

TEST REPORT

Lucideon Reference: 155217 (QT38377/1/SL)/Ref. 6/Supp2

Project Title: Load Testing of FH Brundle's Economic Frameless Tilt Lock System using 1822005 Edge Fixed Spigots with a Range of Glass Panels to BS 6180:2011

Client: FH Brundle
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For the Attention of: Mr Danny Hull

Author(s): Mr Dave Boon

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Work Location: Lucideon UK

This report supersedes the report issued on 27.04.16.



Miss Joanne Booth
Consultancy Team
Reviewer



Mr Dave Boon
Consultancy Team
Project Manager



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1 INTRODUCTION

The system tested was referred to as an Economic Frameless System incorporating Tilt Lock Spigots.

Lucideon Limited were commissioned by the client, FH Brundle to carry out load testing in accordance with BS 6180:2011 Barriers in and about buildings, and EC1-1991-1-1:2002 UK National Annex to Eurocode 1 (BS EN991-1-3:2003+A1:2015): Actions on structures – Part 1-1: General actions - Densities, self-weight, imposed loads for buildings. This will allow their balustrade system to be classified for use in accordance with the Code of Practice included within the standard.

The testing was carried out at the Lucideon Laboratories located in Queens Road, Stoke-on-Trent.

This report summarises the test results obtained during the test programme and does not provide interpretation of those results.

2 SAMPLES RECEIVED

5 pieces of glass of varying types, of dimensions 1084 mm x 1000 mm as follows:

- 12 mm Clear Toughened Glass;
- 12.89 mm Clear Toughened Sentry Glass Laminated;
- 15 mm Clear Toughened Glass;
- 16.89 mm Clear Toughened Sentry Glass Laminated;
- 17.5 mm Clear Toughened PVB Laminated.

5 pieces of glass of varying types, of dimensions 1208 mm x 1200 mm as follows:

- 12 mm Clear Toughened Glass;
- 12.89 mm Clear Toughened Sentry Glass Laminated;
- 15 mm Clear Toughened Glass;
- 16.89 mm Clear Toughened Sentry Glass Laminated;
- 17.5 mm Clear Toughened PVB Laminated.

2 Edge fixed spigots, coded 1822005 for glass widths 12 mm to 17.5 mm.

2 Boxes of 507563 FBN 11 12 x 105 Fixings.

3 SPIGOTS

The Tilt-Lock Spigots were manufactured from Duplex 2205 ultra-marine stainless steel. Each spigot incorporated inner stainless steel adjustable packers and plastic packers to ensure the glass was firmly installed following tightening to the Allen screws.

The system is shown in seven Figures included in the Appendix. The first Figure shows detail of the 1822005 spigot followed by two figures of the 1000 mm and 1200 mm glass fixed into the spigots with dimensions followed by general figures of the spigots with 1000 mm and 1200 mm wide glass.

The system and glass was installed by Lucideon personnel.

4 TEST PROGRAMME

A horizontal line load was applied to system with the adaptors set at the following centres using a range of glass types as follows:

- Two spigots set at 750 mm centres, 1000 mm wide glass:
 - 12 mm Clear Toughened Glass;
 - 12.89 mm Clear Toughened Sentry Glass Laminated;
 - 15 mm Clear Toughened Glass;
 - 16.89 mm Clear Toughened Sentry Glass Laminated;
 - 17.5 mm Clear Toughened PVB Laminated.
- Two Spigots set at 900 mm centres, 1200 mm wide glass:
 - 12 mm Clear Toughened Glass;
 - 12.89 mm Clear Toughened Sentry Glass Laminated;
 - 15 mm Clear Toughened Glass;
 - 16.89 mm Clear Toughened Sentry Glass Laminated;
 - 17.5 mm Clear Toughened PVB Laminated.

5 TEST METHOD

Two Tilt-Lock Spigots were bolted to the edge of a concrete block, initially at 750 mm centres, which was fixed to the laboratory floor at the Lucideon test laboratory. A 1000 mm width glass panel of appropriate thickness and glass detail was fitted into the spigots.

A horizontal imposed line load was applied to the glass at a height of 1.1 m above the datum level of the floor and the deflection measured at the top central point of the panel 1.1 m above the datum level of the floor. The load was applied via a hydraulic ram and the deflection measured using a digital electronic displacement transducer (see Plate 1).

Following the tests on the 1822005 spigots at 750 mm centres the spigots were then set to 900 mm and all the 1200 mm panels of various thicknesses and glass detail were tested.

Plate 1 shows general test arrangement and Plate 2 shows edge fix spigot with glass installed.

6 RESULTS

The tests were carried out in accordance with the guidance given in BS 6180 Barriers in and about buildings – Code of Practice. The standard states that the maximum allowable deflection for a free standing glass protective barrier panel is 25 mm.

Table 2 of BS 6180 Barriers in and about buildings – Code of Practice categorises parapets, barriers and balustrades for areas of use depending on the loads they have achieved under testing.

Load versus deflection curves for the glass panels tested with 1822005 Edge Fixed Spigots tested at 750 mm and 900 mm centres are given in Charts 1 and 2 respectively.

The loads achieved by the FH Brundle Tilt-Lock Spigot system tested with the glass types, detailed above in Section 3, under horizontal imposed line load to the maximum deflection of 25 mm are given in Tables 1 and 2 for 750 mm and 900 mm centres respectively.

All figures quoted in the Tables contain no safety factors and are direct loads as achieved by the system under test conditions.

