testconsult
*Specialist Testing Services*

# TEST REPORT
## No. S3650

# LOAD TESTING OF BALUSTRADE SYSTEMS

**Job No. A6213**

PREPARED BY TESTCONSULT LIMITED FOR
**FASTEC HANDRAIL SYSTEMS**

**FEBRAUARY 2011**

**Testconsult Limited**
Ruby House, 40A Hardwick Grange,
Warrington, Cheshire, WA1 4RF
**T** +44(0) 1925 286880 **F** +44(0) 1925 286881
**E** jo@testconsult.co.uk

www.testconsult.co.uk
Registered in England No: 1182561

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# APPENDIX

# 1. INTRODUCTION

Testconsult Ltd was instructed by **Fastec Handrail Systems** (client) to carry out load testing to a series of different balustrade designs, at our test laboratory in Warrington, Cheshire.

A total of 7 No. systems were submitted for physical loading assessments.

Each balustrade system comprised of: three vertical stainless steel tubular balusters, supporting a tubular stainless steel handrail, with either glass infill panels or a wire rod infill section.

Testing was required to prove compliance with the relevant British Standards, BS 6399: Part 1: 1996 and BS 6180: 1999.

This report presents the results of the specialist testing works which were carried out between 1st & 18th November 2010.

# 2. METHODOLOGY

## 2.1 Balustrade Load Assessments

Barriers for the protection of people should be of adequate strength and stiffness to sustain the applied loads as given in BS 6399.

Table 4 of this standard specifies minimum horizontal imposed loads for parapets, barriers and balustrades, in the various situations where they would be used. In each instance three loading conditions are applicable:

- Uniformly distributed load test (UDL), per metre run of the handrail.
- Infill panel UDL.
- Concentrated / point load test, to the infill area.

For compliance testing of balustrades / pedestrian barriers it is usual to perform all three tests to a section of the barrier:

The line load test on the handrail is applied at a height of 1.1m.

For typical balustrade installations line loadings of 1.5 kN/m, infill panel UDL loads of 1.5 kN/$m^2$, and point loadings of 1.5 kN are required.

According to BS 6180:1999 the balustrade should sustain the applied loads given in BS 6399 ‘without permanent deflection or distortion.’

BS 6180:1999 also states: ‘the limiting condition for deflection appropriate for a barrier for the protection of people is that the total horizontal displacement of the barrier at any point from its original unloaded position should not exceed 25mm.’

## 2.2 Test Systems

Testing was carried out on 7 No. balustrade systems as detailed below:

| **TEST SYSTEM 1 (A)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 42.4 | *42.4, 2.6* |
| S/S Hand Rail Diameter (mm) | 42.4 | *42.4, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Side Bracket | *34.1010.420.S* |
| No. of Fixing Bolts Per Post | 2 | |
| Handrail Connection | Stem | *34.0110.426.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.420.S* |

| **TEST SYSTEM 1 (B)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 48.3 | *48.3, 2.6* |
| S/S Hand Rail Diameter (mm) | 48.3 | *48.3, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Side Bracket | *34.1010.480.S* |
| No. of Fixing Bolts Per Post | 2 | |
| Handrail Connection | Stem | *34.0111.486.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.480.S* |

| **TEST SYSTEM 2 (A)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 42.4 | *42.4, 2.6* |
| S/S Hand Rail Diameter (mm) | 42.4 | *42.4, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1100.420.R* |
| No. of Fixing Bolts Per Post | 3 | |
| Handrail Connection | Stem | *34.0110.426.S* |
| Infill Type | Glass Panel | |

| | | |
|---|---|---|
| Glass Clamps | 4 Per Panel | *34.3210.420.S* |

| **TEST SYSTEM 2 (B)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 48.3 | *48.3, 2.6* |
| S/S Hand Rail Diameter (mm) | 48.3 | *48.3, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1100.480.R* |
| No. of Fixing Bolts Per Post | 3 | |
| Handrail Connection | Stem | *34.0111.486.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.480.S* |

| **TEST SYSTEM 3 (A)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 42.4 | *42.4, 2.6* |
| S/S Hand Rail Diameter (mm) | 42.4 | *42.4, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1110.420.R* |
| No. of Fixing Bolts Per Post | 2 | |
| Handrail Connection | Stem | *34.0110.426.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.420.S* |

| **TEST SYSTEM 3 (B)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 48.3 | *48.3, 2.6* |
| S/S Hand Rail Diameter (mm) | 48.3 | *48.3, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1100.480.R* |
| No. of Fixing Bolts Per Post | 2 | |
| Handrail Connection | Stem | *34.0111.486.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.480.S* |

| **TEST SYSTEM 4 (A)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 42.4 | *42.4, 2.6* |
| S/S Hand Rail Diameter (mm) | 42.4 | *42.4, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1120.420.R* |
| No. of Fixing Bolts Per Post | 2 | |
| Handrail Connection | Stem | *34.0110.426.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.420.S* |

| **TEST SYSTEM 4 (B)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 48.3 | *48.3, 2.6* |
| S/S Hand Rail Diameter (mm) | 48.3 | *48.3, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1120.480.R* |
| No. of Fixing Bolts Per Post | 2 | |
| Handrail Connection | Stem | *34.0111.486.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.480.S* |

| **TEST SYSTEM 5 (A)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 42.4 | *42.4, 2.6* |
| S/S Hand Rail Diameter (mm) | 42.4 | *42.4, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1110.420.R* |
| No. of Fixing Bolts Per Post | 3 | |
| Handrail Connection | Glued Connector | *34.0731.426.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.420.S* |

| **TEST SYSTEM 5 (B)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 48.3 | *48.3, 2.6* |
| S/S Hand Rail Diameter (mm) | 48.3 | *48.3, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1100.480.R* |
| No. of Fixing Bolts Per Post | 3 | |
| Handrail Connection | Glued Connector | *34.0731.486.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.480.S* |

| **TEST SYSTEM 6 (A)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 42.4 | *42.4, 2.6* |
| S/S Hand Rail Diameter (mm) | 42.4 | *42.4, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1100.420.R* |
| No. of Fixing Bolts Per Post | 3 | |
| Handrail Connection | Stem | *34.0110.426.S* |
| Infill Type | 12mm Cross Bars | |
| Cross Bar Holders | 9 Per Post | *34.3312.420.S* |

| **TEST SYSTEM 6 (B)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 48.3 | *48.3, 2.6* |
| S/S Hand Rail Diameter (mm) | 48.3 | *48.3, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Flange Base | *34.1100.480.R* |
| No. of Fixing Bolts Per Post | 3 | |
| Handrail Connection | Stem | *34.0111.486.S* |
| Infill Type | 12mm Cross Bars | |
| Cross Bar Holders | 9 Per Post | *34.3312.480.S* |

| **TEST SYSTEM 7 (A)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 42.4 | *42.4, 2.6* |
| S/S Hand Rail Diameter (mm) | 42.4 | *42.4, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Clamp Fix | *34.1310.420.S* |
| No. of Fixing Bolts Per Post | 1 | |
| Handrail Connection | Stem | *34.0110.426.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.420.S* |

| **TEST SYSTEM 7 (B)** | | |
|---|---|---|
| | | *Fastec Code* |
| S/S Baluster Tube Diameter (mm) | 48.3 | *48.3, 2.6* |
| S/S Hand Rail Diameter (mm) | 48.3 | *48.3, 2.0* |
| Handrail Height (mm) | 1100 | |
| Baluster Post Spacing (mm) | 1300 | |
| Mounting Type | Clamp Fix | *34.1310.480.S* |
| No. of Fixing Bolts Per Post | 1 | |
| Handrail Connection | Stem | *34.0111.486.S* |
| Infill Type | Glass Panel | |
| Glass Clamps | 4 Per Panel | *34.3210.480.S* |

## 2.3 Test Procedure

All test systems were assembled under the guidance of the client's representative.

In each case a horizontal line load was applied to the handrails using an 8T hydraulic ram, attached to a hand pump with a calibrated pressure gauge.

(2 No. additional jacks were used to apply similar point loadings to the outer posts at the same time, in order to simulate adjacent bays).

The load was applied gradually, with constant monitoring of the rail displacement from an independent datum position, until sufficient loading had been achieved or the maximum allowable displacement had been exceeded.

The initial test was performed to generate a loading of 1.5 kN/m run on the handrail. Once this load was achieved the maximum displacement was recorded, the load was released, and the residual deflection under zero loading was measured.

Additional loading cycles were then performed where the loads were increased to 2.25 kN/m and 3.0 kN/m, for ultimate strength considerations.

Testing of the infill panels was performed using a reaction system comprising of a series of interconnecting aluminium tubular sections, with a 5T small diameter hydraulic jack built inside one of the tubes. The jack was then attached to a hand pump with a calibrated pressure gauge. A 1m square timber pad was used to distribute the load evenly over the glass panel. The loadings were applied as above.

A point load was applied to the glass infill panel using a 300mm square metal block. Load and deflection were monitored as for the previous testing.

## 3. RESULTS & FINDINGS

Plots showing the results of the testing are presented on the test certificates which are included in Appendices A-G.

On the test certificates for the handrail UDL, the first loading cycle of 1.5 kN/m is denoted in black.

For Test Systems 1-6, & 7b, all of the balustrades produced maximum deflections which were less than 25mm for this loading, with no permanent deflections recorded. For this loading scenario these balustrades are therefore considered to be satisfactory and meet the conditions stated in the aforementioned British Standards.

Test System 7 (42.4 mm diameter tube) exceeded the maximum allowable deflection at a load of 1.4 kN. This system does not meet the requirements for the 1.5 kN loading situations, as given in Table 4 of BS 6399: Part 1: 1996, but would be suitable for 0.74 kN load case situations.

Following the initial loading cycle of 1.5 kN/m, the loading was increased to 2.25 kN/m, with the maximum deflection being measured and again the final deflection on removal of the load. This load cycle is shown in red on the test certificate graphs.

A third loading cycle was also carried out to 3.0 kN/m – this is plotted in dark blue on the test certificate graphs.

For these additional loading cycles the permanent deflections clearly exceeded 25mm, and permanent deflection was evident in all cases. Therefore the balustrade systems should not be used in situations where the loadings will exceed 1.5 kN.

**********

**DEAN KENDALL**
**Technician**

**SIMON AITKEN**
**Operations manager**

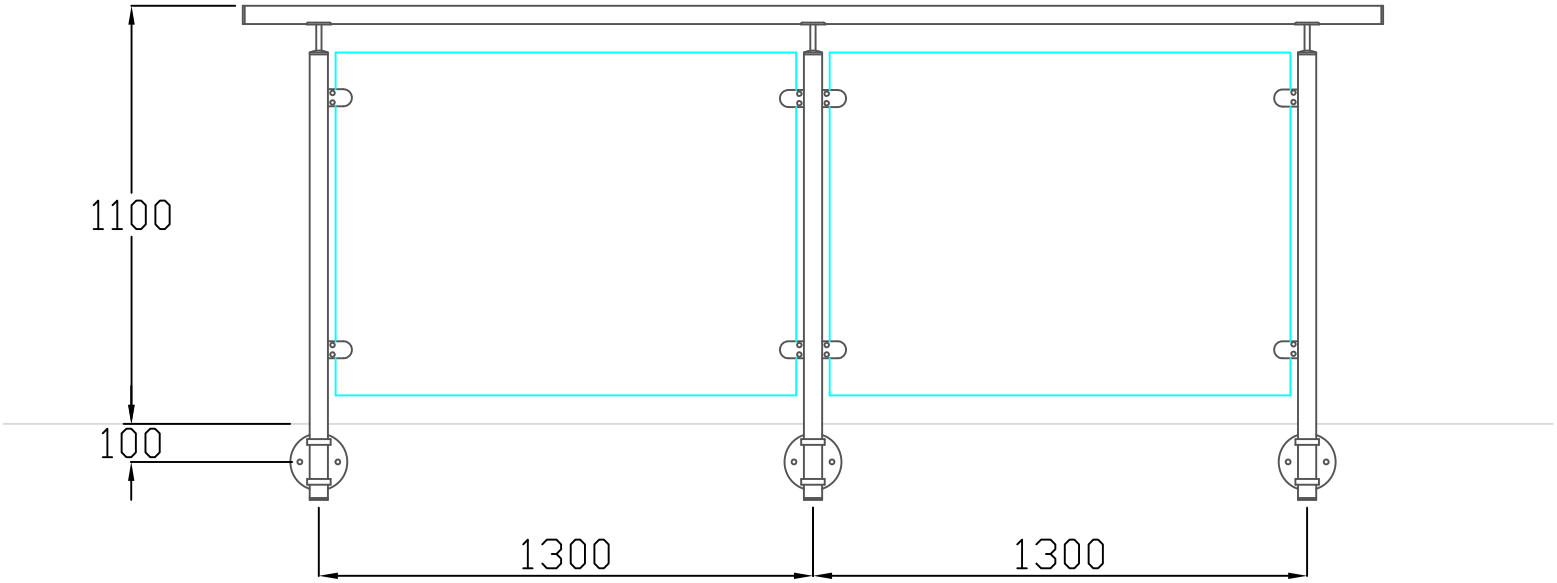
**For and on behalf of TESTCONSULT LIMITED**

# APPENDIX A

## TEST CERTIFICATES & BALUSTRADE SETUP -

## SYSTEM 1

# Balustrade - Test System 1



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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 1 - SIDE MOUNTED, 42.4mm DIAMETER TUBE

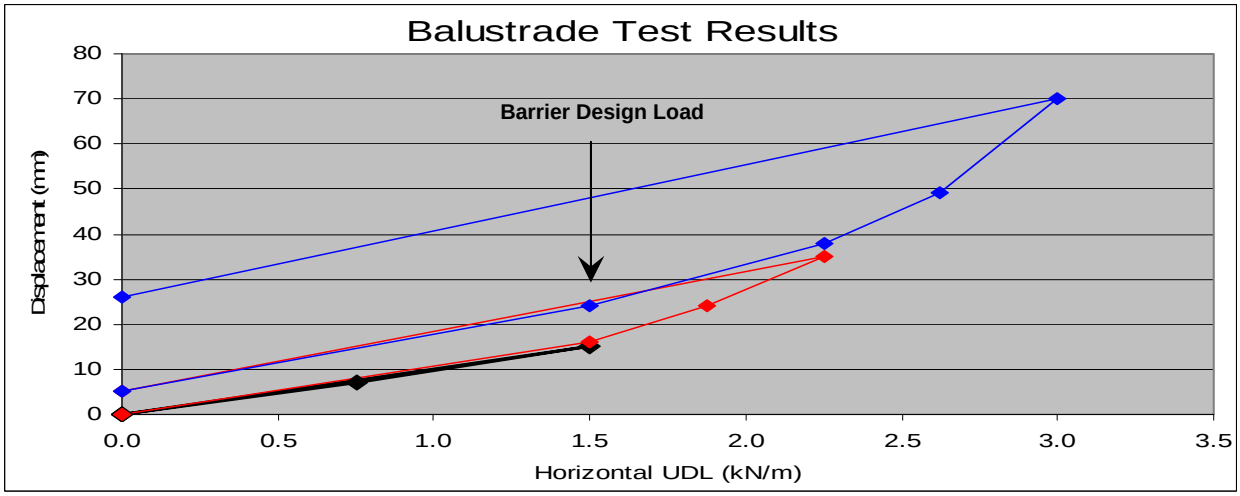
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0001** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Side mounted. 2 No. fixing bolts per bracket mount. (Fastec code: 34.1010.420.S) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 1.9 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 1 - SIDE MOUNTED, 42.4mm DIAMETER TUBE

