of water necessary depends on the moisture content of the ballast prior to mixing.

Posts shall be vertical. The holes for the posts shall be filled to ground level, top of ground beam or road level with concrete which shall be rammed as the filling proceeds. Care and attention should be taken to make sure concrete is entered into the securing holes at the bottom of the BOXposts™ as this will tie the post in securely to the base. The top of the concrete shall be weathered.

NOTE 2 See Table 8 for foundation sizes.

10.4 Posts for gates

Posts shall be fixed in a concrete base to the appropriate depth in accordance with Table 1 & Table 2 in terms of embedded depths and Table 8 in terms of concrete surround dimensions.

Posts shall be vertical. The hole for the posts shall be filled to ground level, top of ground beam or road level with concrete which shall be rammed as the filling proceeds. The top of the concrete shall be weathered.

10.5 Intermediate supports

Intermediate supports, where required, shall be embedded in concrete to a depth of 100 mm. The concrete shall be either a concrete sill as specified in 9.1 or a concrete base (150 × 150 × 150) mm deep with the top at ground level.

10.6 Fastenings

On completion, fastenings shall be secure and tamper resistant, i.e. not removed using easily obtainable tools.

11 Statement of conformity

11.1 Fence installer

BS 1722-12:2016 requests that: On completion of any installation of fence, the fence installer shall provide the end user with a certificate, conforming to **10.2**, confirming that the installation and materials used are in accordance with the British Standard, however, although Palisafe™ and composite GRP materials do not fully comply with the standard; in lieu of this; the certificate shall confirm the installation and materials are in accordance with this specification UKP-PS-001.

*NOTE 1 This certificate can be in the form of an invoice provided this conforms to **10.2**.*

The installer shall take responsibility for the materials used.

NOTE 2 On delivery, the installer can obtain a certificate/documentation from the UK PULTRUSIONS, stating materials supplied are in accordance with this specification.

11.2 Certificate/documentation

In addition to the requirements of **10.1**, the certificate/documentation shall also include the following information:

- a) UK PULTRUSIONS' name and address;
- b) the contract or order number;
- c) the date of delivery or installation;
- d) the purchaser's name and address.

Test reports shall be provided as part of the certificate in accordance with **A.5**, **B.4** and **C.4**.

11.3 Statement

The installer shall make a written statement which details that it is their policy to conform to a previously agreed specification with the client and to offer goods and/or services accordingly. The installer shall obtain the same written statement from UK PULTRUSIONS.

NOTE This might be done by inclusion in any trade advertising and/or any terms of trading statements supplied with quotations.

12 Test A: Flexural strength of pales

A.1 Principle

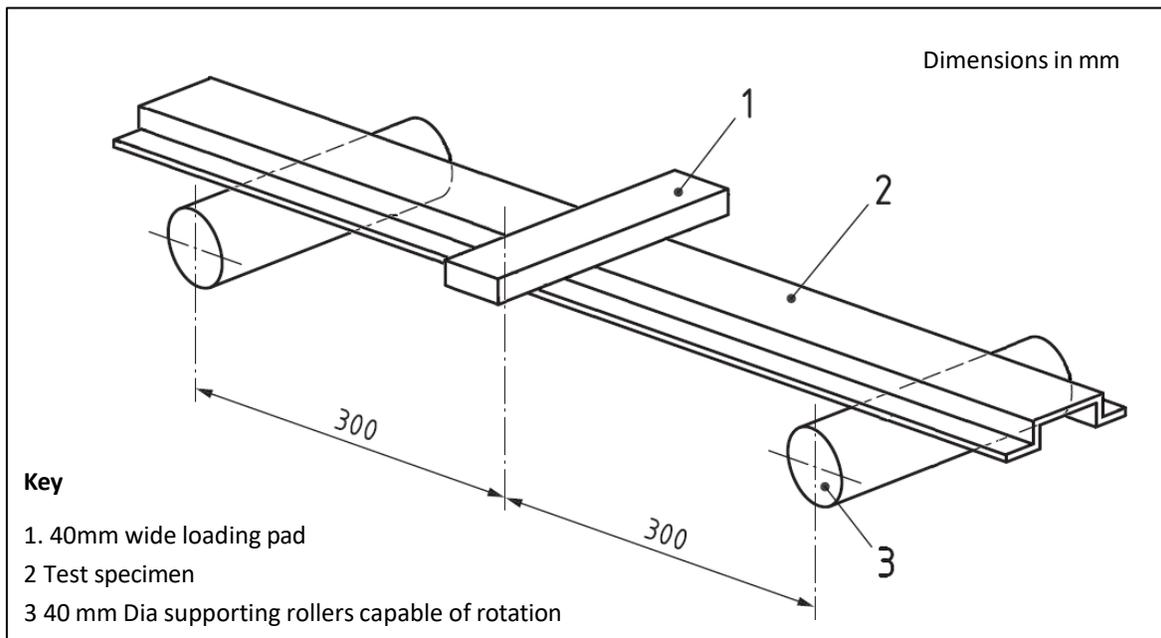
This test determines the flexural strength of pales.

