TECHNICAL REPORT

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Our Ref.: **TCMSF17040**
Date: 27 June 2007
Date delivered: 24 May 2007
Date of tests: 24 – 25 May 2007

For the attention of Mr Kevin Jones

SAMPLE(S) FOR TEST :

One, Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS

TEST REQUIREMENTS :	**RESULT :**
BS 6180: 1999: Barriers in and about buildings – Code of practice - General Contract use – Clauses 6.4.1	PASS

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INTRODUCTION

As part of the BM TRADA Certification Ltd Balustrade Product Conformity Scheme, FIRA was commissioned to undertake structural testing of Richard Burbidge Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGSin accordance with the requirements of the following documents:

BS 6180: 1999: Barriers in and about buildings – Code of practice

BS 6399: Part 1: 1996: Loading for buildings - Code of practice for dead and imposed loads

BS 5268: Part 2: 2002: Structural use of timber – Code of practice for permissible stress design, materials and workmanship

The intention of the testing was to assess whether the products were structurally suitable for use commercial arenas. Their failure mode and critical failure load were to be established in order to assess and improve upon future designs with the outcome that the developed design could be included in the BM TRADA Certification Ltd Balustrade Product Conformity Scheme.

TEST SPECIMEN(S)

Description of Specimen

General

Fusion commercial aluminium system using stainless steel A4 fixings. Horizontal unit set to a height of 1100mm and 2.2m-handrail length, 2 end newels with intermediate newel set at 1004mm centers. Newels fixed using m16 threaded bar running through the newel and screwed to a base plate, and tightened at the top with M16 nyloc nut and washer. Newel base fixed using 4 x M10 bolts.

Material type	Aluminium newels and rails: Alloy 6060-T6 supplied with the material properties of 6063 extrusion. Connectors and brackets: High pressure die casting, aluminium zinc alloy (zamak 3)
System	Fusion commercial exterior balustrade with glass in-fill panels
Description of Test Unit	Fusion commercial aluminium system using stainless steel A4 fixings. Horizontal unit set to a height of 1100mm and 2.2m-handrail length, 2 end newels with intermediate newel set at 1004mm centers
Handrail	Hardwood (Sapele) Round Handrail (Richard Burbidge reference – 06-0179-008-H0406 LD585)
Handrail - Length	2.2 m
Infill – 1	Safety glass in-fill panel (large) 800 mm x 750 mm x 6 mm. (Richard Burbidge reference – 06-2000-070-A0407 P/LD579)
Infill - 2	Safety glass in-fill panel (small) 350 mm x 750 mm x 6 mm. (Richard Burbidge reference – 06-2000-070-A0407 P/LD579)
Infill – 3	6 x Hardwood (Sapele) Baluster 750 mm x 46.2 mm x 21 mm (Richard Burbidge reference – 06-0179-023-H1105 LD581)
Infill – 4	Hardwood slatted panel (Richard Burbidge reference – 06-0179-026-F1105 LD580)
Newel Dimensions	101 mm x 80 mm o/d with aluminium welded base (Richard Burbidge reference – 06-0179-008-LATEST LD575)
Base rail /Top rail	Aluminium extrusion 46 mm o/d x 900 mm long (Richard Burbidge reference – 06-2000-0+0-A0507 LD578)
Base rail - Length	900 mm
Connectors Used	**Top cap** 06-2000-003-B0307 **Base plate fixing** 06-2000-001-A0407 **Top hat** 06-2000-002-A0207 **Newel post cowling** 06-2000-004-A0307 **Newel to rail bracket** 06-2000-005-A0307 **Rail to rail bracket** 06-2000-007-C0407 **In-fill panel bracket** 06-2000-071-A0407 **In-fill panel clamp** 06-2000-062-A0407 **Newel to rail support** 06-2000-030-B0407
Fixings Used	All fixings used are stainless steel A4 Screws: 4.2 x 13, 4.2 x 16, 4.2 x 19, 4.2 x 32 M4 x 10, M6 x 16, M8 x 10 M16 Nyloc nut, M16 washer, M16 threaded bar

TEST PROCEDURE

The landing balustrade is laid horizontally and mounted in a universal test rig with both end newels fully supported by, and clamped too, steel channel sections. Both the end and the central newels are logged between supporting wall bars. A timber strut also supports the central newel. The newels are clamped in order to simulate as closely as possible the fixing method commonly used in practice. In this case the base is clamped.

Balustrade Handrail Stiffness Test

A uniformly distributed load is applied to the handrail using calibrated weights and load bags suspended vertically from the handrail.

It has been found that in general the aforementioned test method causes timber based balustrades to deflect by amounts greater than the 25mm required by the standard. However in such cases the increased deflection does not necessarily present a safety hazard to the user as the balustrade remains intact. In such cases the BM TRADA Certification Ltd Balustrade Product Conformity Scheme states that, where the aforementioned deflection limit is exceeded, the unit will be deemed to have satisfied the requirements of the scheme provided that it is capable of passing the strength of handrail test.