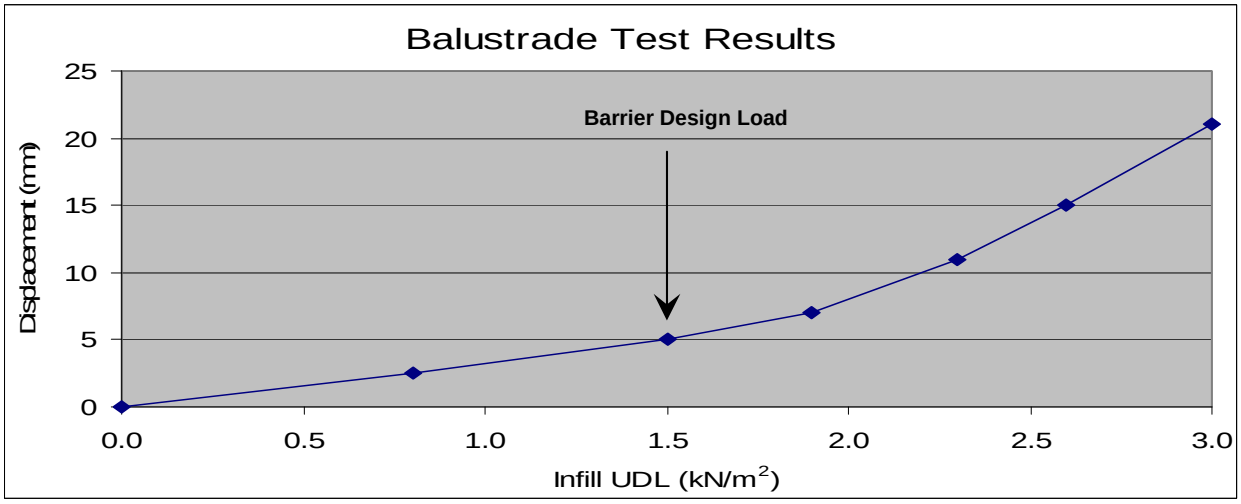
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0002** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Side mounted. 2 No. fixing bolts per bracket mount. (Fastec code: 34.1010.420.S) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 1 - SIDE MOUNTED, 42.4mm DIAMETER TUBE

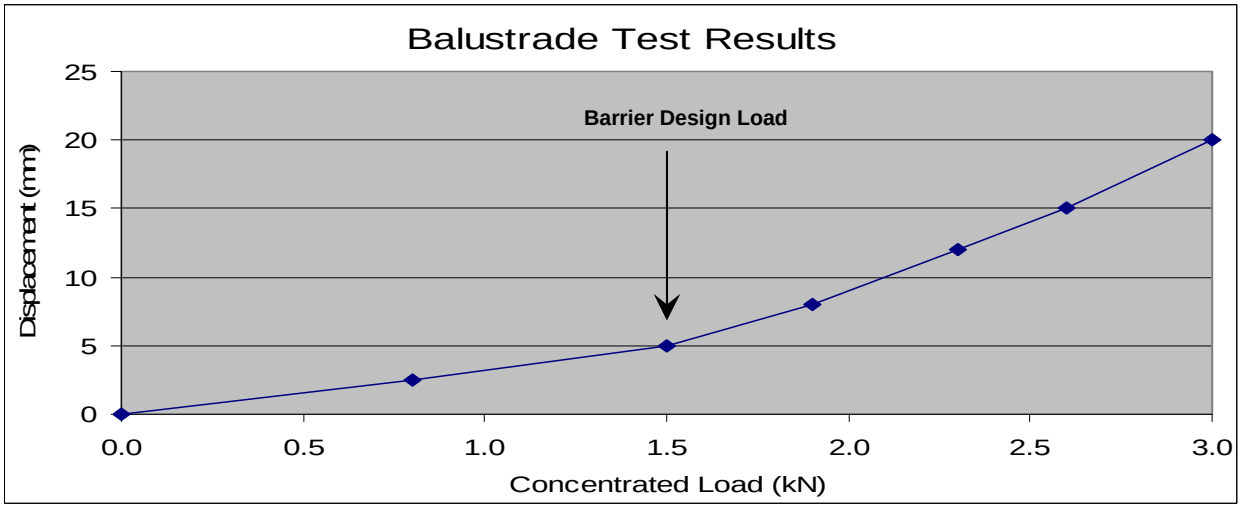
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0003** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Side mounted. 2 No. fixing bolts per bracket mount. (Fastec code: 34.1010.420.S) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 1 - SIDE MOUNTED, 48.3mm DIAMETER TUBE

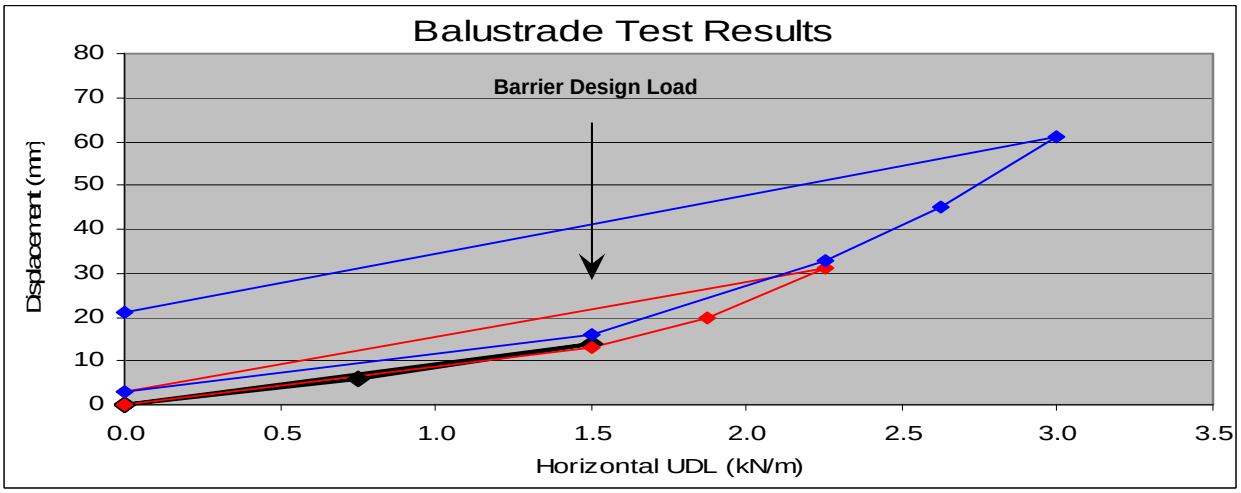
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0004** | **CERTIFICATE DATE:** | 7th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Side mounted. 2 No. fixing bolts per bracket mount. (Fastec code: 34.1010.480.S) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.0 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 1 - SIDE MOUNTED, 48.3mm DIAMETER TUBE

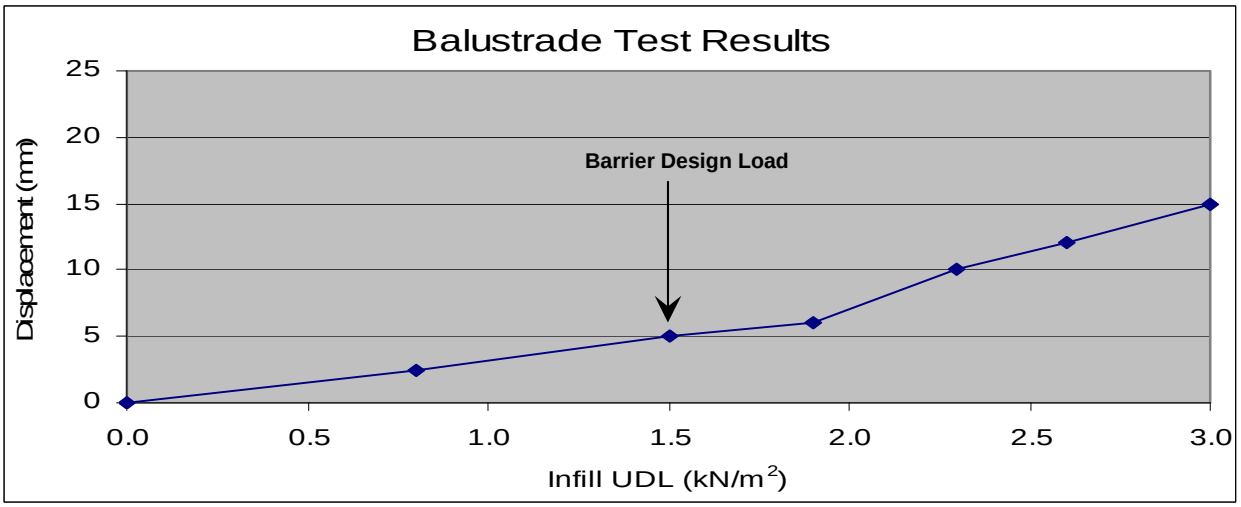
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0005** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Side mounted. 2 No. fixing bolts per bracket mount. (Fastec code: 34.1010.480.S) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 1 - SIDE MOUNTED, 48.3mm DIAMETER TUBE

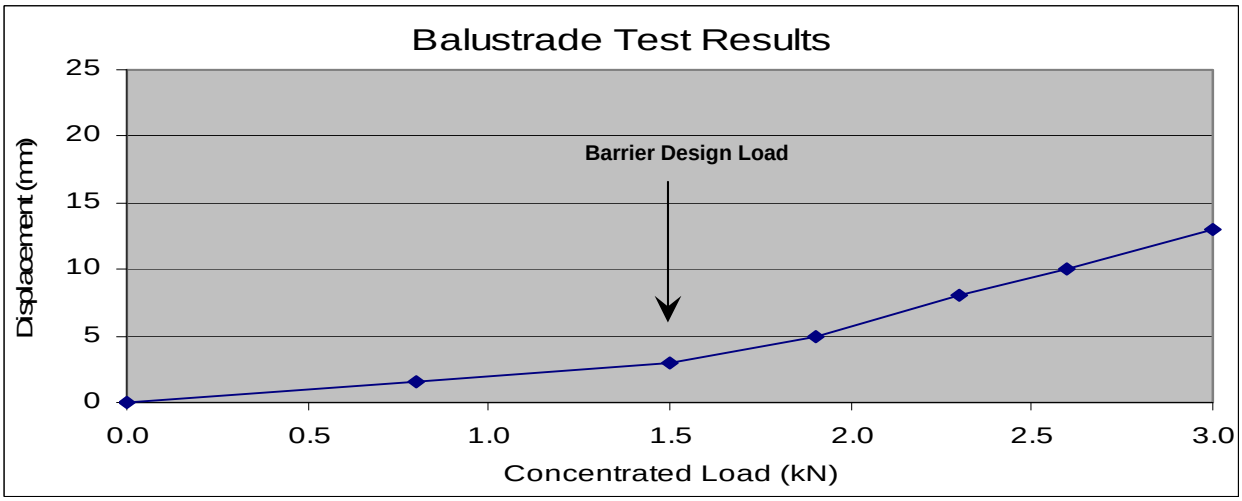
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0006** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Side mounted. 2 No. fixing bolts per bracket mount. (Fastec code: 34.1010.480.S) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**

The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

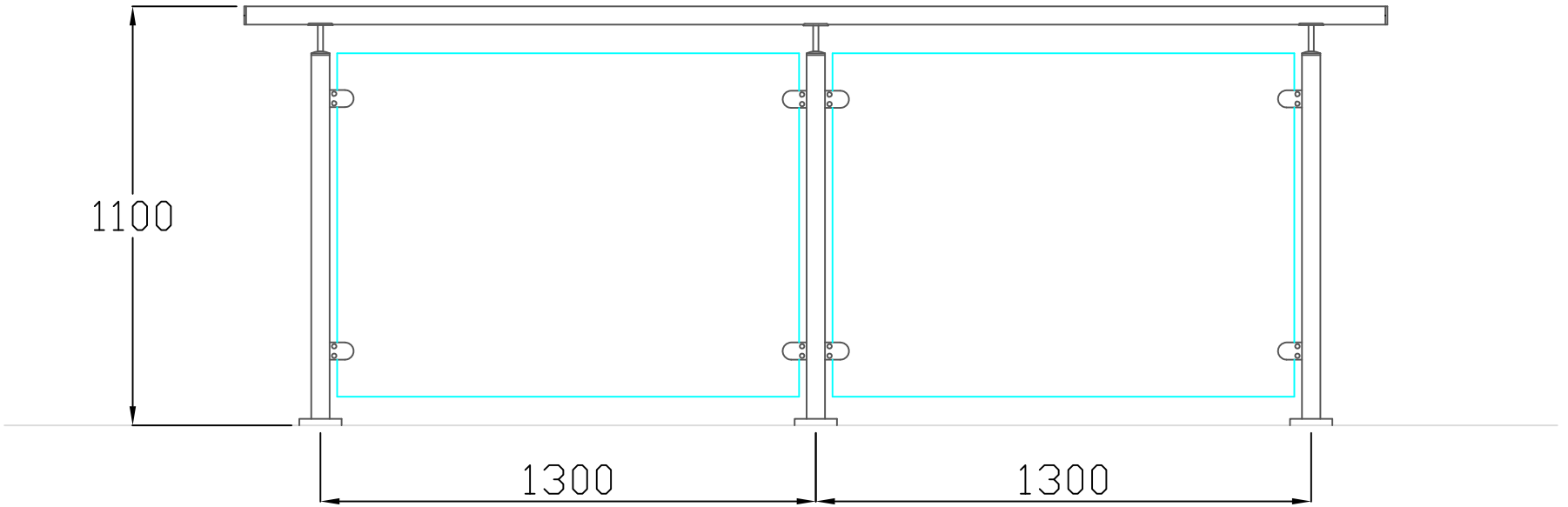
**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

# APPENDIX B

## TEST CERTIFICATES & BALUSTRADE SETUP -

## SYSTEM 2

# Balustrade - Test System 2



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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 2 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

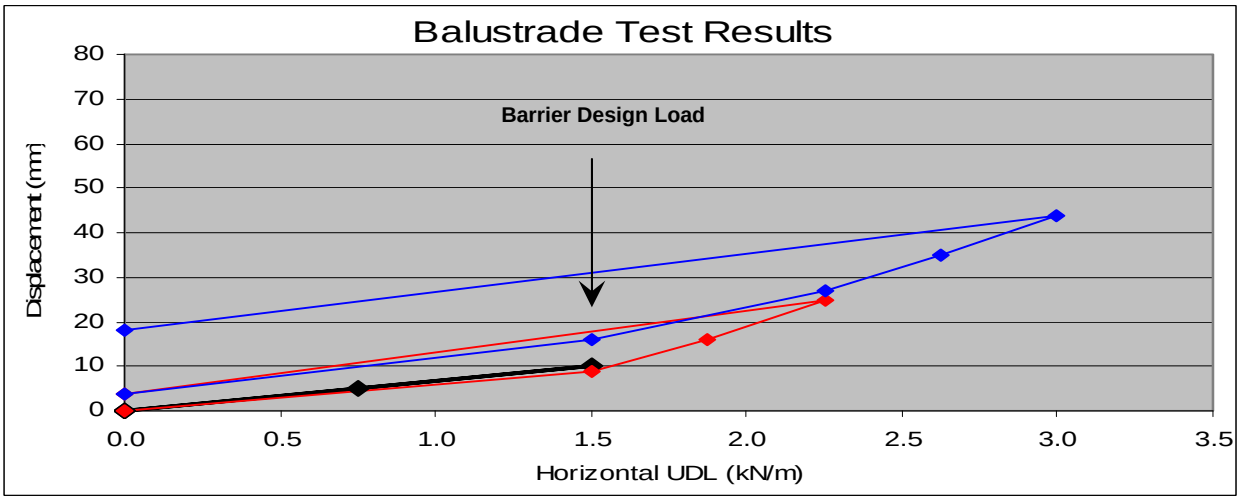
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 1st November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0007** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.25 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 2 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