A.2 Test Report

The test was carried out using apparatus that complies with BS 1722-12:2016 requirements A.2, save that the loading pad used was a 40mm wide pad as opposed to 40mm in diameter (see Figure A below).

All other test requirements were in accordance with Annex A of BS 1722-12:2016.

Figure A.1 Arrangement of loading test specimen



Date of test	15th June 2017
Sampling	Pale samples were taken directly from quality assured stock manufactured by UK PULTRUSIONS within June 2017.
Information on tested pales	<p>Pales were of the 'Top-Hat' profile</p> <p>Pales measured 72mm wide x 24mm deep with a 4mm wall</p> <p>Pales were cut to 1 metre in length</p> <p>No surface preparation was required</p> <p>Deflection at the specified GP (General Purpose) loading of 2.5kN was 14.7mm</p> <p>Deflection at the specified SP (Security Purpose) loading of 3.5kN was 20.6mm</p>

Further testing	<p>Deflection at 5kN loading (Above requirements of BS 1722-12:2016) was 23.2mm</p> <p>Ultimate failure load was 7kN.</p> <p>Failure occurred in the form of splitting of the pale along the line of the glass rovings:</p> <p>Ultimate failure load equated to 4375kN/m²</p> <p>NOTE even at failure load; a failure of this nature would still not facilitate the removal of the pale from the rail nor allow for access through the pales.</p>
Conclusion	<p>The Palisafe™ pale profile is able to withstand a load 2.8 times the load specified for GP (General Purpose) fence within BS 1722-12:1026, although a greater deflection than maximum allowable in this; the steel standard occurs. The profile fully recovers and has no permanent set, unlike steel, which, would face permanent set and not recover when deflected beyond the 8 to 10mm allowable in the standard.</p> <p>It should be noted that as this is the case the deflection allowable for steel cannot be taken into account when testing Palisafe™ as the Pass/Fail criteria are different/not appropriate. Palisafe™ is more than capable of withstanding the required load, i.e.; it is as strong as steel, it just performs differently.</p>

13 Test B: Flexural strength of posts

B.1 Principle

This test determines the flexural strength of posts.

B.2 Test Report

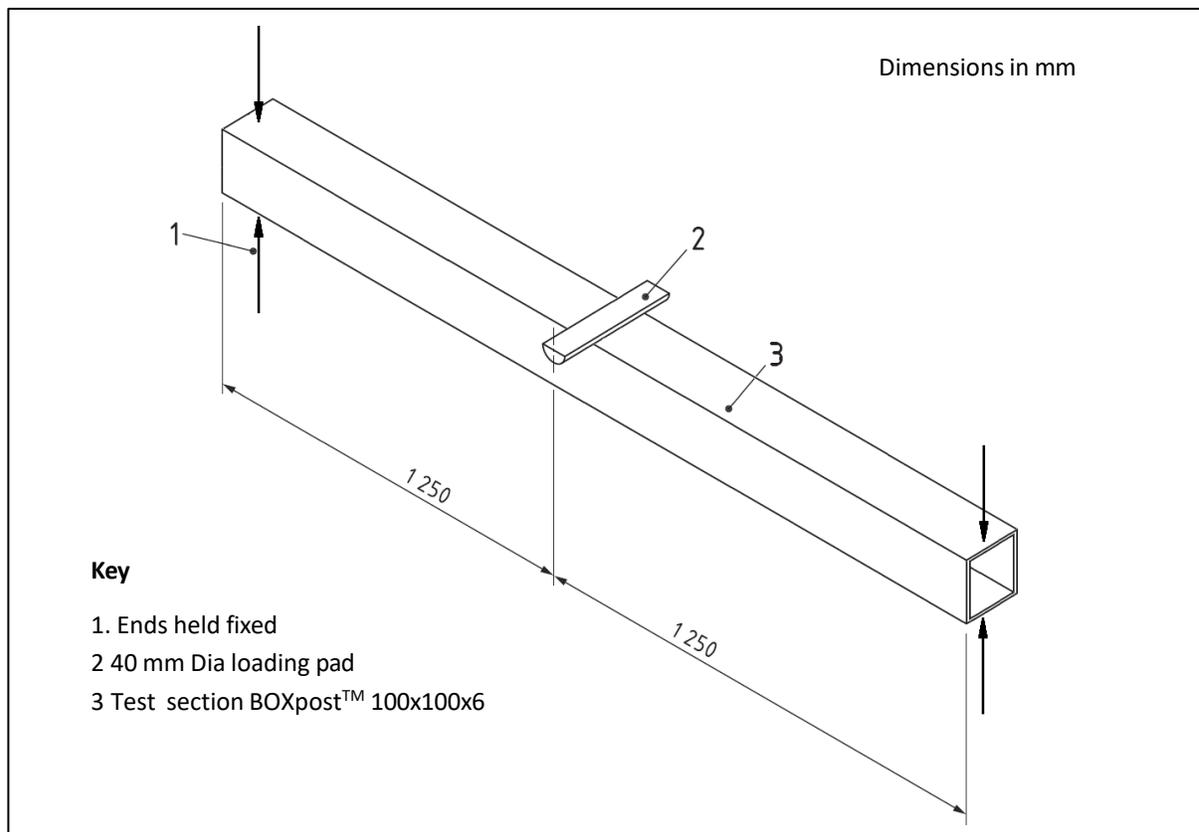
The test was carried out using Finite Element Analysis (FEA). The 100mm x 100mm x 6mm BOXpost™ has a GPA of 42 which is in excess of the maximum 23GPA required by EN 13706 Reinforced plastics composites. Specifications for pultruded profiles.