Tables 3 and 4 summarise the suitability of the tested systems in accordance with Table 2 of BS 6180:2011.

NOTE: The results given in this report apply only to the samples that have been tested.

END OF REPORT

Table 1 - Summary of Performance of FH Brundle Tilt-Lock System Tested with a Range of Glass Panels under Horizontal Imposed Line Load with 1822005 Edge Fixed Spigots set at 750 mm Centres

Number of Spigots and Centres	Glass Width (mm)	Glass Type	Imposed Line Load at 25 mm Deflection (kN/m)	Expected Working Line Load for System (kN/m)	Deflection at Working Line Load for System (mm)	Achieved Working Line Load for System (kN/m)
Two adapters set at 750 mm centres	1000	12 mm Clear Toughened Glass	0.40	0.36	22.46	0.36
		12.89 mm Clear Toughened Sentry Glass Laminated	0.43	0.36	18.47	0.36
		15 mm Clear Toughened Glass	0.52	0.74	15.93	0.36
		16.89 mm Clear Toughened Sentry Glass Laminated	0.75	0.74	24.73	0.74
		17.5 mm Clear Toughened PVB Laminated	0.46	0.36	17.86	0.36

Table 2 - Summary of Performance of FH Brundle Tilt-Lock System Tested with a Range of Glass Panels under Horizontal Imposed Line Load with 1822005 Edge Fixed Spigots set at 900 mm Centres

Number of Spigots And Centres	Glass Width (mm)	Glass Type	Imposed Line Load at 25 mm Deflection (kN/m)	Expected Working Line Load for System (kN/m)	Deflection at Working Line Load for System (mm)	Achieved Working Line Load for System (kN/m)
Two adapters set at 900 mm centres	1200	12 mm Clear Toughened Glass	0.33	0.36	N/A	0.36
		12.89 mm Clear Toughened Sentry Glass Laminated	0.30	0.36	N/A	0.36
		15 mm Clear Toughened Glass	0.54	0.74	15.21	0.36
		16.89 mm Clear Toughened Sentry Glass Laminated	0.63	0.74	9.57	0.36
		17.5 mm Clear Toughened PVB Laminated	0.45	0.36	17.52	0.36

Table 3 - Summary of Suitability of FH Brundle Tilt-Lock Spigot and Glass Balustrade System in Accordance with Table 2 of BS 6180:2011
1000 mm Glass, 1822005 Edge Fixed Spigots at 750 mm Centres

Type of Occupancy for Part of the Building	Examples of Specific Use	Horizontal Uniformly Distributed Line Load (kN/m)	Tilt-Lock System with Two 1822005 Spigots				
			12 mm Clear Toughened Glass	12.89 mm Clear Toughened Sentry Glass Laminated	15 mm Clear Toughened Glass	16.89 mm Clear Toughened Sentry Glass Laminated	17.5 mm Clear Toughened PVB Laminated
Domestic and residential activities	(i) all areas within or serving exclusively one single family dwelling including stairs, landings, etc. but excluding external balconies and edges of roofs	0.36	✓	✓	✓	✓	✓
	(ii) other residential, i.e. houses of multiple occupancy and balconies, including Juliette balconies and edges of roofs in single family dwellings	0.74	X	X	X	✓	X
Offices and work areas not included elsewhere, including storage areas	(iii) light access stairs and gangways not more than 600 mm wide	0.36	✓	✓	✓	✓	✓
	(iv) light pedestrian traffic routes in industrial and storage buildings except designated escape routes	0.36	✓	✓	✓	✓	✓
	(v) areas not susceptible to overcrowding in office and institutional buildings, also industrial and storage buildings except as given above	0.74	X	X	X	✓	X
Areas where people might congregate	(vi) areas having fixed seating within 530 mm of the barrier, balustrade or parapet	1.50	X	X	X	X	X
Areas with tables or fixed seating	(vii) restaurants and bars	1.50	X	X	X	X	X

Table 3 (Continued)

Type of Occupancy for Part of the Building	Examples of Specific Use	Horizontal Uniformly Distributed Line Load (kN/m)	Tilt-Lock System with Two 1822005 Spigots				
			12 mm Clear Toughened Glass	12.89 mm Clear Toughened Sentry Glass Laminated	15 mm Clear Toughened Glass	16.89 mm Clear Toughened Sentry Glass Laminated	17.5 mm Clear Toughened PVB Laminated
Areas without obstacles for moving people and not susceptible to overcrowding	(viii) stairs, landings corridors ramps	0.74	X	X	X	✓	X
	(ix) external balconies including Juliette balconies and edges of roofs; footways and pavements within building cartilage adjacent to basement/sunken areas	0.74	X	X	X	✓	X
Areas susceptible to overcrowding	(x) footways or pavements less than 3 m wide adjacent to sunken areas	1.50	X	X	X	X	X
	(xi) theatres, cinemas, discotheques, bars, auditoria, shopping malls, assembly areas, studios; footways or pavements greater than 3 m wide adjacent to sunken areas	3.00	X	X	X	X	X
	(xii) grandstands and stadia	(Note A)	-	-	-	-	-
Retail areas	(xiii) all retail areas including public areas of banks/building societies or betting shops	1.50	X	X	X	X	X
Vehicular	(xiv) pedestrian areas in car parks, including stairs, landings, ramps, edges of internal floors, footways, edges of roofs	(Note B)	X	X	X	X	X
	(xv) horizontal loads imposed by vehicles	(Note B)	-	-	-	-	-

Note A – See requirements of the appropriate certifying authority.