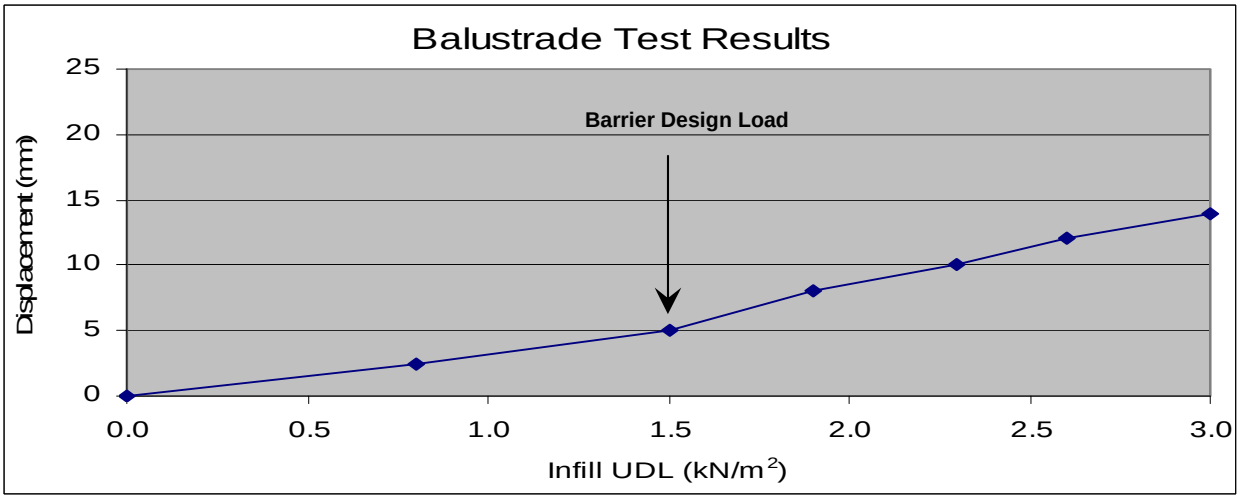
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 1st November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0008** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 2 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

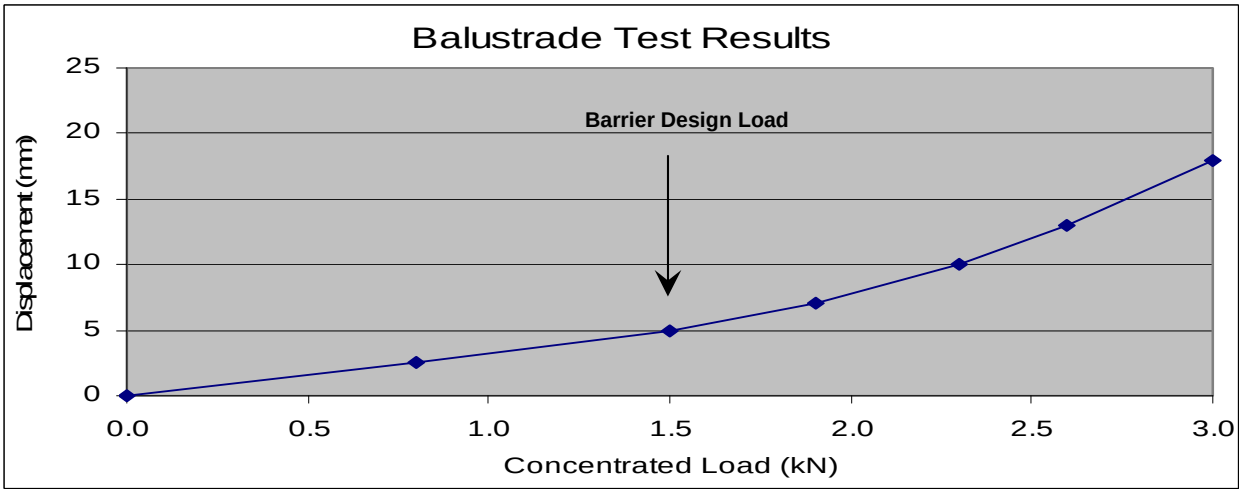
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 1st November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0009** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 2 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

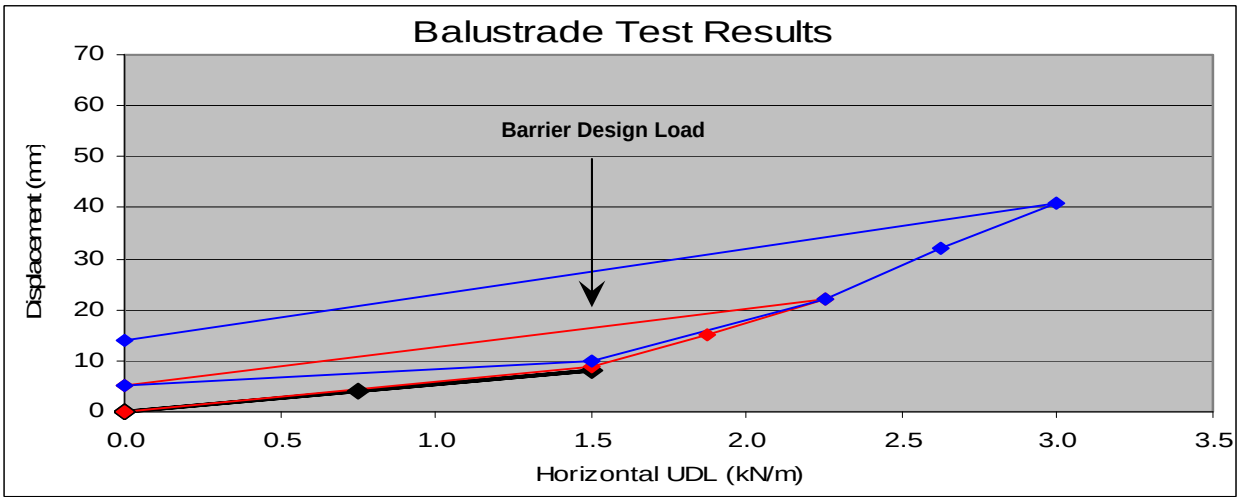
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 2nd November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0010** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**

The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.4 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 2 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

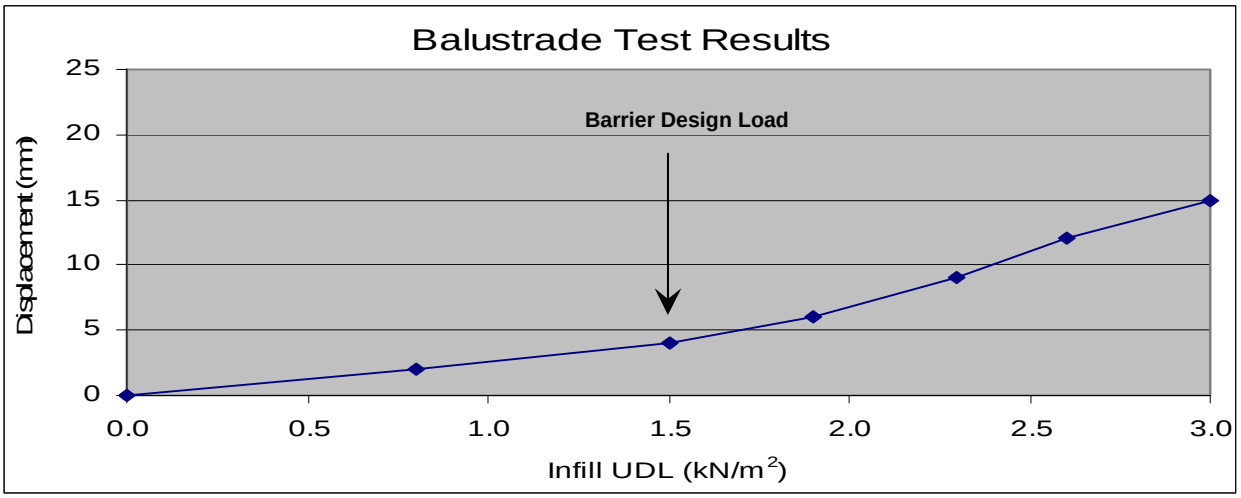
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 2nd November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0011** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 2 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

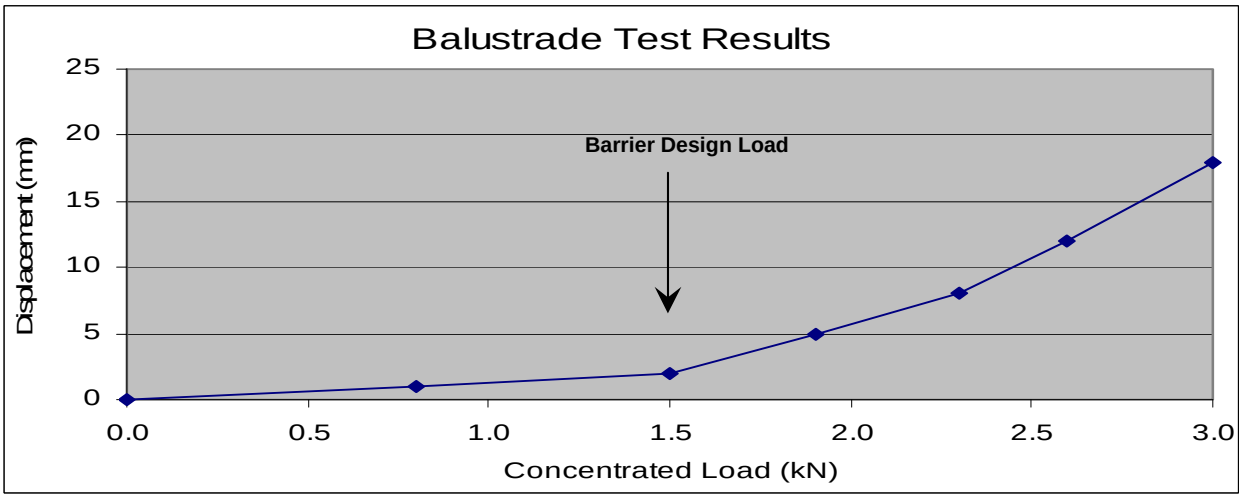
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 2nd November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 14th December 2010 |
| **CERTIFICATE NO.:** | **TC0012** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

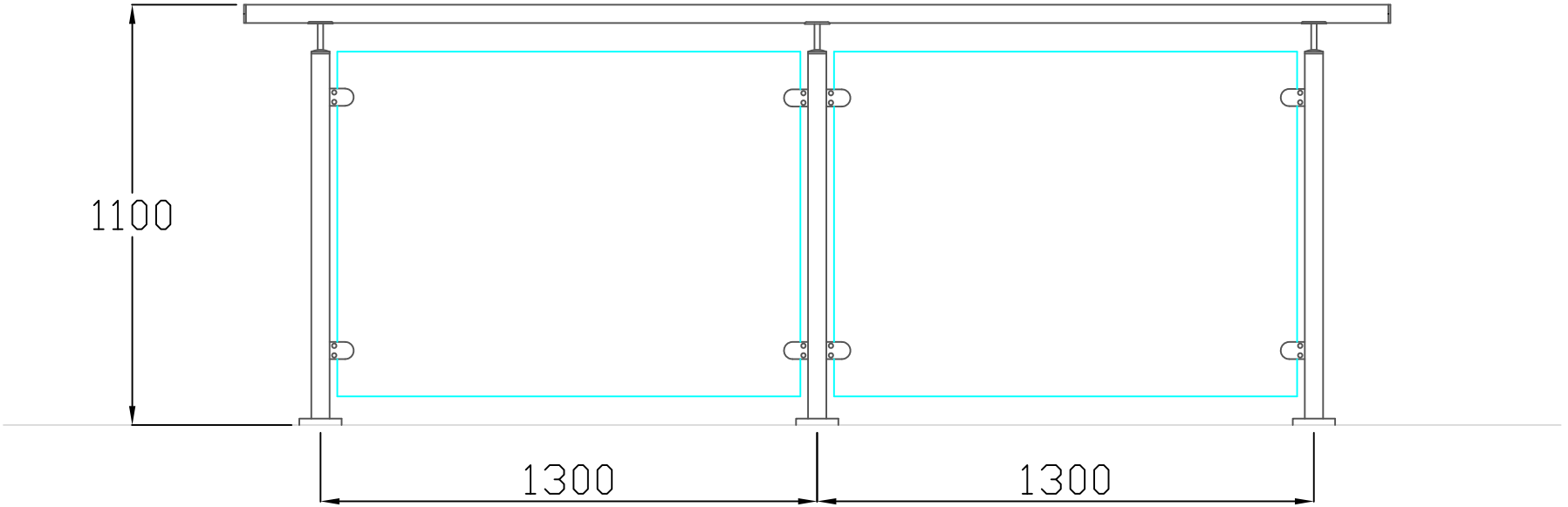
**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

# APPENDIX C

## TEST CERTIFICATES & BALUSTRADE SETUP -

## SYSTEM 3

# Balustrade - Test System 3



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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 3 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

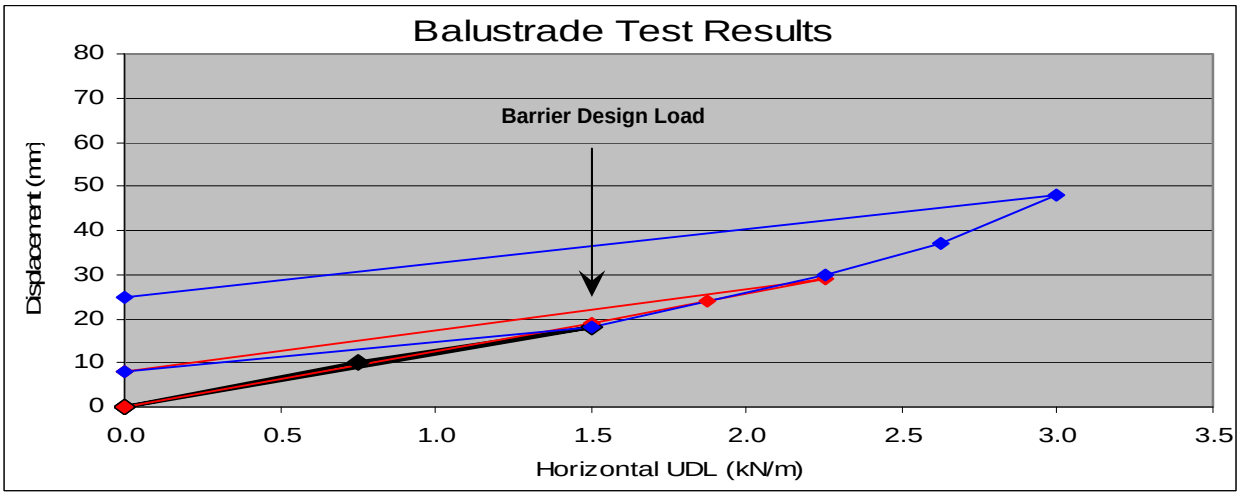
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0013** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1110.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**