Despite this fact; FEA was run based upon the lower 23GPA

BS 1722-12:2016 test method in Annex B allows the post to freely move at it's ends on 40mm dia. rollers that are capable of rotation. This allows the ends of the post to deflect upwards when the test load is applied at the centre. For purposes of FEA this is not possible and the ends were in fact held in place. The effect of this creates a worse case scenario as the deflection in the centre is heightened and the stresses are greater as the post cannot flex as it would if rollers were used.

All other test requirements were in accordance with Annex B of BS 1722-12:2016.

Figure B.1 Arrangement of loading test specimen



Date of test

15th June 2017

Sampling

Computer generated post is based upon BOXposts™ manufactured by UK PULTRUSIONS.

Information on tested post

Post measured 100mm wide x 100mm deep with a 6mm wall

Post was 2.5 metres long

Deflection at the specified GP loading of 10kN was 15.2mm (simulated 79MPa)

Deflection at the specified SP loading of 20kN was 30.4mm (simulated 158MPa)

Conclusion

As the materials ultimate failure load is 357MPa, (versus steel of 235MPa) the simulated loads of 79MPa and 158MPa are well within safety factors of 4.5 x and 2.3x accordingly.

B.3 Supporting FEA

Figure B.2 FEA Stress Analysis.

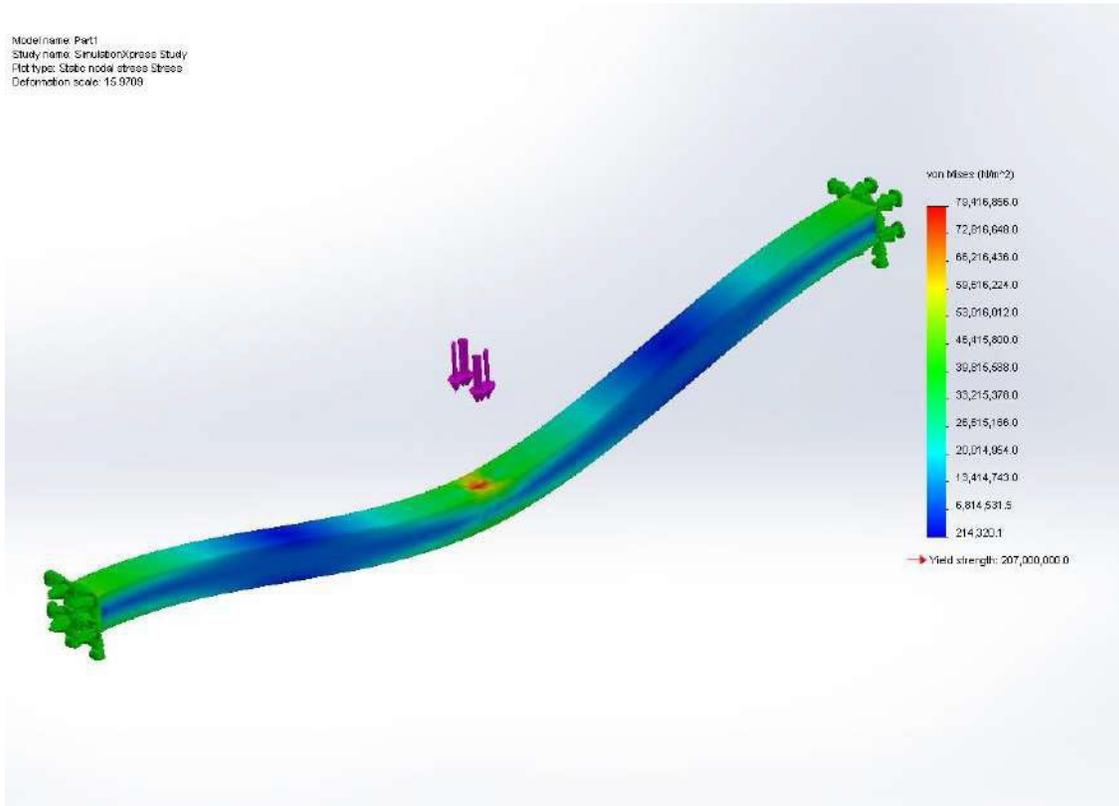
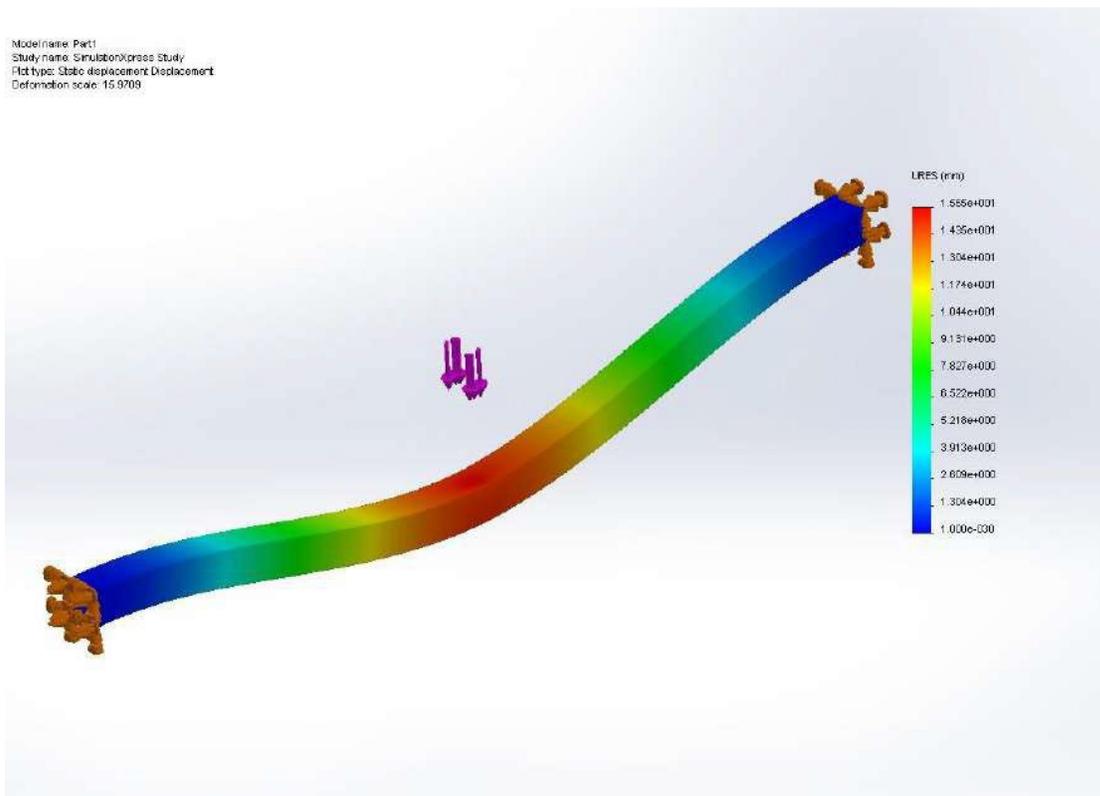