Note B – See Appendix A of BS 6180 – 2011.

Table 4 - Summary of Suitability of FH Brundle Tilt-Lock Spigot and Glass Balustrade System in Accordance with Table 2 of BS 6180:2011
1200 mm Glass, 1822005 Edge Fixed Spigots at 900 mm Centres

Type of Occupancy for Part of the Building	Examples of Specific Use	Horizontal Uniformly Distributed Line Load (kN/m)	Tilt-Lock System with Two 1822005 Spigots				
			12 mm Clear Toughened Glass	12.89 mm Clear Toughened Sentry Glass Laminated	15 mm Clear Toughened Glass	16.89 mm Clear Toughened Sentry Glass Laminated	17.5 mm Clear Toughened PVB Laminated
Domestic and residential activities	(i) all areas within or serving exclusively one single family dwelling including stairs, landings, etc. but excluding external balconies and edges of roofs	0.36	X	X	✓	✓	✓
	(ii) other residential, i.e. houses of multiple occupancy and balconies, including Juliette balconies and edges of roofs in single family dwellings	0.74	X	X	X	X	X
Offices and work areas not included elsewhere, including storage areas	(iii) light access stairs and gangways not more than 600 mm wide	0.36	X	X	✓	✓	✓
	(iv) light pedestrian traffic routes in industrial and storage buildings except designated escape routes	0.36	X	X	✓	✓	✓
	(v) areas not susceptible to overcrowding in office and institutional buildings, also industrial and storage buildings except as given above	0.74	X	X	X	X	X
Areas where people might congregate	(vi) areas having fixed seating within 530 mm of the barrier, balustrade or parapet	1.50	X	X	X	X	X
Areas with tables or fixed seating	(vii) restaurants and bars	1.50	X	X	X	X	X

Table 4 (Continued)

Type of Occupancy for Part of the Building	Examples of Specific Use	Horizontal Uniformly Distributed Line Load (kN/m)	Tilt-Lock System with Two 1822005 Spigots				
			12 mm Clear Toughened Glass	12.89 mm Clear Toughened Sentry Glass Laminated	15 mm Clear Toughened Glass	16.89 mm Clear Toughened Sentry Glass Laminated	17.5 mm Clear Toughened PVB Laminated
Areas without obstacles for moving people and not susceptible to overcrowding	(viii) stairs, landings corridors ramps	0.74	X	X	X	X	X
	(ix) external balconies including Juliette balconies and edges of roofs; footways and pavements within building cartilage adjacent to basement/sunken areas	0.74	X	X	X	X	X
Areas susceptible to overcrowding	(x) footways or pavements less than 3 m wide adjacent to sunken areas	1.50	X	X	X	X	X
	(xi) theatres, cinemas, discotheques, bars, auditoria, shopping malls, assembly areas, studios; footways or pavements greater than 3 m wide adjacent to sunken areas	3.00	X	X	X	X	X
	(xii) grandstands and stadia	(Note A)	-	-	-	-	-
Retail areas	(xiii) all retail areas including public areas of banks/building societies or betting shops	1.50	X	X	X	X	X
Vehicular	(xiv) pedestrian areas in car parks, including stairs, landings, ramps, edges of internal floors, footways, edges of roofs	(Note B)	X	X	X	X	X
	(xv) horizontal loads imposed by vehicles	(Note B)	-	-	-	-	-

Note A – See requirements of the appropriate certifying authority.

Note B – See Appendix A of BS 6180 – 2011.