The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 1.9 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 3 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

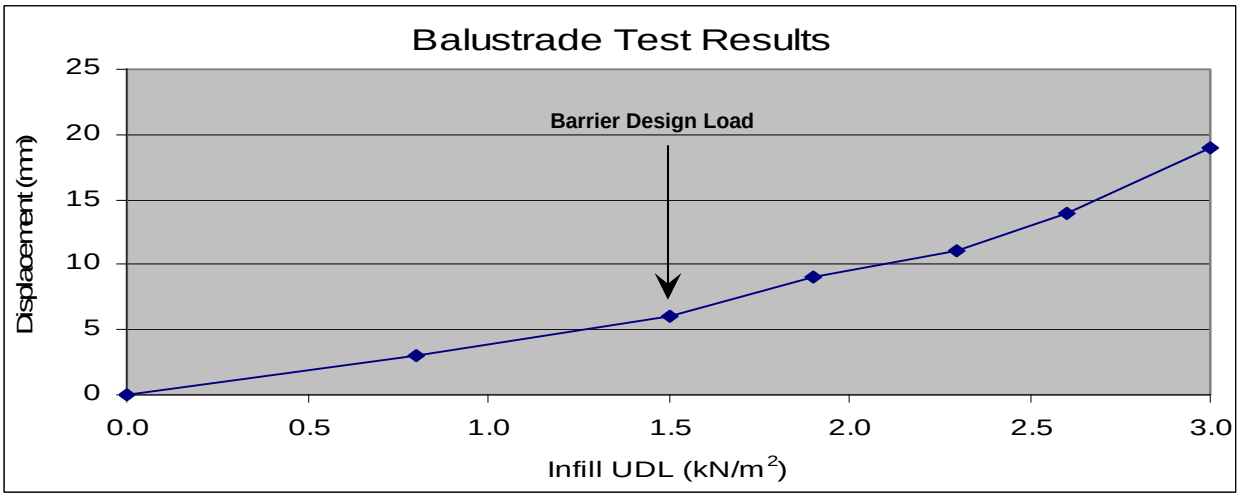
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0014** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1110.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 3 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

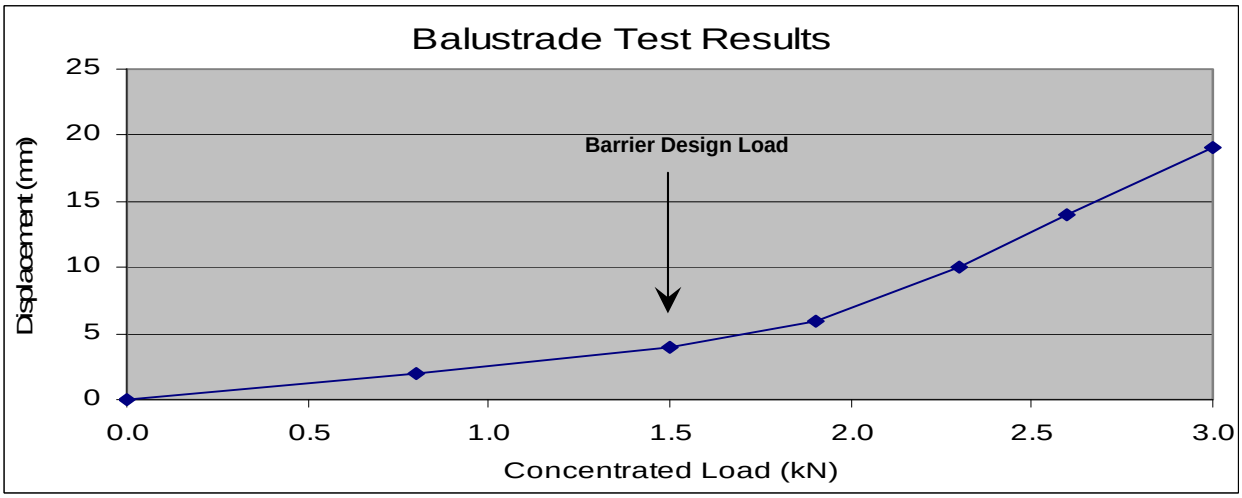
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0015** | **CERTIFICATE DATE:** | 6th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1110.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**

The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 3 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

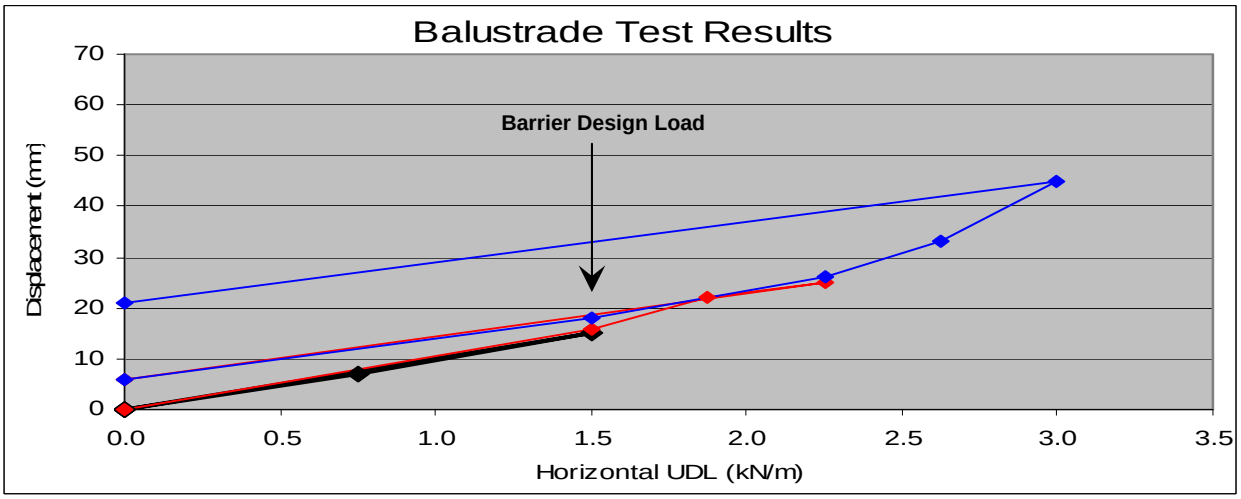
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0016** | **CERTIFICATE DATE:** | 7th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1110.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.2 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 3 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

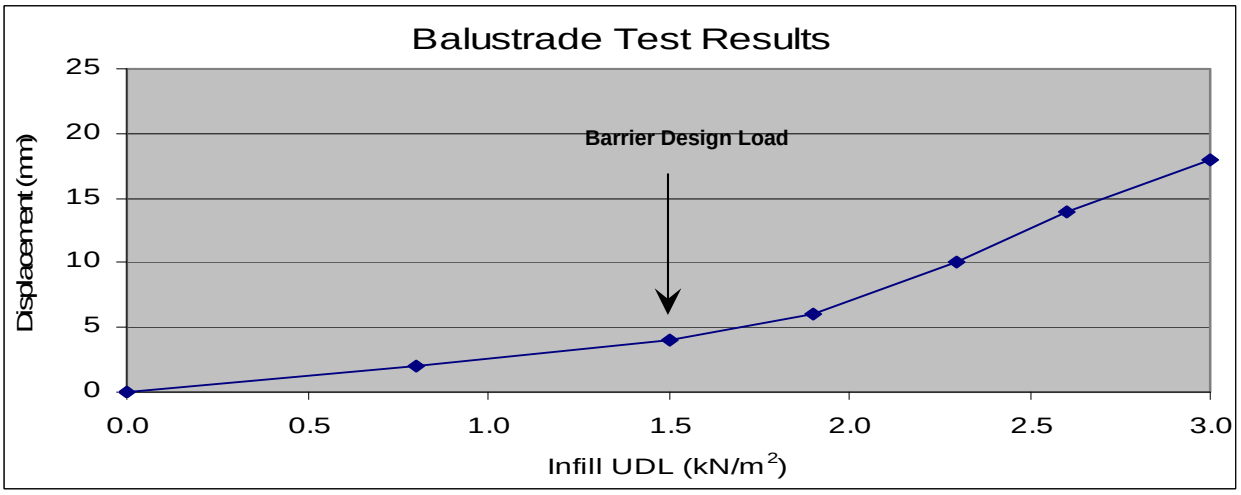
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0017** | **CERTIFICATE DATE:** | 7th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1110.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**

The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 3 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

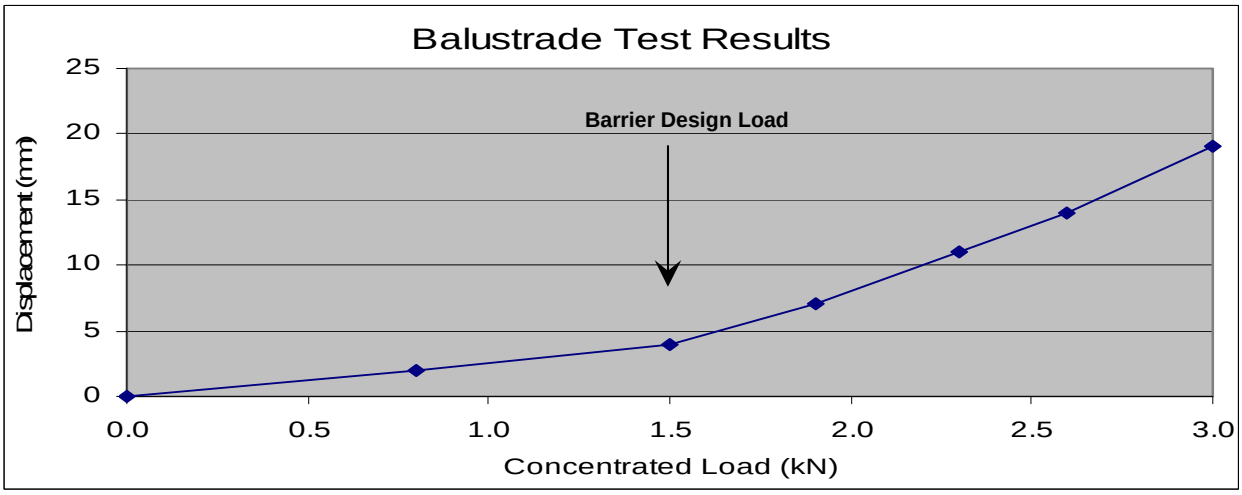
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0018** | **CERTIFICATE DATE:** | 7th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1110.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

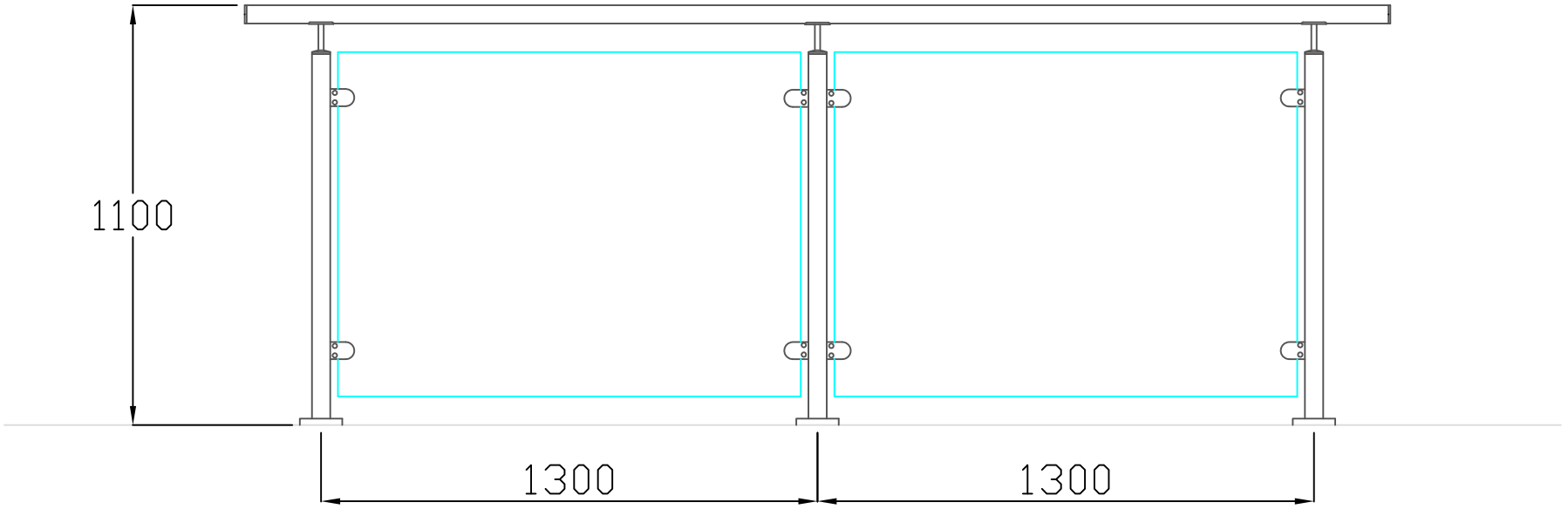
**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

# APPENDIX D

## TEST CERTIFICATES & BALUSTRADE SETUP -

## SYSTEM 4

# Balustrade - Test System 4



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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 4 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

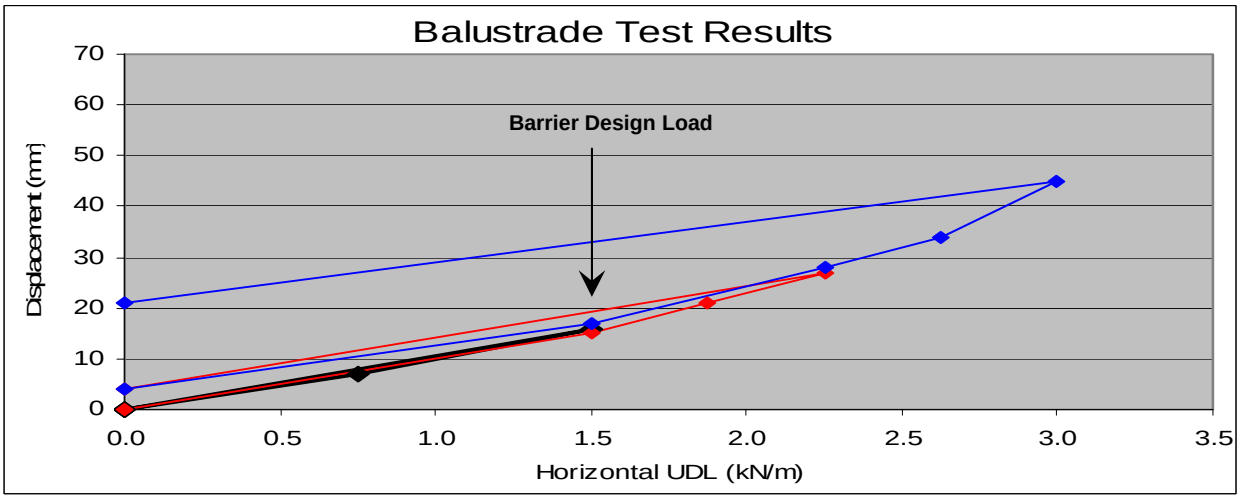
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0019** | **CERTIFICATE DATE:** | 7th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1120.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.05 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 4 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