Figure B.3 FEA Displacement Analysis



14 Test C: Flexural strength of rails

C.1 Principle

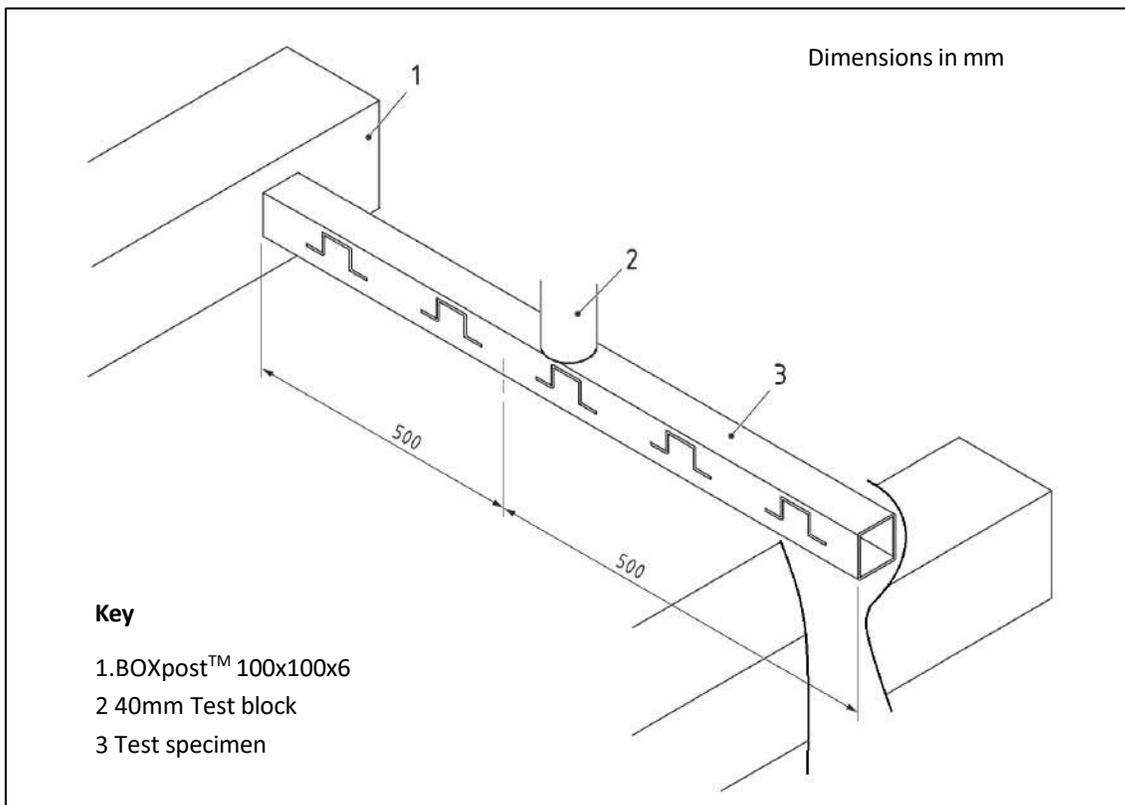
This test determines the flexural strength of pales.

C.2 Test Report

The test was carried out using apparatus that complies with BS 1722-12:2016 requirements C.1, save that the loading pad used was a 40mm diameter test block; with load applied through the circular face opposed to via the outside circumference (see Figure C below). In addition the fixing arrangement of the ends of the rail differs to the standard; As per the images in B.3; the rail was fixed to the post using fishtails that in turn were bolted to the rail with fixings specified in Tables 1 and 2 of this document.

All other test requirements were in accordance with Annex C of BS 1722-12:2016.

Figure C.1 Arrangement of loading test specimen



Date of test	15th June 2017
Sampling	Rail samples were taken directly from quality assured stock manufactured by UK PULTRUSIONS within June 2017.
Information on tested pales	<p>Rails were of the 50x50 box profile, with pre-machined 'Top-hat' pale profile slots.</p> <p>Rails measured 50mm wide x 50mm deep with a 5mm wall</p> <p>Pales were cut to 1.1 metre in length with 5cm inserted in a BOXpost™ at each end leaving 1 metre exposed to test</p>

Conclusion

No surface preparation was required

Deflection at the specified GP (General Purpose) loading of 5kN was 16mm

Deflection at the specified SP (Security Purpose) loading of 5kN was 16mm

The Palisafe™ pass through rail is able to withstand the required loading required in BS 1722-12:1026, although a greater deflection than maximum allowable in this; the steel standard occurs. The profile fully recovers and has no permanent set, unlike steel, which, would face permanent set and not recover when deflected beyond the 5 to 12mm allowable in the standard.

It should be noted that as this is the case the deflection allowable for steel cannot be taken into account when testing Palisafe™ as the Pass/Fail criteria are different/not appropriate. Palisafe™ is more than capable of withstanding the required load, i.e.; it is as strong as steel, it just performs differently.