Plate 1 - General Test Arrangement

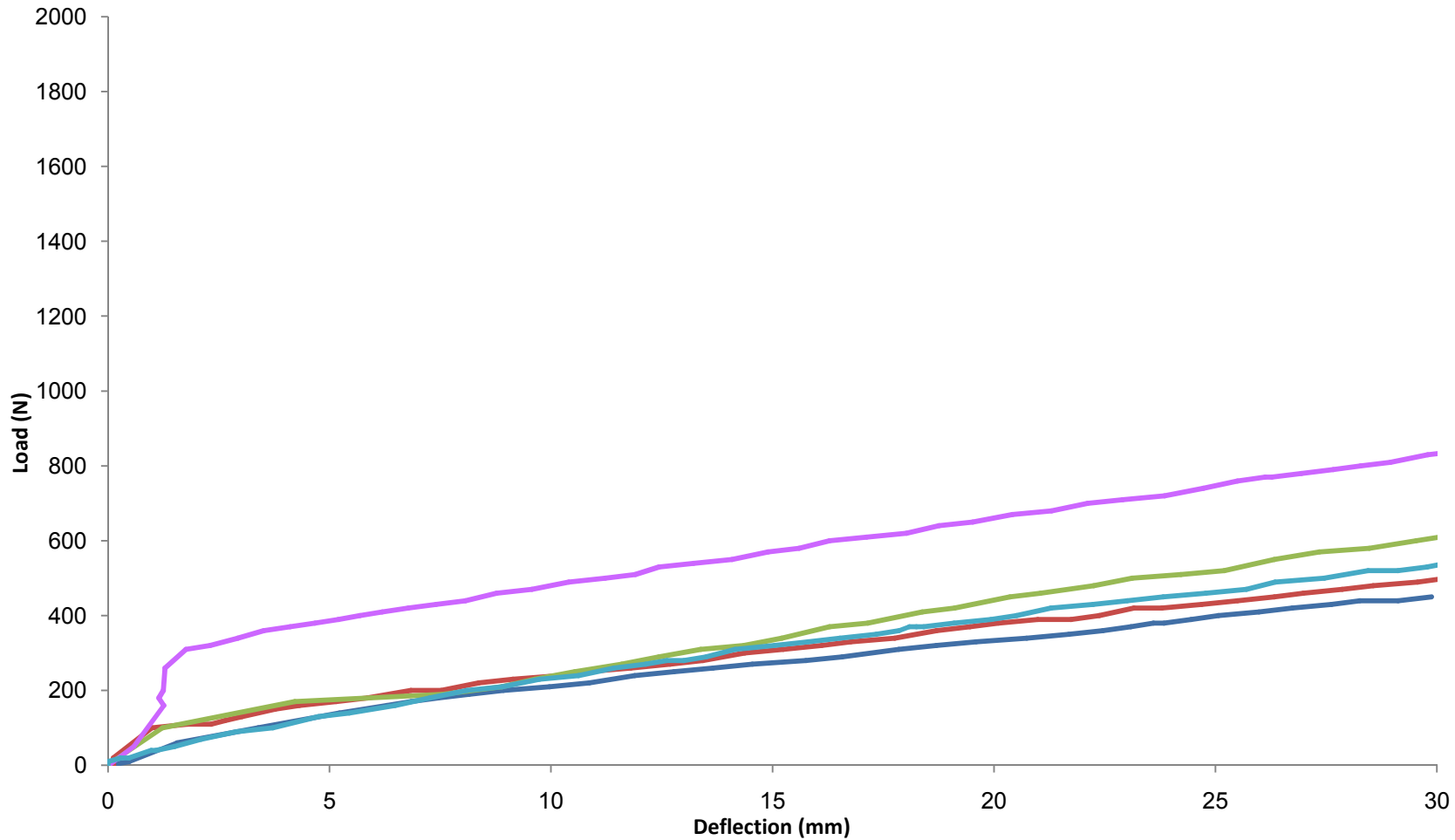


Plate 2 – Edge Fix Spigot with Glass Installed



Chart 1 - Load v Deflection for FH Brundle Tilt-Lock Spigot System with Various Glass Panels
Tested with 1822005 Edge Fixed Spigots Set at 750 mm Centres

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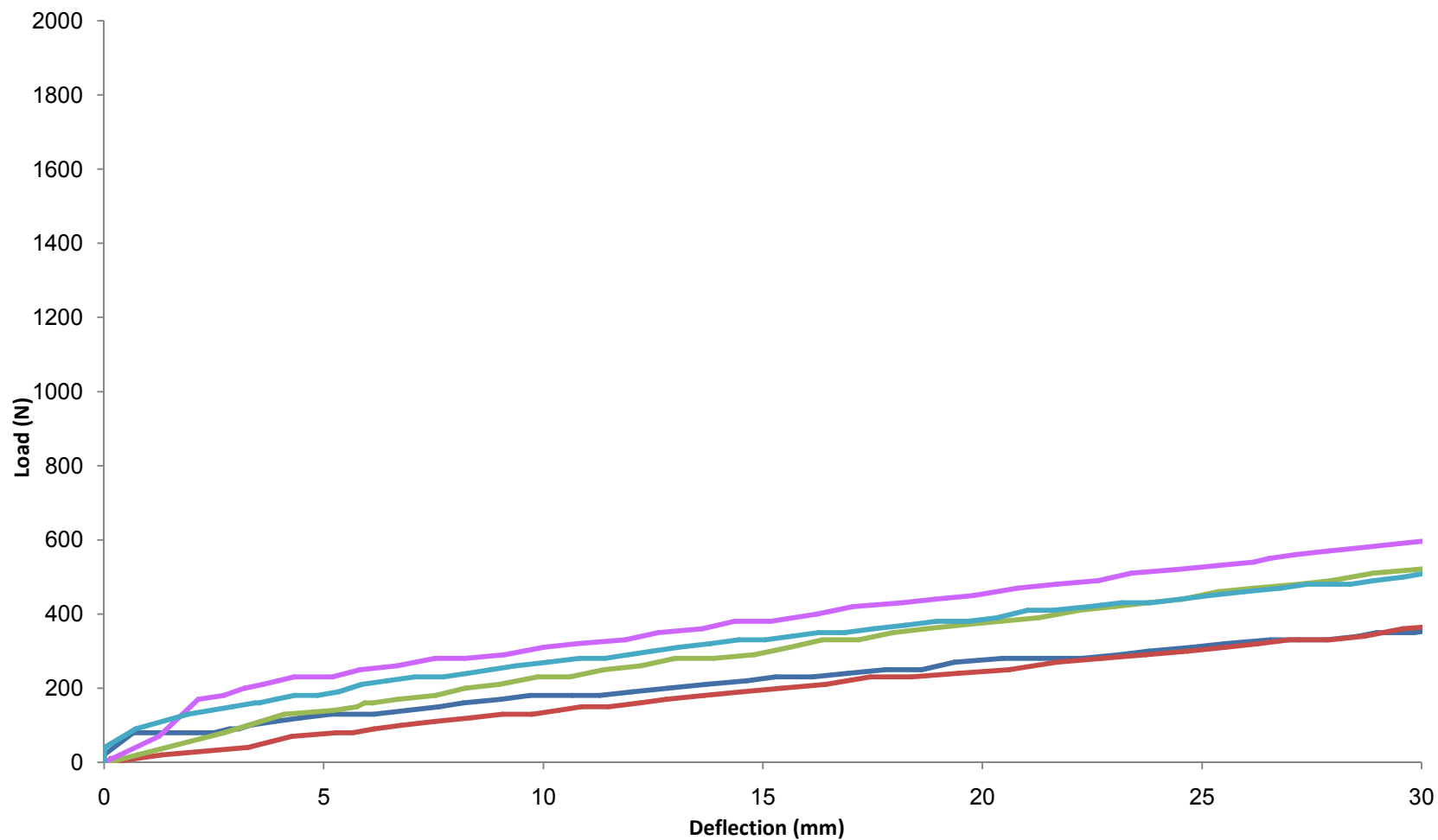