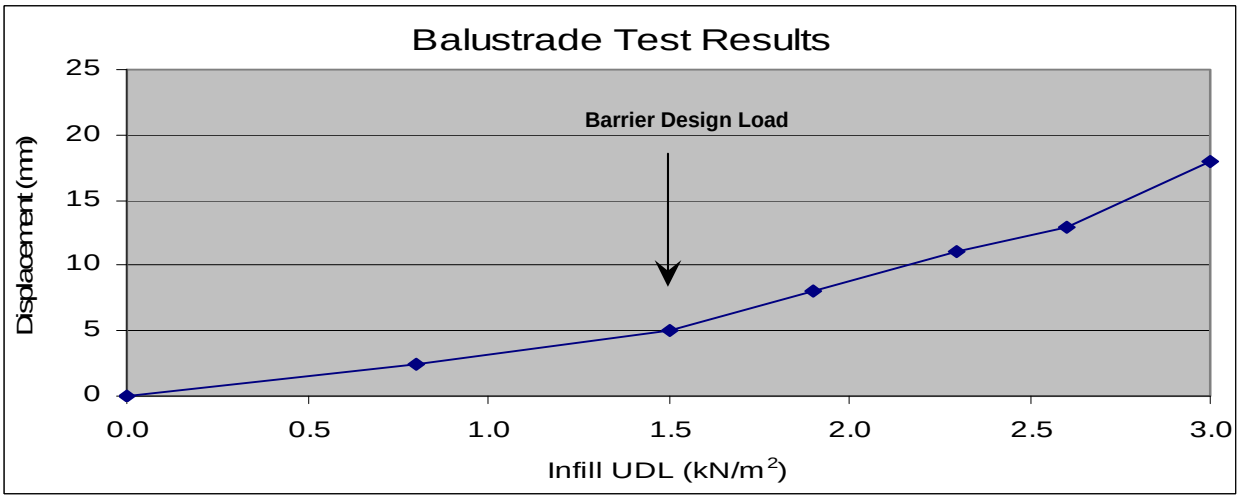
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0020** | **CERTIFICATE DATE:** | 7th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1120.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 4 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

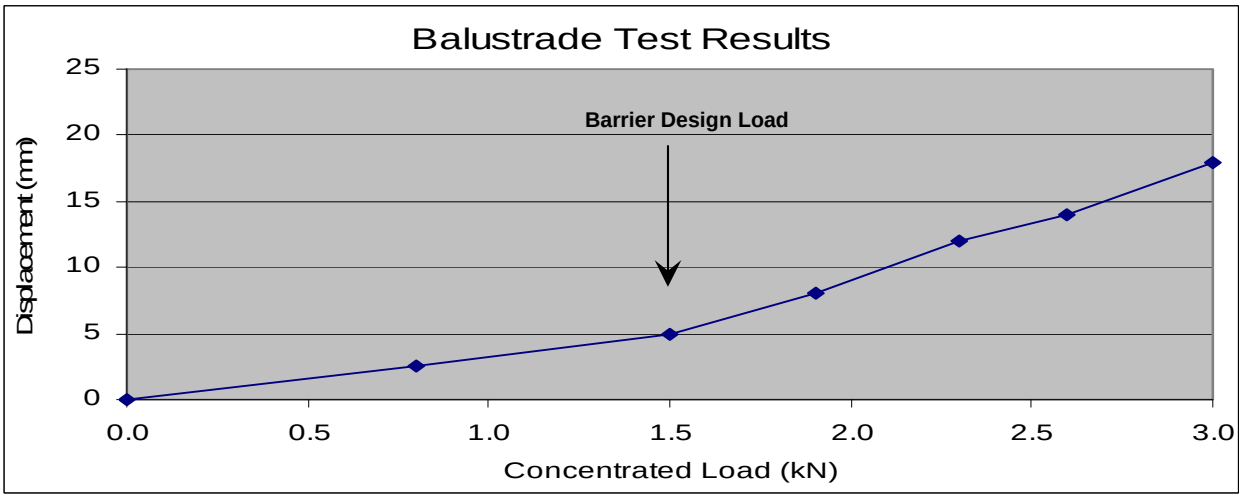
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 15th December 2010 |
| **CERTIFICATE NO.:** | **TC0021** | **CERTIFICATE DATE:** | 7th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1120.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 4 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

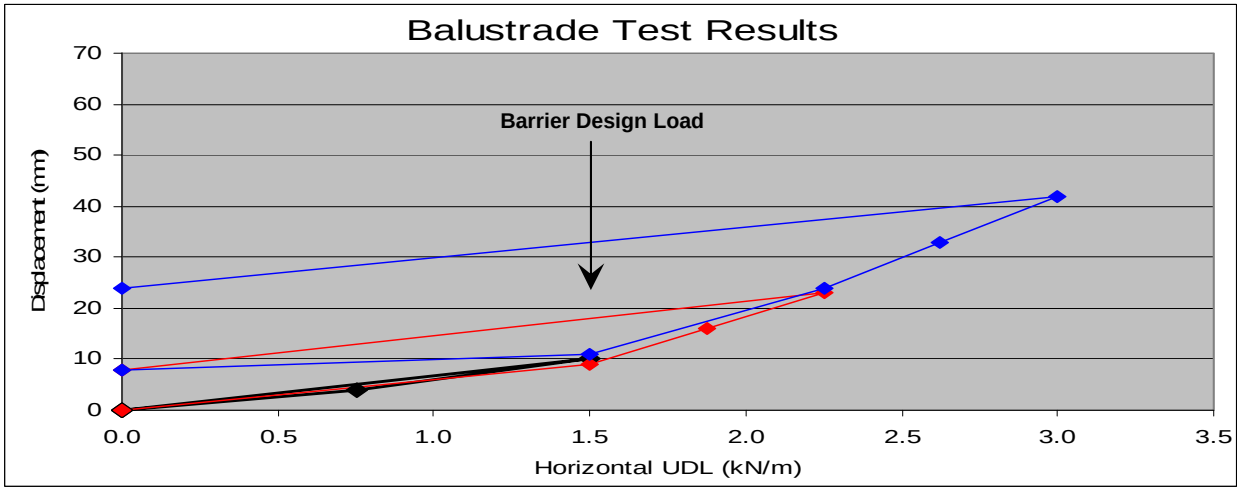
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0022** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1120.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.3 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 4 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

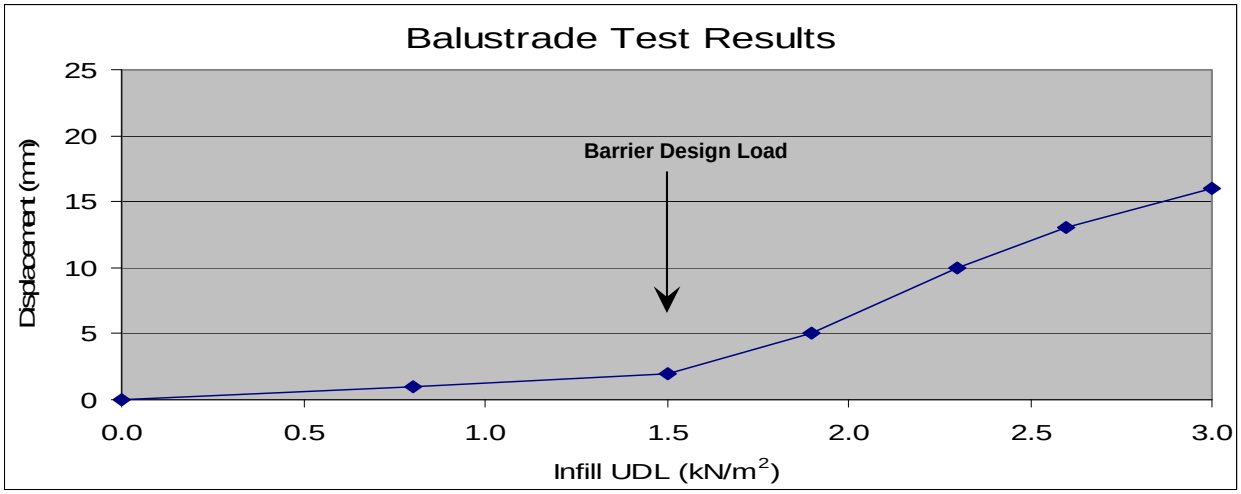
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0023** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1120.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 4 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

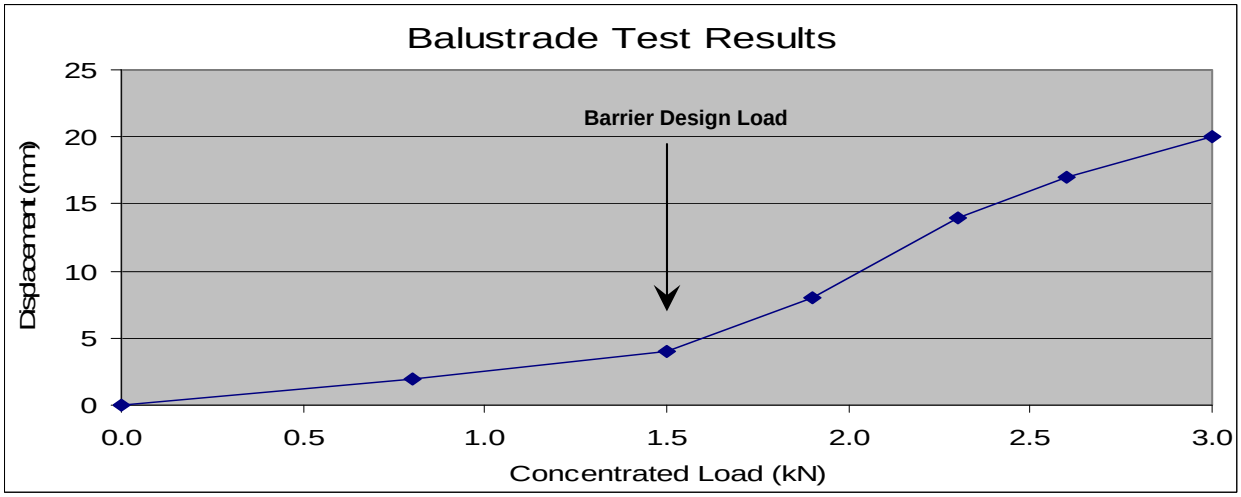
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0024** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 2 No. fixing bolts per flange base. (Fastec code: 34.1120.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

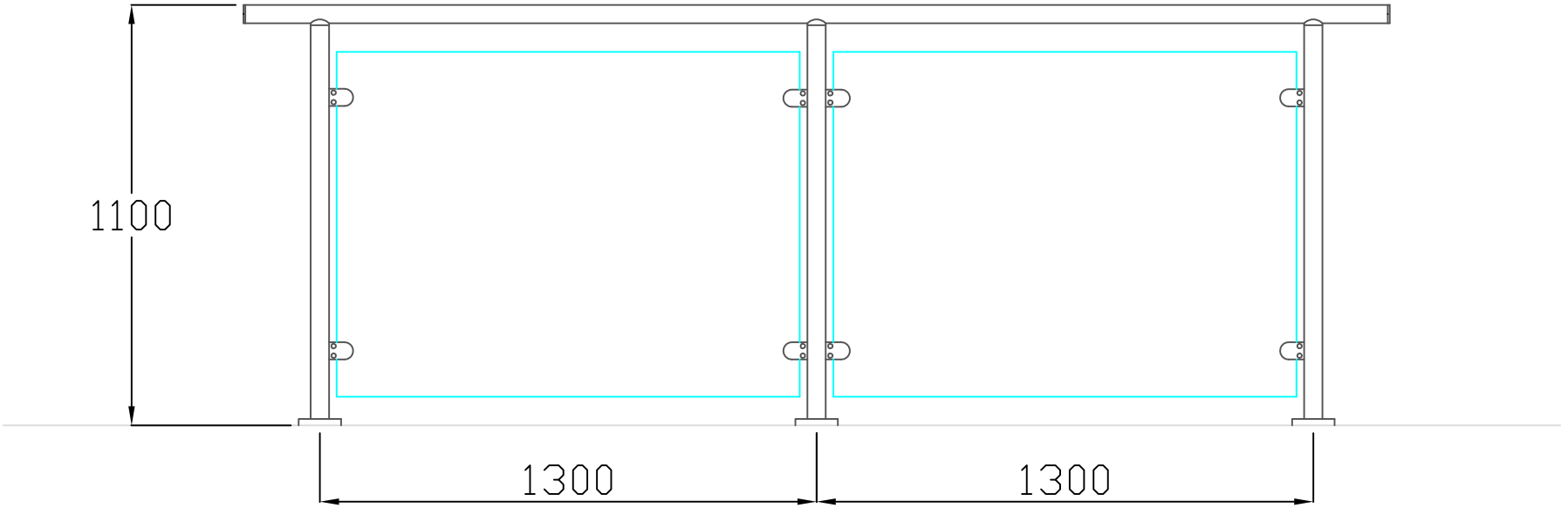
**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

# APPENDIX E

## TEST CERTIFICATES & BALUSTRADE SETUP -

## SYSTEM 5

# Balustrade - Test System 5



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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 5 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

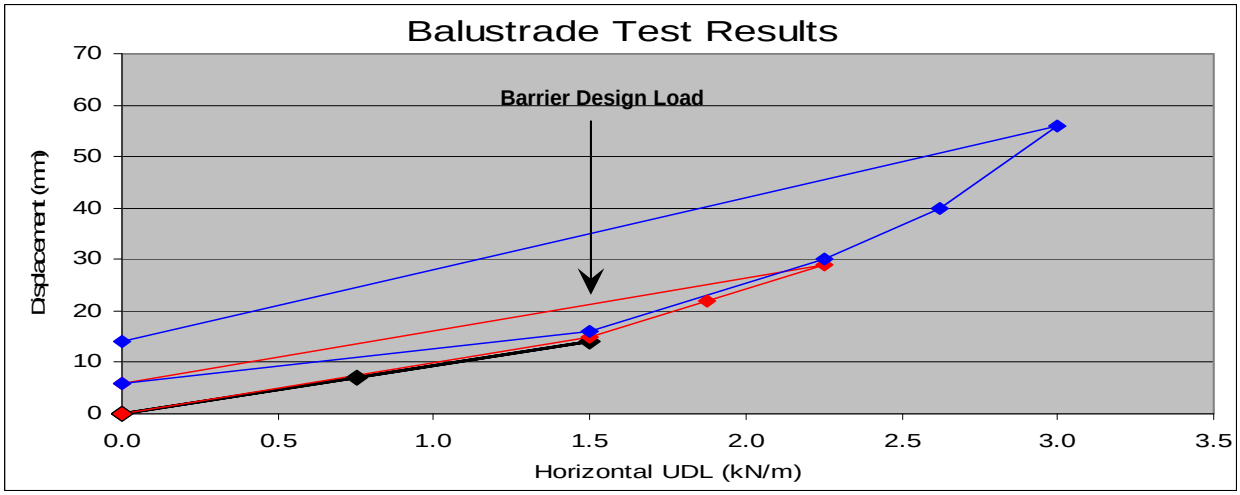
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0025** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.420.R) |
| Rail connection: | Baluster / handrail connector (Fastec code: 34.0731.426.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.0 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 5 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