C.3 Supporting images

Figure C.2 Rail under test load



Figure C.3 Rail to post arrangement



15 Test D: Punch shear through strength of fixings to fishtail

D.1 Note on shear testing

BS 1722-12:2016 requires two tests (Annex D: Determination of tensile strength of cold swaged pin and collar fixings and , Annex E: Determination of the strength of the pale to fence rail fastening assembly) which UK PULTRUSIONS have dealt with under one test; the punch shear through strength of fixings to fishtails.

Due to the ‘pass through’ nature of the pale to rail with the Palisafe™ fencing system, the pale is not able to be levered from the rail as it would be with a steel system.

As such the test detailed in Annex E of BS 1722-12:2016 is not relevant; as the weak point of the fence transfers to the fishtail.

In addition; as the fishtail passes through a twin wall structure in the BOXpost™ as opposed to a single wall of a steel I beam post (the BOXpost™ being a stronger alternative) this weak point is further transferred to the fixing of rail to the fishtail interaction.

Therefore a punch shear through test becomes more appropriate.

D.2 Principle

This test determines the punch shear through strength of fixings to fishtails.

D.3 Test Report

The test was carried out using apparatus that complies with BS 1722-12:2016 requirements.

Figure D.1 Loading test specimen



Date of test	15th June 2017
Sampling	Fishtail samples were taken directly from quality assured stock manufactured by UK PULTRUSIONS within June 2017.
Information on tested pales	<p>Fishtail measured 40mm wide 220 mm long x 11mm thick</p> <p>Fishtail was fitted with an M10 bolt and 23mm washer</p> <p>No surface preparation was required</p> <p>The fishtail and bolt held a 10kN loading without damage</p>
Conclusion	The Palisafe™ fishtail bolt system meets the requirements of 5.6 Post to rail connections