Key

- 12 mm Toughened
- 12.89 mm Sentry
- 15 mm Toughened
- 16.89 mm Sentry4
- 21.5 mm Laminated

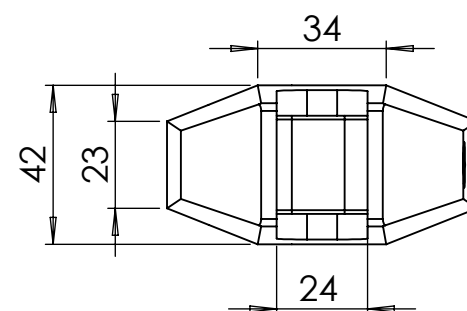
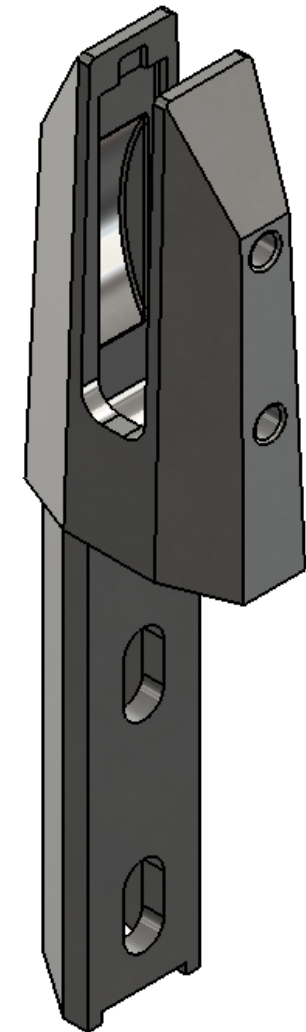
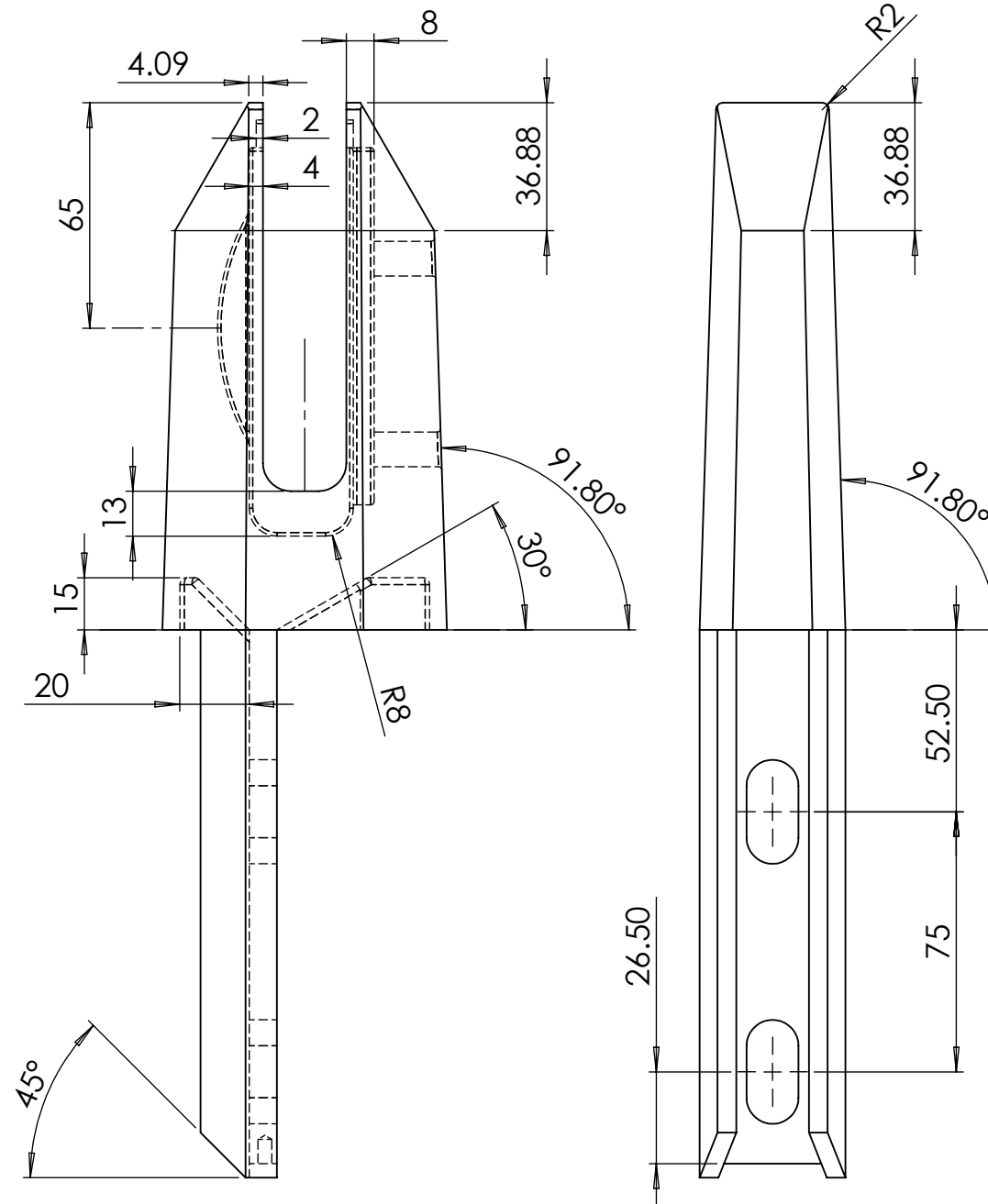
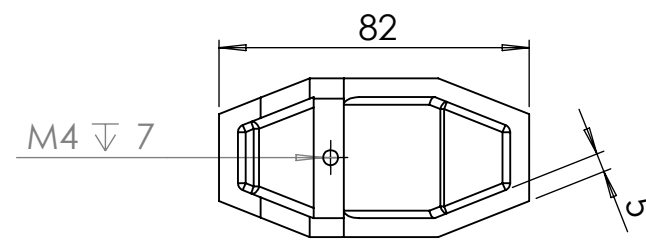
Chart 2 - Load v Deflection for FH Brundle Tilt-Lock Spigot System with Various Glass Panels
Tested with 1822005 Edge Fixed Spigots Set at 900 mm Centres