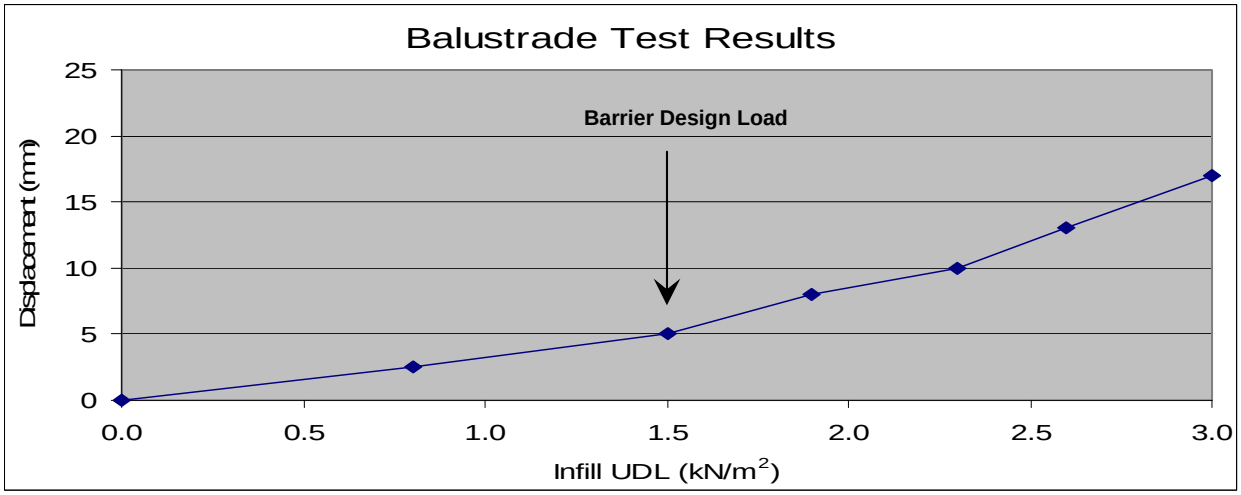
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0026** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.420.R) |
| Rail connection: | Baluster / Handrail connector (Fastec code: 34.0731.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 5 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

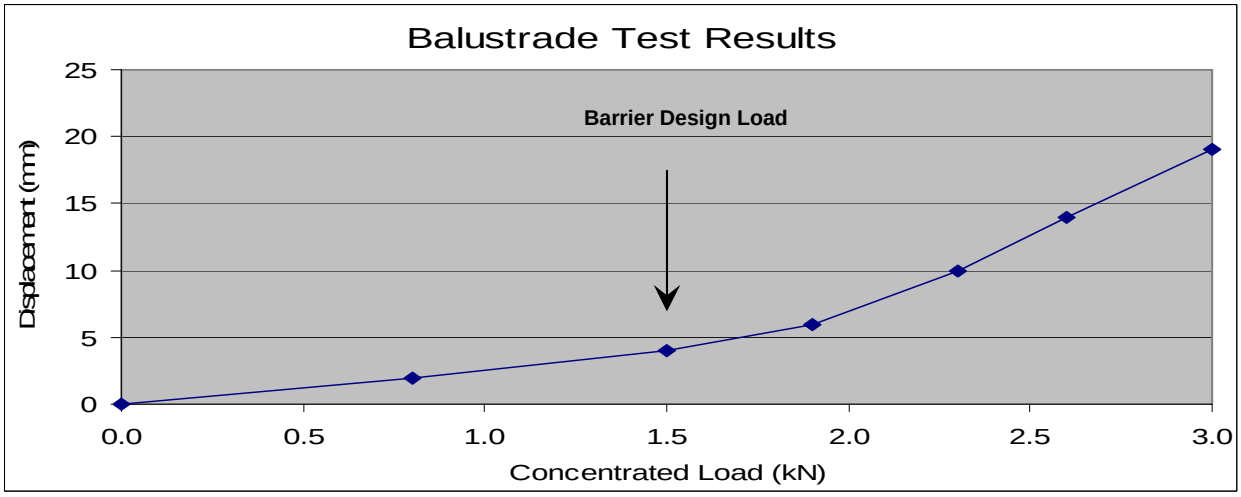
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0027** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.420.R) |
| Rail connection: | Baluster / Handrail connector (Fastec code: 34.0731.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 5 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

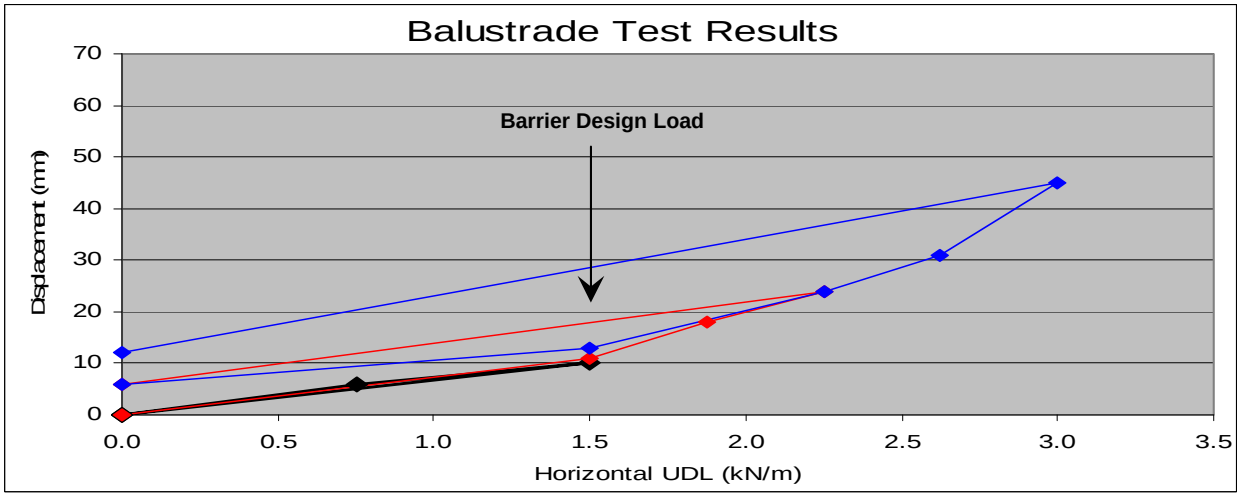
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0028** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.480.R) |
| Rail connection: | Baluster / Handrail connector (Fastec code: 34.0731.486.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.25 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 5 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

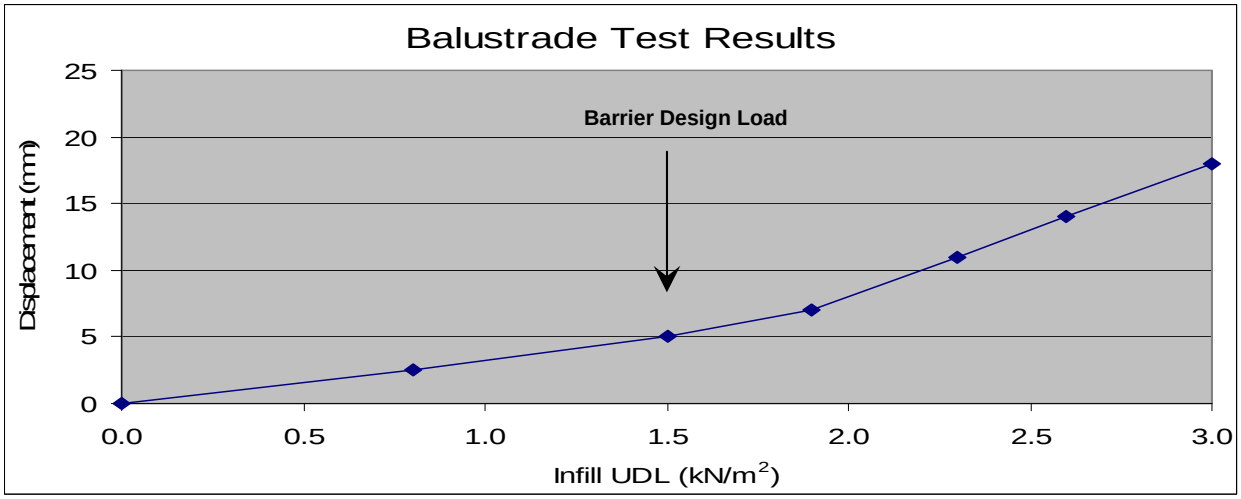
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0029** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.480.R) |
| Rail connection: | Baluster / Handrail connector (Fastec code: 34.0731.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 5 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

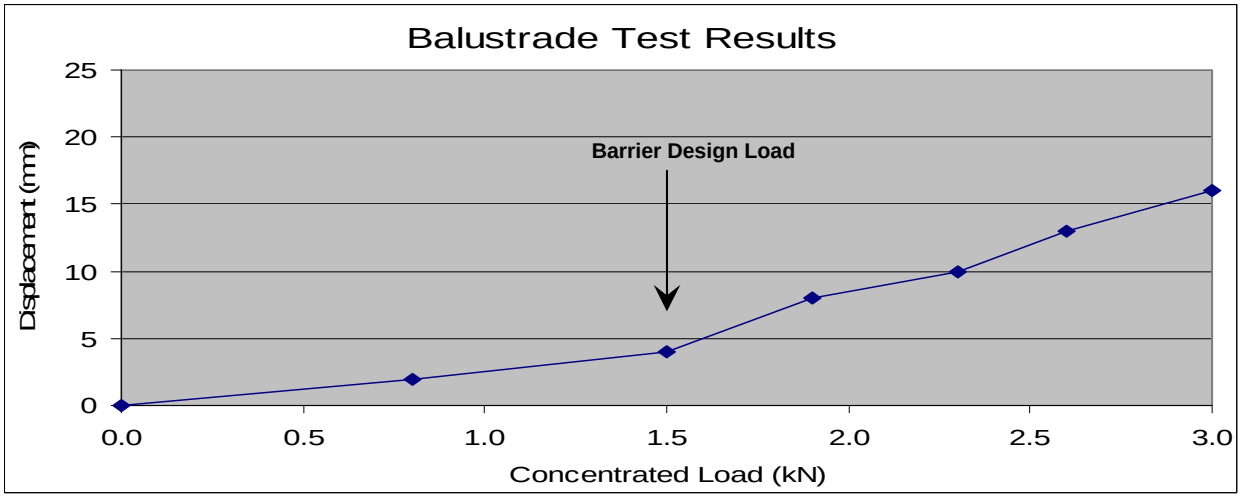
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0030** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.480.R) |
| Rail connection: | Baluster / Handrail connector (Fastec code: 34.0731.486.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S) |

**TEST RESULTS:**




**ANALYSIS:**

The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

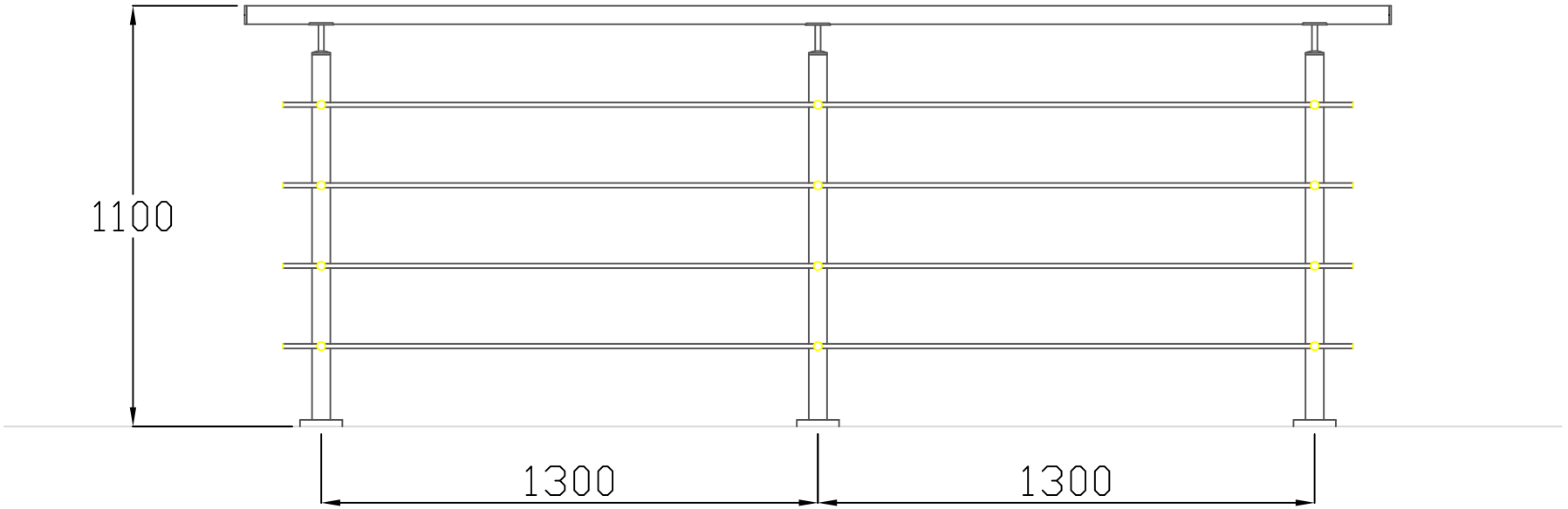
**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

# APPENDIX F

## TEST CERTIFICATES & BALUSTRADE SETUP -

## SYSTEM 6

# Balustrade - Test System 6




| REVISIONS | | | | |
|---|---|---|---|---|
| ZONE | REV | DESCRIPTION | DATE | APPROVED |

| | | | |
|---|---|---|---|
| SIZE | FSCM NO. | DWG NO. | REV |
| SCALE | | SHEET | |

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 6 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

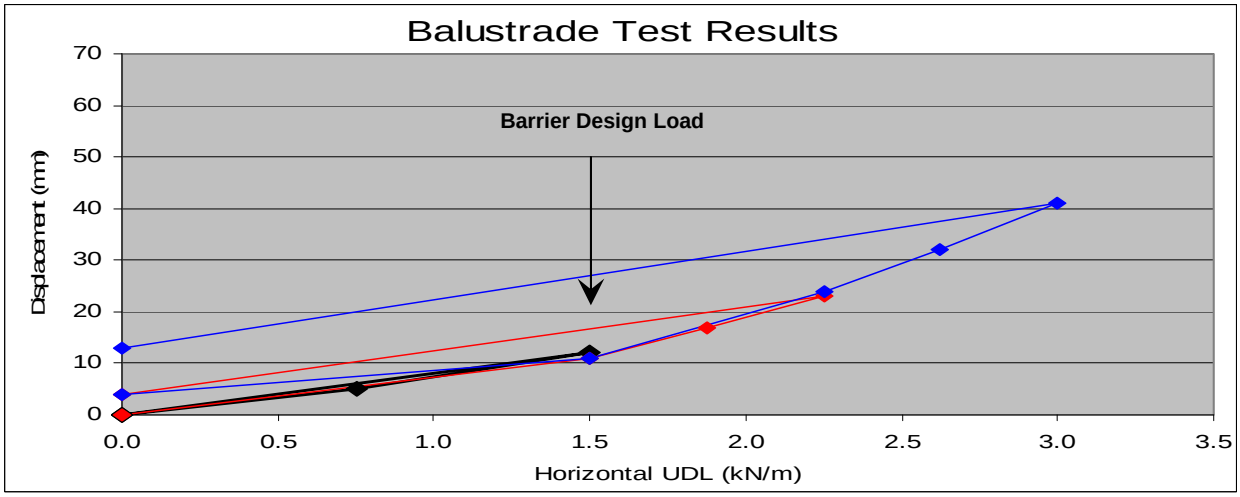
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0031** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Infill panel: | 9 No. 12mm diameter stainless steel cross bars. |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.25 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# RAIL INFILL UDL
# SYSTEM 6 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