Annex E (informative) Specifying a composite GRP palisade fence

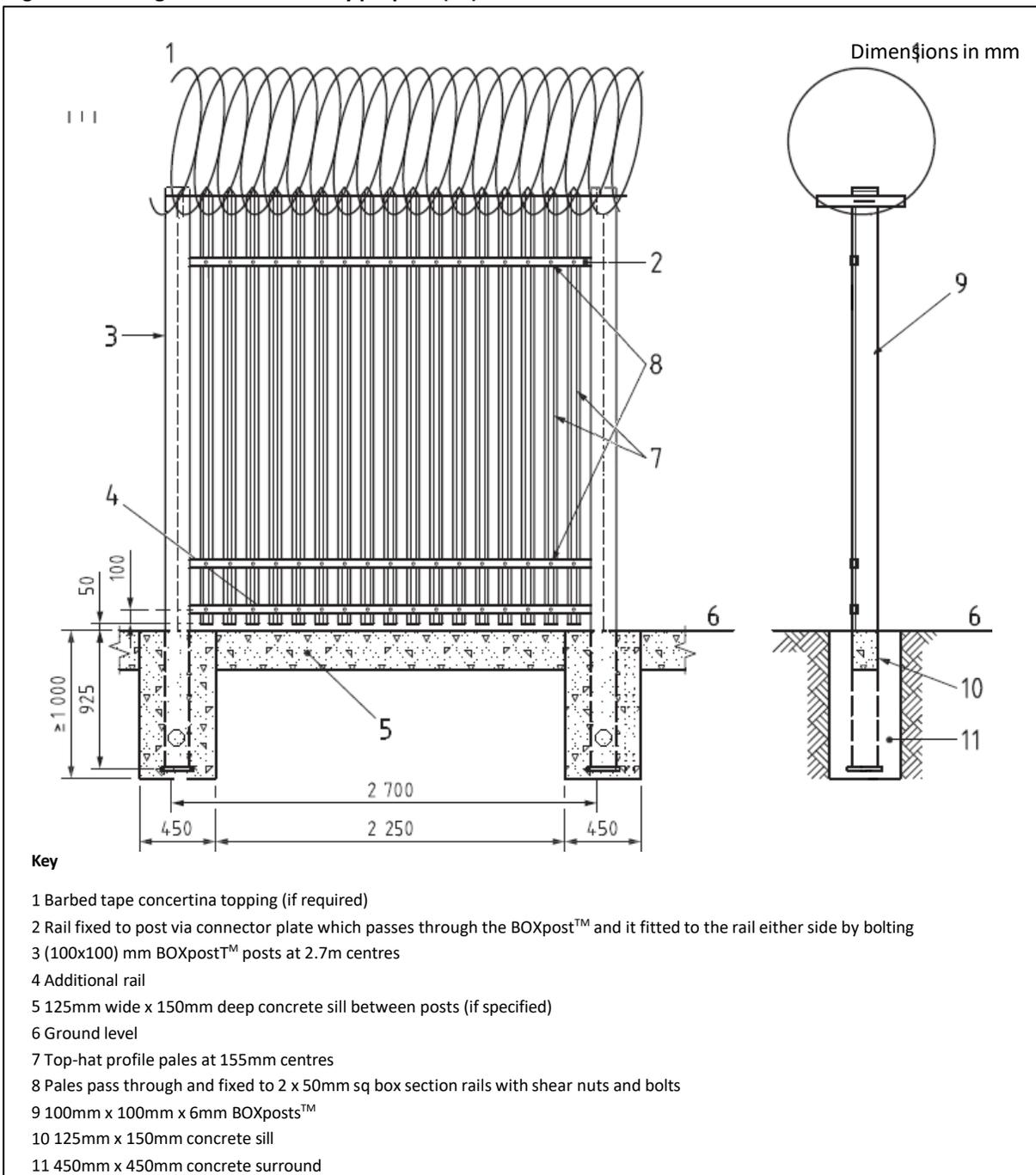
E.1 General

When preparing a specification for a fence, precise details of the requirements of the fence and the installation site should be determined and written into the specification .

NOTE This may require a site survey prior to raising the specification, which, if the site is greater than 10 linear metres or contains deviations in height or fence line direction, is essential.

This annex lists those items that should be specified at the time of ordering the fence. As conditions vary from site to site, this annex should not be assumed to be exhaustive.

Figure E.1 Arrangement for a security purpose (SP) fence



E.2 Site conditions

The following should be agreed between the client and UK PULTRUSIONS at the time of enquiry and/or order:

- a) the line and length of fence;
- b) the height and type of fence, i.e. GP or SP (see Table 1 and Table 2);