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Key

- 19 mm Toughened
- 12.89 mm Sentry
- 15 mm Toughened
- 16.89 mm Sentry
- 17.7 mm Laminated

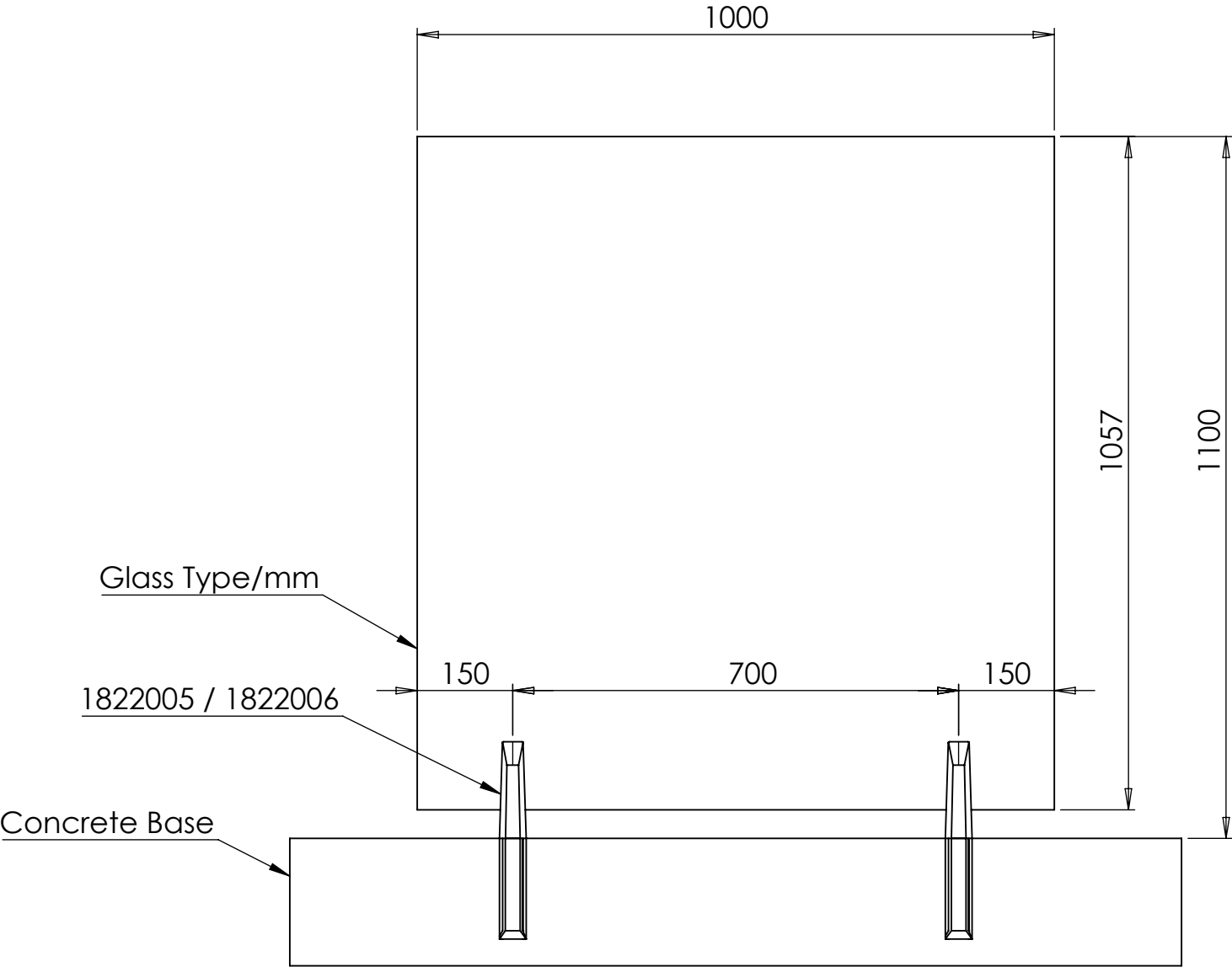
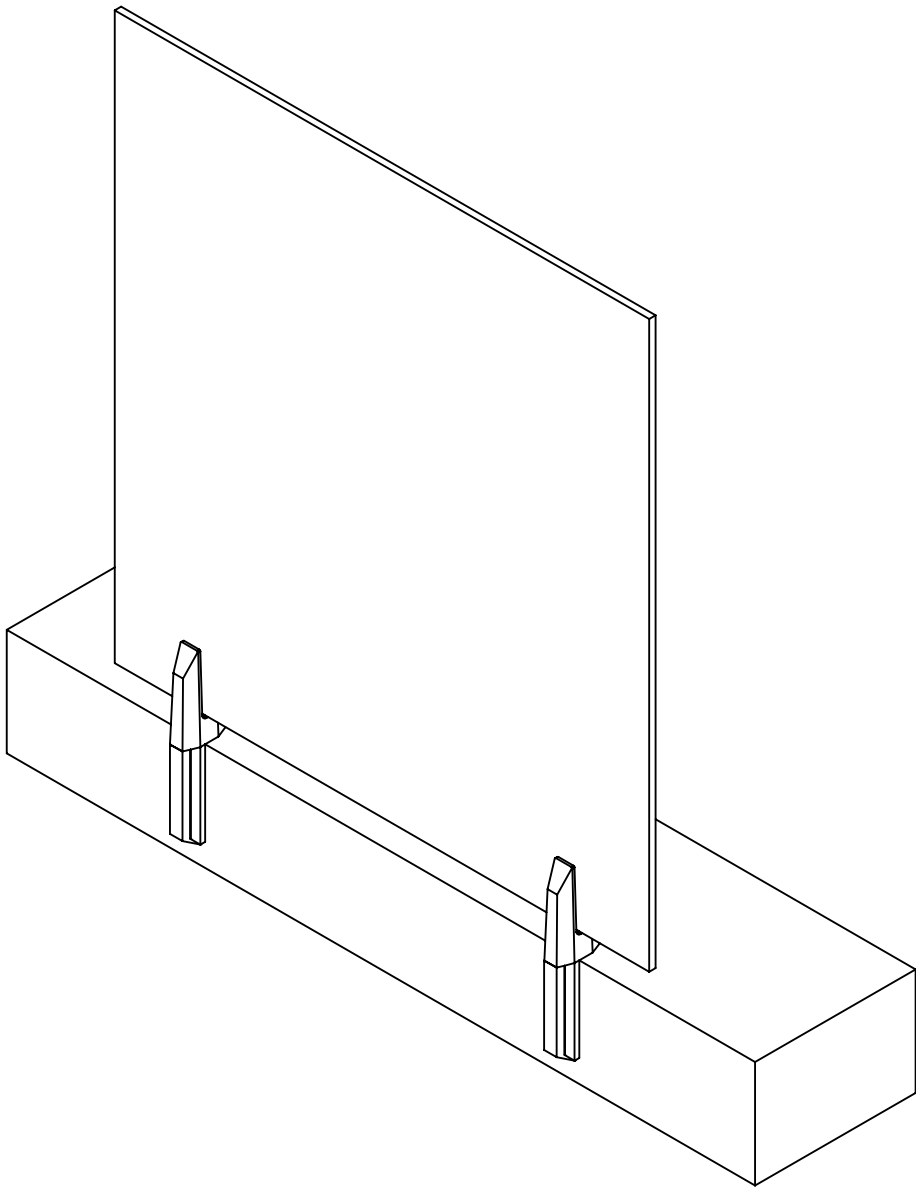