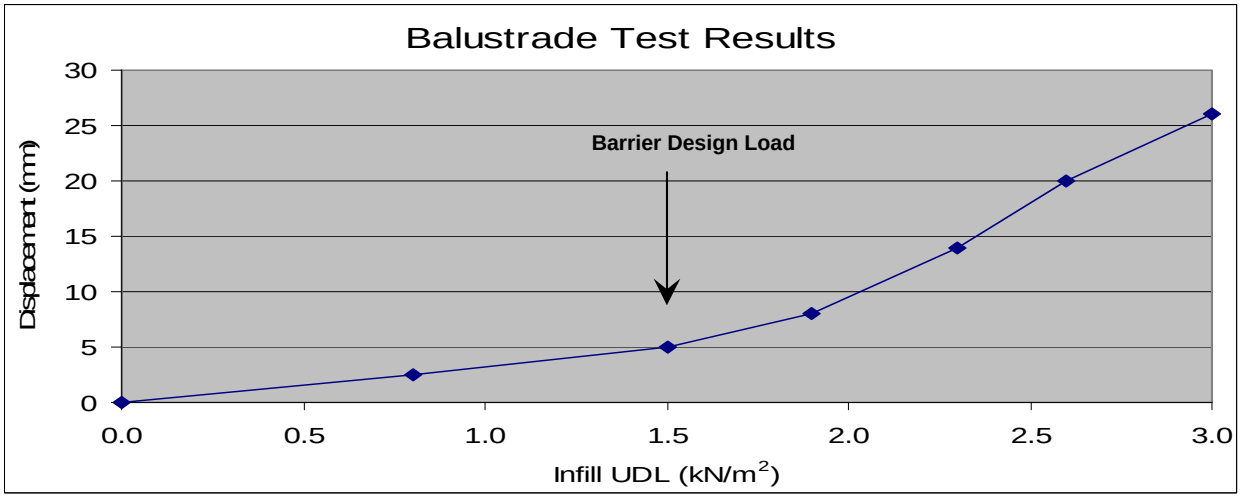
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the rail infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0032** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.420.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S). |
| Infill panel: | 9 No. 12mm diameter stainless steel cross bars. |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load of 2.9 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 6 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

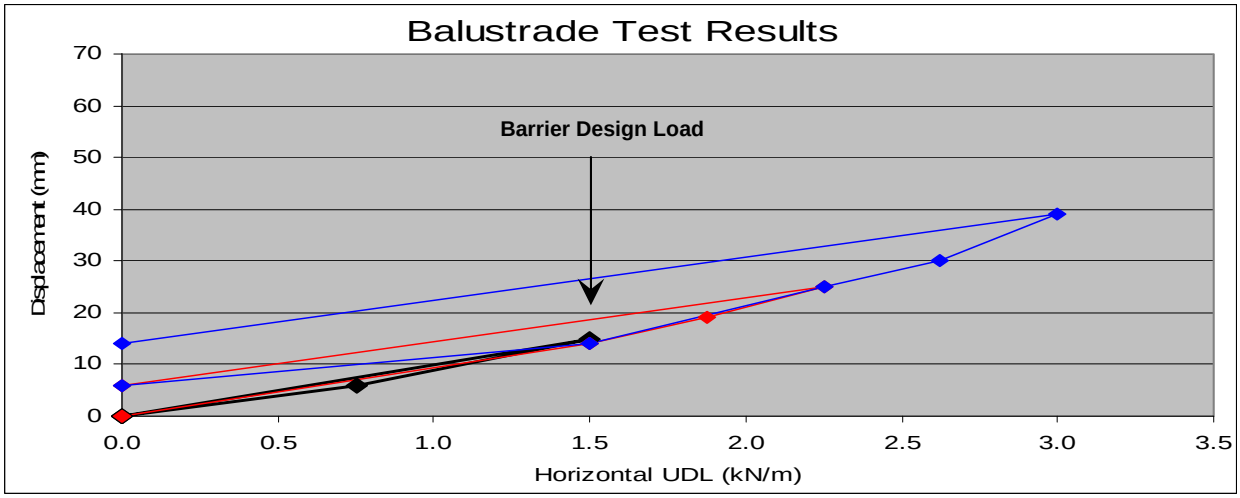
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0033** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S) |
| Infill panel: | 9 No. 12mm diameter stainless steel cross bars. |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 2.2 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# RAIL INFILL UDL
# SYSTEM 6 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

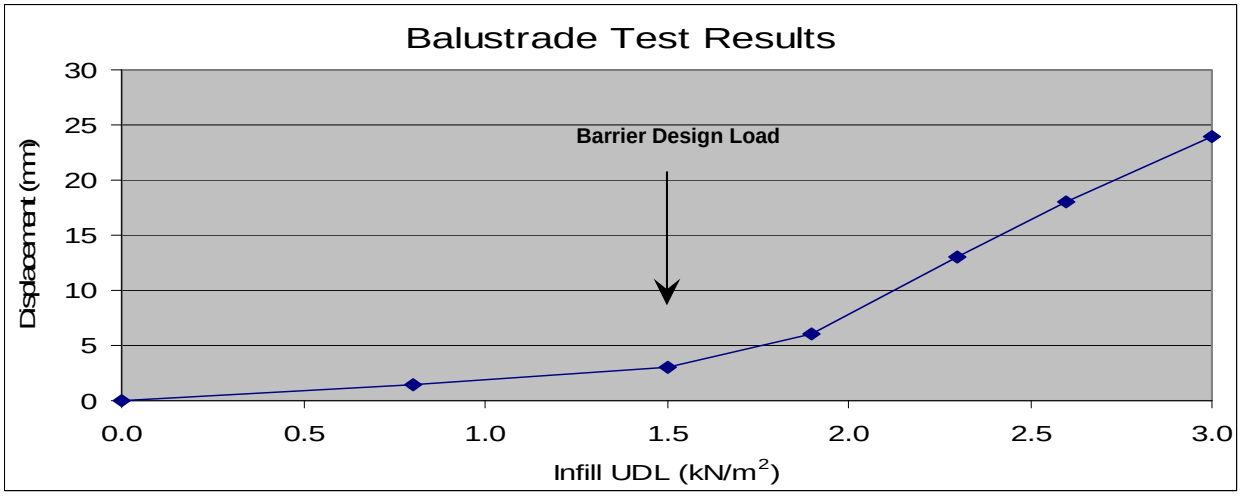
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the rail infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 18th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 22nd December 2010 |
| **CERTIFICATE NO.:** | **TC0034** | **CERTIFICATE DATE:** | 12th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Surface mounted. 3 No. fixing bolts per flange base. (Fastec code: 34.1100.480.R) |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S). |
| Infill panel: | 9 No. 12mm diameter stainless steel cross bars. |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load in excess of the applied load.

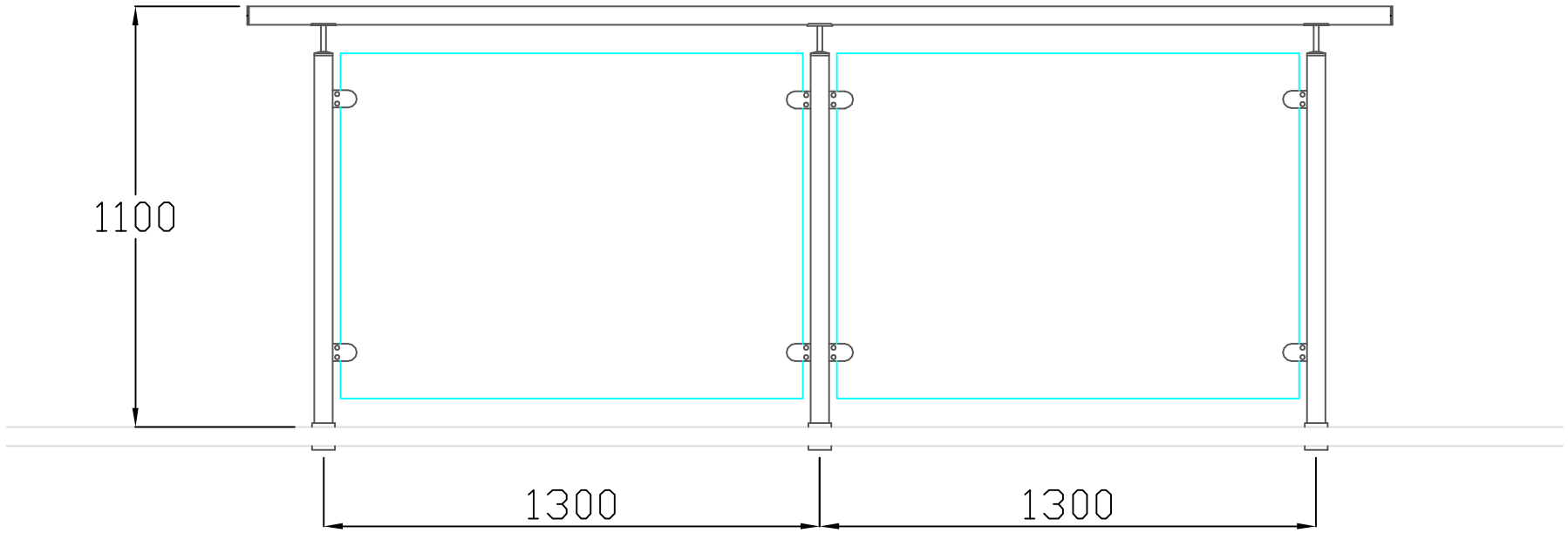
**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

# APPENDIX G

## TEST CERTIFICATES & BALUSTRADE SETUP -

## SYSTEM 7

# Balustrade - Test System 7



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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 7 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

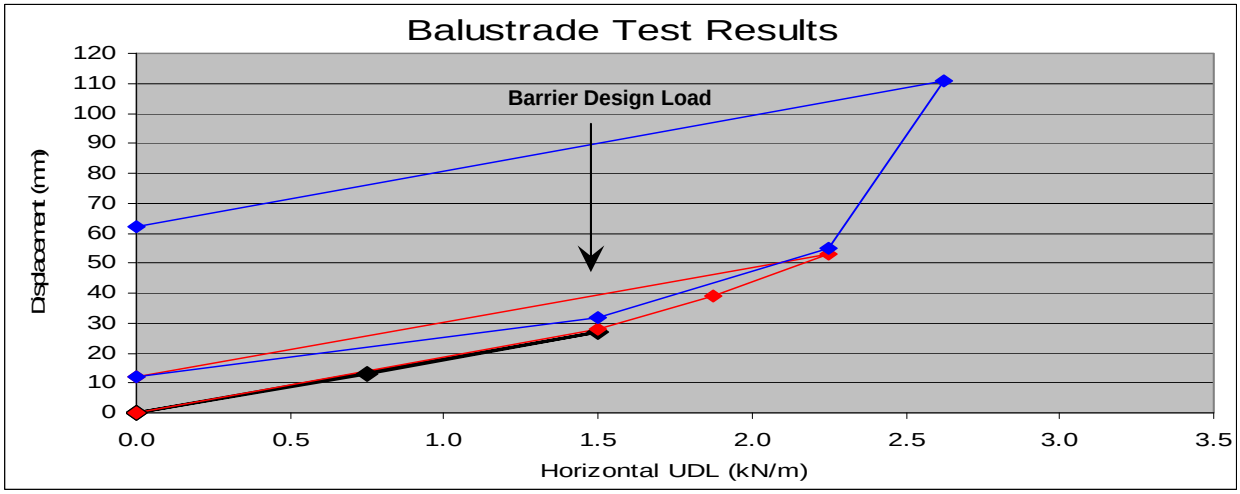
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 7th January 2011 |
| **CERTIFICATE NO.:** | **TC0035** | **CERTIFICATE DATE:** | 17th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Clamp Fix (Fastec codes: 34.1300.420.R; 34.1310.420.S & 34.1320.060.S) |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**

The balustrade barrier when assembled and tested in the manor indicated within this certificate does not conform to BS6180:1999 at the barrier design load of 1.5kN/m.

The balustrade conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of areas C (vi), C1/C2 (vii), C5 (x), C5 (xi), D (xiii), and F/G (xiv).

Deflection beyond the allowable limits occurred at a load of 1.4 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 7 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

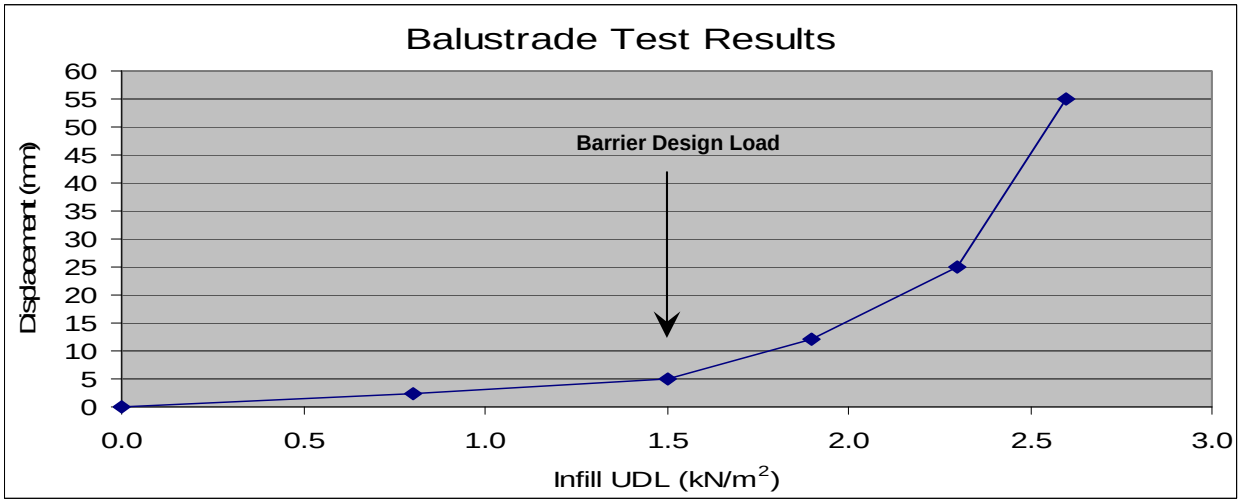
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 7th January 2011 |
| **CERTIFICATE NO.:** | **TC0036** | **CERTIFICATE DATE:** | 17th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Clamp Fix. (Fastec codes: 34.1300.420.R; 34.1310.420.S; & 34.1320.060.S). |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**

The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load of 2.3 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 7 - SURFACE MOUNTED, 42.4mm DIAMETER TUBE