- c) the colour of fence;
- d) site preparation (see Section 1.6);
 - 1) site clearance;
 - 2) cutting or filling of ground level;
- e) any specific requirements for non-standard post lengths due to ground conditions;

NOTE The requirements for the lengths of posts and stays in British Standard BS 1722-12:2016 and foundation sizes are for average ground conditions. The British Standard and/or this specification document does not cover conditions of particularly firm or soft ground, where other lengths or foundation sizes might be required. Unless otherwise agreed with the installer the client must make separate arrangements for the work required to cut or fill the ground to vary the levels.

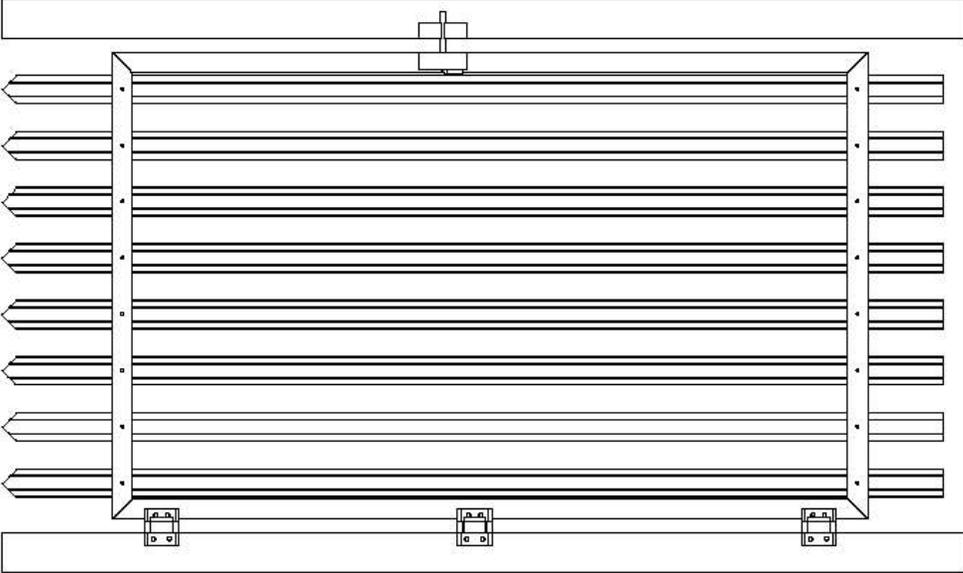
- e) any special measures required due to site gradients (see Section 1.9 for solutions to gradients) and;
- f) the number and position of any gates (see Section 1.8).