SCALE 1 : 2

1. EDGE FIX TO SUIT 12MM - 17.52
2. REMOVE ALL BURRS & SHARP EDGES

				<h1>Pro-Railing</h1> <p>Tel: 0121 565 8282 Email: prorailing@brundle.com Web: www.prorailing.co.uk</p>		NOTES: Technical Drawing - Drawing Not To Be Supplied To Customer	
				MATERIAL: 316 Stainless Steel		DESCRIPTION: Tilt-Lock Spigot For Edge Fix. Glass 12mm - 17.52mm	
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETERS				FINISH: Stainless Steel		PART NO: 1822005	
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REV. BY				SCALE:1:5		DO NOT SCALE DRAWING	
						SHEET 1 OF 1	

Test:	BS Standard	Parts Needed	Fixed Into	Glass Size	Glass Type/mm	Loading	Hole Size	Fixings Needed	Notes
Test 6: Edge Fix	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1000mm	12mm Toughened	0.36kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
1000mm panel	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1000mm	12.89mm Sentry	0.36kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1000mm	15mm Toughened	0.74kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1000mm	16.8mm Sentry	0.74kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1000mm	17.5mm Laminated	0.36kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1000mm	19mm Toughened	1.5kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1000mm	21.5mm Laminate	0.74kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1000mm	20.89mm Sentry	1.5kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1000mm	25.5mm Laminate	1.5kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1000mm	25mm Toughened	3.0kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1000mm	25.5mm Sentry	3.0kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1000mm glass - 150mm in from each side



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NOTES: Technical Drawing - Drawing Not To Be Supplied To Customer

DESCRIPTION: Test 6

PART NO: NA

DWG NO: 0197-010_06

A3

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETERS			
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DRAWN	GC	25/01/2016	A
REV. BY			