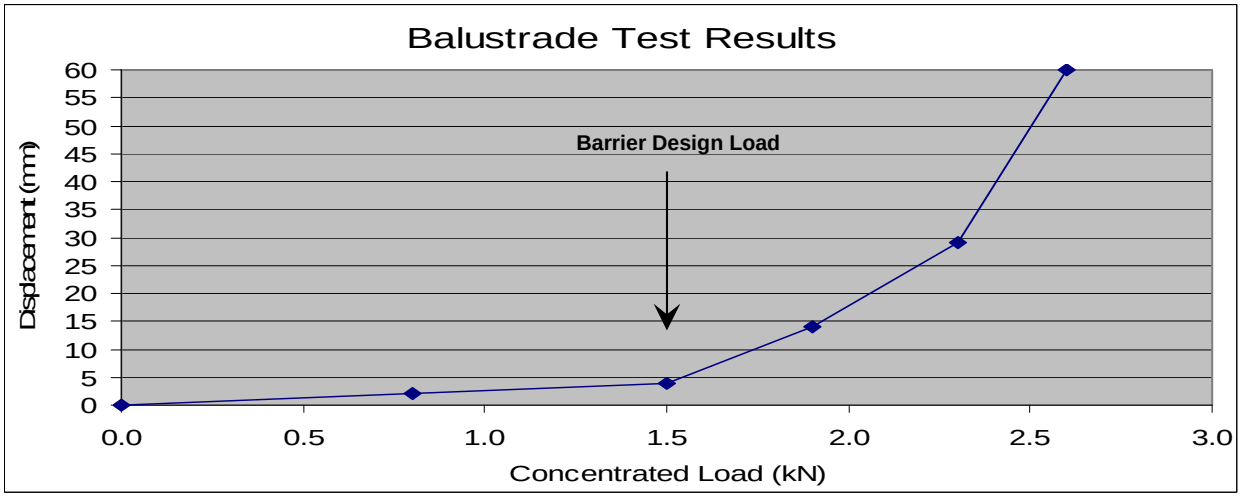
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 17th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 7th January 2011 |
| **CERTIFICATE NO.:** | **TC0037** | **CERTIFICATE DATE:** | 17th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø42.4mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø42.4mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Clamp Fix. (Fastec codes: 34.1300.420.R; 34.1310.420.S; & 34.1320.060.S). |
| Rail connection: | Stem connectors (Fastec code: 34.0110.426.S) |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.420.S) |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load of 2.2 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# HORIZONTAL UDL
# SYSTEM 7 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

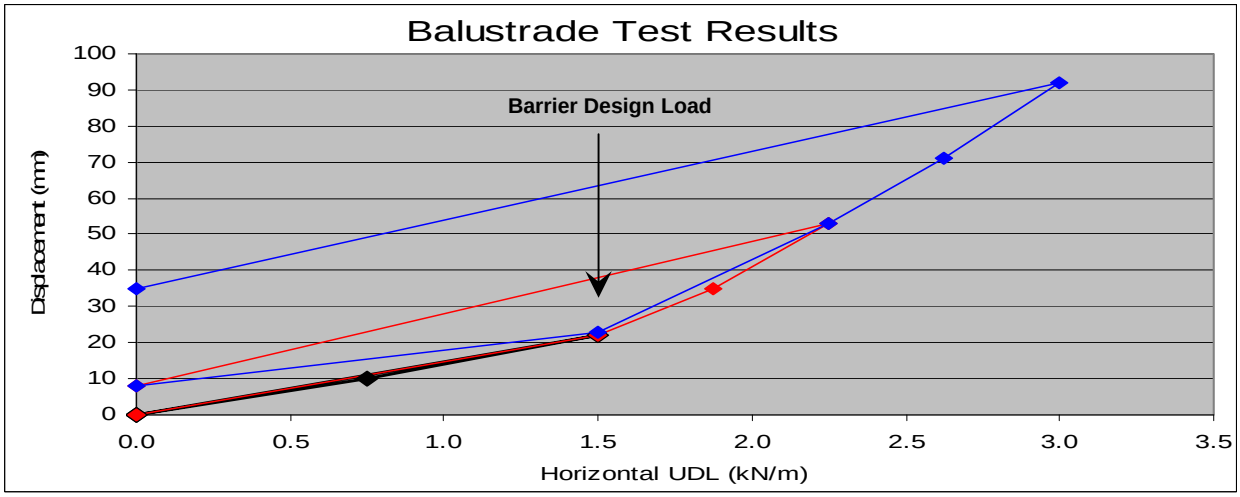
**TEST DESCRIPTION:** A uniformly distributed load applied to the handrail at a height of 1100mm to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 15th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 7th January 2011 |
| **CERTIFICATE NO.:** | **TC0038** | **CERTIFICATE DATE:** | 17th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Clamp Fix (Fastec codes: 34.1300.480.R; 34.1310.480.S & 34.1320.060.S). |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S). |
| Glass clamps: | 'D' clamps (Fastec code: 34.3210.480.S). |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to BS6180:1999 at the barrier design load of 1.5kN/m, with no permanent deflection.

The balustrade also conforms with the requirements detailed in Table 4 of BS 6399: Part 1:1996, with the exception of area C5 (xi).

Deflection beyond the allowable limits occurred at a load of 1.55 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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Specialist Testing Services

# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL UDL
# SYSTEM 7 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

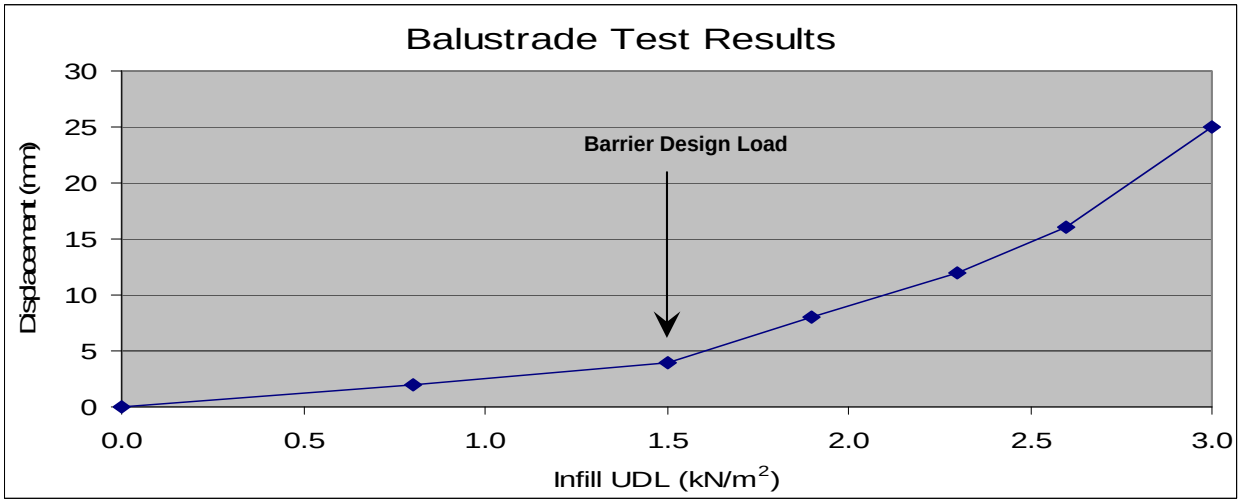
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 15th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 7th January 2011 |
| **CERTIFICATE NO.:** | **TC0039** | **CERTIFICATE DATE:** | 17th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Clamp Fix (Fastec codes: 34.1300.480.R; 34.1310.480.S & 34.1320.060.S). |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S). |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S). |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load of 3.0 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

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# TEST CERTIFICATE

## BALUSTRADE TESTING IN ACCORDANCE WITH BS 6180:1999 & BS 6399: Part 1:1996

On behalf of FASTEC HANDRAIL SYSTEMS

# GLASS INFILL POINT LOAD
# SYSTEM 7 - SURFACE MOUNTED, 48.3mm DIAMETER TUBE

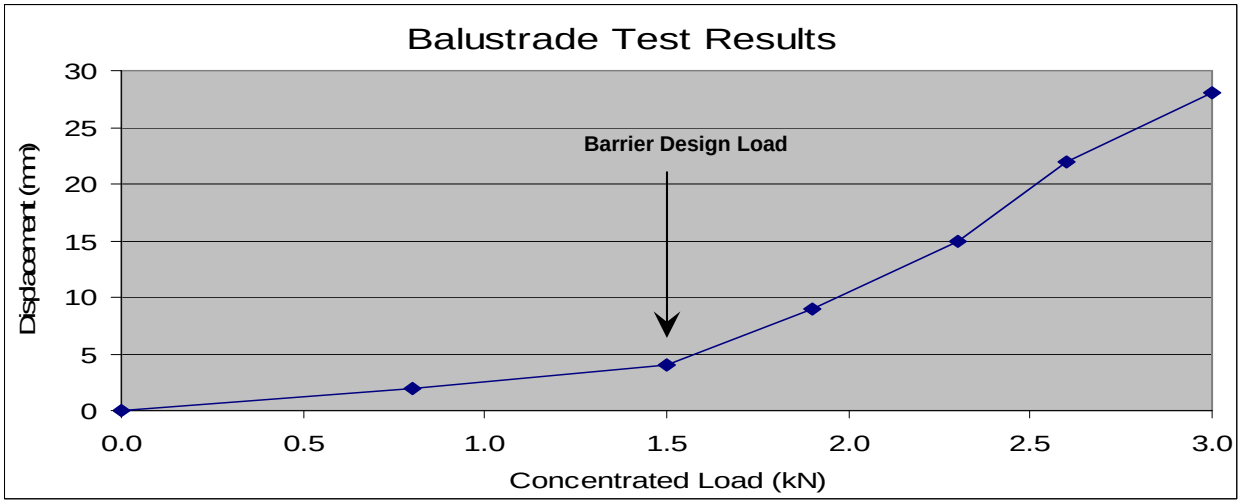
**TEST DESCRIPTION:** A uniformly distributed load applied to the centre of the glass infill, with a barrier height of 1100mm, to determine the deflection of the balustrade when assembled as indicated below.

| | | | |
|---|---|---|---|
| **REF NO.:** | S3650 | **DATE TESTED:** | 15th November 2010 |
| **JOB NO.:** | A6213 | **DATE REPORTED:** | 7th January 2011 |
| **CERTIFICATE NO.:** | **TC0040** | **CERTIFICATE DATE:** | 17th January 2011 |

**TEST DETAILS:**

| | |
|---|---|
| Barrier height: | 1100 mm |
| Baluster centres: | 1300 mm |
| Baluster post material: | Ø48.3mm x 2.6mm, grade 304 stainless steel tube. |
| Handrail material: | Ø48.3mm x 2.0mm, grade 304 stainless steel tube. |
| Mounting details: | Clamp Fix (Fastec codes: 34.1300.480.R; 34.1310.480.S & 34.1320.060.S). |
| Rail connection: | Stem connectors (Fastec code: 34.0111.486.S). |
| Glass clamp details: | 'D' type glass clamps (Fastec code: 34.3210.480.S). |

**TEST RESULTS:**




**ANALYSIS:**
The balustrade barrier when assembled and tested in the manor indicated within this certificate conforms to the requirements detailed in Table 4 of BS6399: Part 1:1996.

Deflection beyond the allowable limits occurred at a load of 2.75 kN.

**NAME:** **Simon Aitken**
**POSITION:** **Test Engineer**

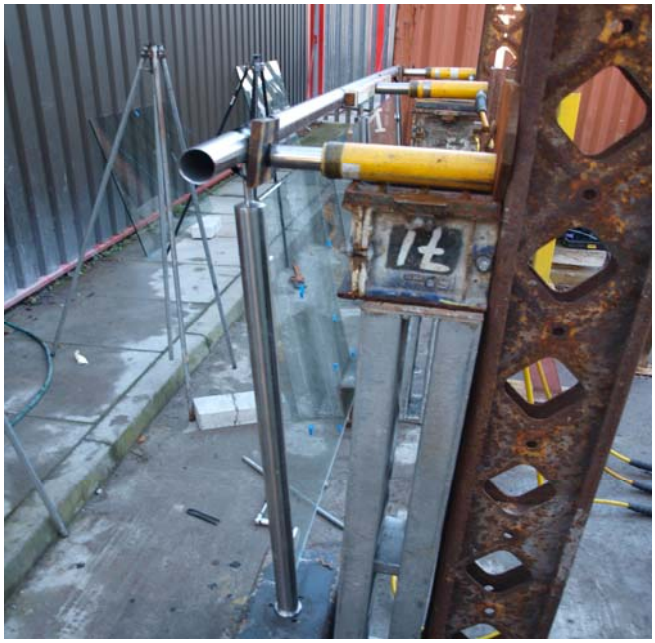
# APPENDIX H

## PHOTOGRAPHIC RECORDS

# PHOTOGRAPHIC RECORDS

## Load testing of Balustrade Systems

## November 2010



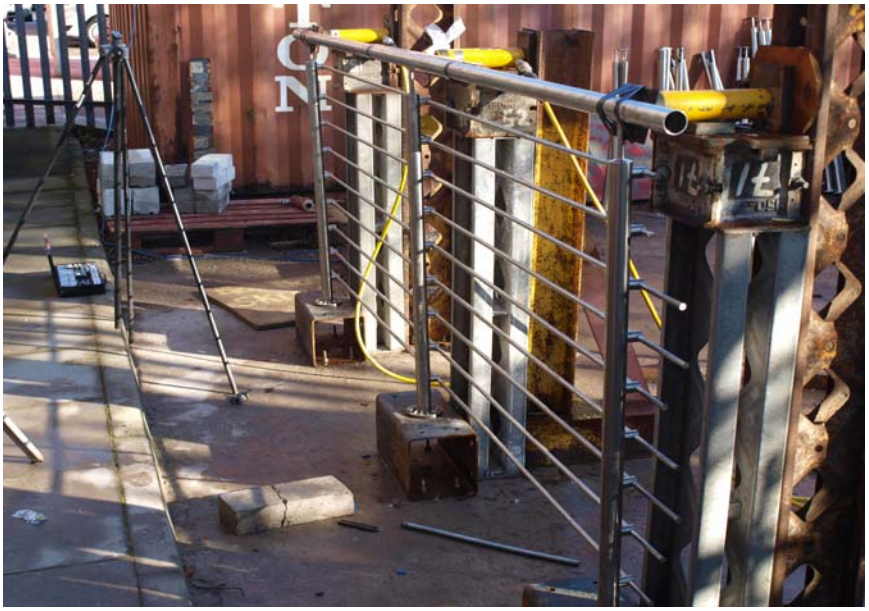
Photograph 1: Load testing of the handrail at a height of 1.1m above fixing point.

Photograph 2: Method of fixing balustrades to test slab.

# PHOTOGRAPHIC RECORDS

## Load testing of Balustrade Systems

## November 2010



Photograph 3: Load testing of balustrade system with metal rod infill panels.

Photograph 4: Load being applied to the handrail of balustrade test system 6.

# PHOTOGRAPHIC RECORDS

## Load testing of Balustrade Systems

## November 2010

Photograph 5: Testing of side mounted balustrade fixing.

Photograph 6: Side mounting detail.

# PHOTOGRAPHIC RECORDS

## Load testing of Balustrade Systems

## November 2010

Photograph 7: Typical test setup prior to loading operations.

Photograph 8: Testing balustrade system beyond acceptable limits.