E.3 Construction of fence

The following items should be specified by the designer / client at the time of enquiry and/or order:

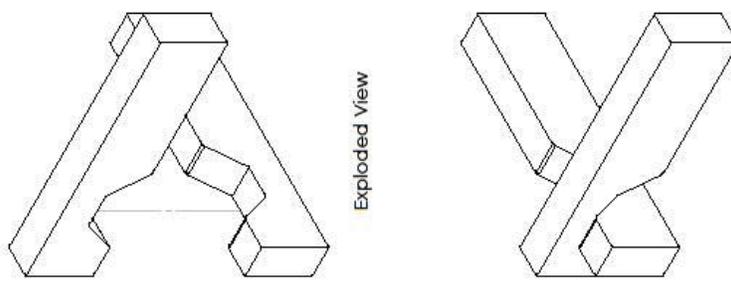
- a) pales:
 - 1) whether GP or SP;
 - 2) the shape of tops of pales (see 5.1);
- b) posts:
 - 1) 5.3 specifies 2.7 m centres for posts; if shorter bays are required, they should be specified;
 - 2) the design and foundation requirements for removable posts (see 5.3).
- c) gates (see also E.2):
 - 1) if any clear openings are required (see NOTE to Table 5);
 - 2) the type of post (see Table 7);
 - 3) locking devices (see 8.4);
 - 4) road profile (see 8.1); and
- e) additional security:
 - 1) burrowing (see 6.2);
 - 2) pale removal (see 6.3); and
 - 3) topping (see 6.4).

F.2 Typical Single Leaf Gate Detail



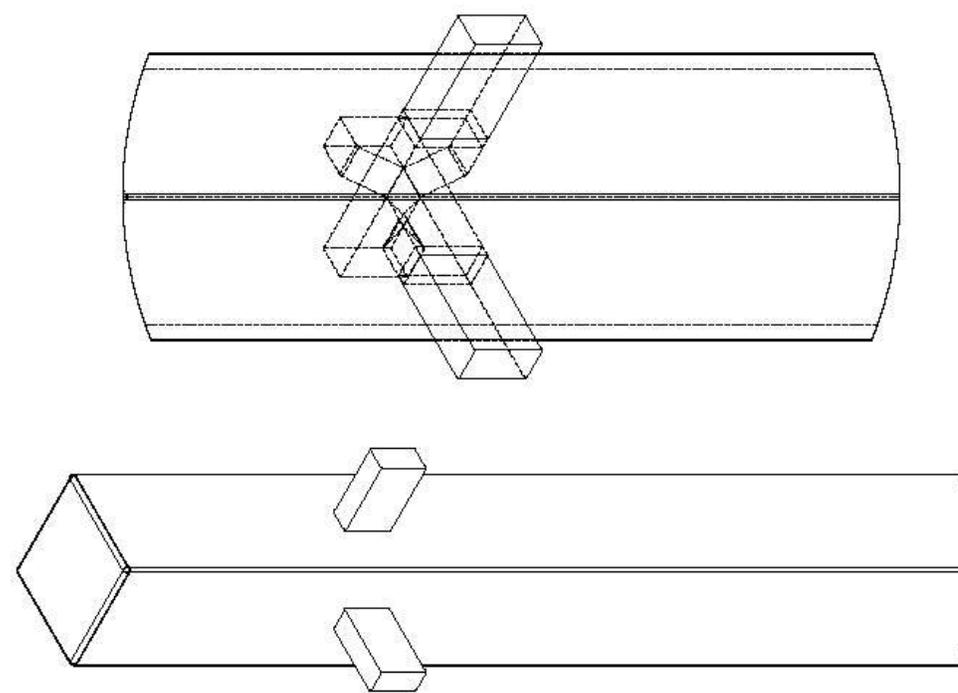
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		Drawn by:	Byron Yeardley	Weight:	N/A	Palisade Gate	
		Date:	12/12/2016	Revision No.:	A		
		Scale:	NTS	Working Sheet Size:	A3		
				Finish:	N/A		

F.3 90 Degree Fishtail Assembly Detail



Exploded View

90 Degree Fishtail Assembly



Sheet 1 of 1	
DRAWING NUMBER:	
90Degree Fishtail Assembly	
Title /Name	
Material:	N/A
Weight:	N/A
Revision No.:	A
Finish:	N/A
Drawn By:	Byron Teasley
Date:	18/09/2016
Scale:	NIS
Blanking Sheet Size:	A3
REVISIONS	Changes Made
Date Modified	
	

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