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FINISH: NA

GRIT SIZE: NA

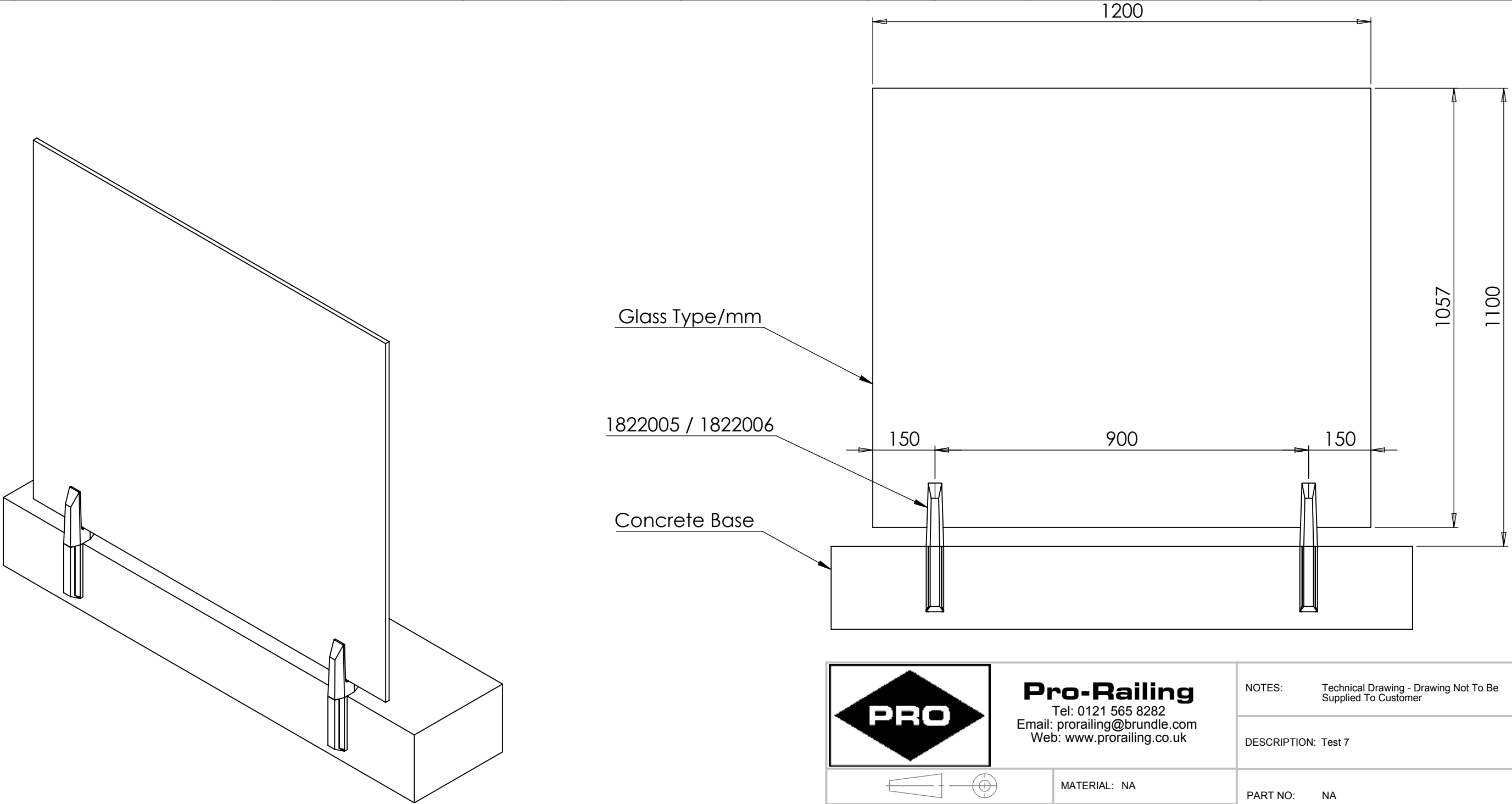
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SCALE:1:20

DO NOT SCALE DRAWING

SHEET 1 OF 1

Test:	BS Standard	Parts Needed	Fixed Into	Glass Size	Glass Type/mm	Loading	Hole Size	Fixings Needed	Notes
Test 7: Edge Fix	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1200mm	12mm Toughened	0.36kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
1200mm panel	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1200mm	12.89mm Sentry	0.36kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1200mm	15mm Toughened	0.74kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1200mm	16.8mm Sentry	0.74kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822005 - Edge Fix	Concrete	1057 x 1200mm	17.5mm Laminated	0.36kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1200mm	19mm Toughened	1.5kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1200mm	21.5mm Laminate	0.74kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1200mm	20.89mm Sentry	1.5kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1200mm	25.5mm Laminate	1.5kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 - Edge Fix	Concrete	1057 x 1200mm	25mm Toughened	3.0kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side
	BS6180:2011 and EC1-1991-1-1:2002	2 x 1822006 – Edge Fix	Concrete	1057 x 1200mm	25.5mm Sentry	3.0kn	30x15mm	507563 - FBN 11 12 X 105 - 316	1200mm glass - 150mm in from each side



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NOTES: Technical Drawing - Drawing Not To Be
 Supplied To Customer

DESCRIPTION: Test 7

PART NO: NA

DWG NO: 0197-010_07

A3



MATERIAL: NA

FINISH: NA

GRIT SIZE: NA

WEIGHT: NA

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN MILLIMETERS

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REV. BY			