Handrail Strength Test

A uniformly distributed load is applied to the handrail using calibrated weights and load bags suspended vertically from the handrail. The load is maintained for a period of 15 minutes, at the end of which the balustrade is inspected for structural damage.

In- fill strength

A uniformly distributed load is applied to the handrail using calibrated weights and load bags laid on top of a foam sheet, which rests on the in-fills. The load is maintained for a period of 15 minutes, at the end of which the balustrade is inspected for structural damage. Experience has shown that if the in- fill can sustain the load when it is initially applied, then unless there is visual movement or lots of cracking noises at the fixings it not necessary to hold the load for 15 minutes.

Baluster Strength

The point load is applied thought the application of calibrated weights and load bags hung from a hook in the middle of the baluster. Five balusters are subjected to the testing to establish consistency. Experience has shown that if the in- fill can sustain the load when it is initially applied, then unless there is visual movement or lots of cracking noises at the fixings it not necessary to hold the load for 15 minutes. At the end of which the balustrade is inspected for structural damage.

TECHNICAL REPORT

TEST RESULTS

BS 6180: 1999, Clause 6.4.1 Balustrade horizontal deflection test

Item: Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS
Test Level: Light Commercial applications
Initial Inspection: No apparent faults.

Load Table

	Contract Level	DL x BS 5268: Part 2: 2002 Safety Factor
Load per Meter	1.5kN/m	3.36kN/m
UDL Required	305kg	685kg
UDL Achieved	175kg	N/R
UDL to In-fill	1. 5kN/m^2	N/R
UDL^2 Required	123kg	N/R
UDL^2 Achieved Infill –1 Large glass panel	125kg	N/R
UDL^2 Achieved Infill –2 Small glass panel	125kg	N/R
UDL^2 Achieved Infill –4 Slatted hardwood panel	125kg	N/R
PL Balusters Required	1.5 KN	N/R
PL Balusters Achieved	150kg	N/R

Results Table

TEST	TEST REQUIREMENT		RESULT- Commercial Level
Handrail Stiffness	Design Load	Initial Loading	PASS
		Deflection	22mm
Handrail Strength	BS 5268: Part 2: 2002 Safety Factor	Initial Loading	N/R
		After 15 minutes	N/R
In-fill Strength	Design Load	Initial Loading	PASS
Strength of Balusters	Design Load	Initial Loading	PASS

* See COMMENTS

COMMENTS

As the balustrade did not deflect passed 25 mm during the test to contract loading levels the load was not increased to the BS 5268: Part 2: 2002 Safety Factor for contract applications.

On completion of the testing a 5 mm permanent deflection of the balustrade was recorded.

Balustrade testing was carried out on 2.2 m handrail samples with a central newel large glass infill panels as a worst case unit. The test results are considered to cover the 1.2 m handrail variations offered by the customer.

Infill and baluster testing was carried out on 1.2 m handrail sections. Test results are deemed to be valid for 2.2 m handrail variations offered by the customer.

CONCLUSION

When tested the Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS supplied by Richard Burbidge Ltd satisfied the selected combined rules of BS 6180: 1999: Barriers in and about buildings and BS 5268: Part 2: 2002: Structural use of timber – Code of practice for permissible stress design, materials and workmanship.

When tested the Large Glass Infill Panel for the Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS supplied by Richard Burbidge Ltd satisfied the selected combined rules of BS 6180: 1999: Barriers in and about buildings and BS 5268: Part 2: 2002: Structural use of timber – Code of practice for permissible stress design, materials and workmanship.

When tested the Small Glass Infill Panel for the Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS supplied by Richard Burbidge Ltd satisfied the selected combined rules of BS 6180: 1999: Barriers in and about buildings and BS 5268: Part 2: 2002: Structural use of timber – Code of practice for permissible stress design, materials and workmanship.

When tested the Hardwood Balusters for the Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS supplied by Richard Burbidge Ltd satisfied the selected combined rules of BS 6180: 1999: Barriers in and about buildings and BS 5268: Part 2: 2002: Structural use of timber – Code of practice for permissible stress design, materials and workmanship.

When tested the Slatted Hardwood Infill Panel for the Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS supplied by Richard Burbidge Ltd satisfied the selected combined rules of BS 6180: 1999: Barriers in and about buildings and BS 5268: Part 2: 2002: Structural use of timber – Code of practice for permissible stress design, materials and workmanship.

The Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS is therefore considered to be suitable for contract applications.

NOTE(S)

A, B, and C1, C2, C3 are the full range of applications for which the products are suitable as specified by BS 6399: Part 1: 1996. For more information see ANNEX B.

Tested by: D Gardner and P Reynolds

Reported and Approved by: Phil Reynolds
Testing Manager

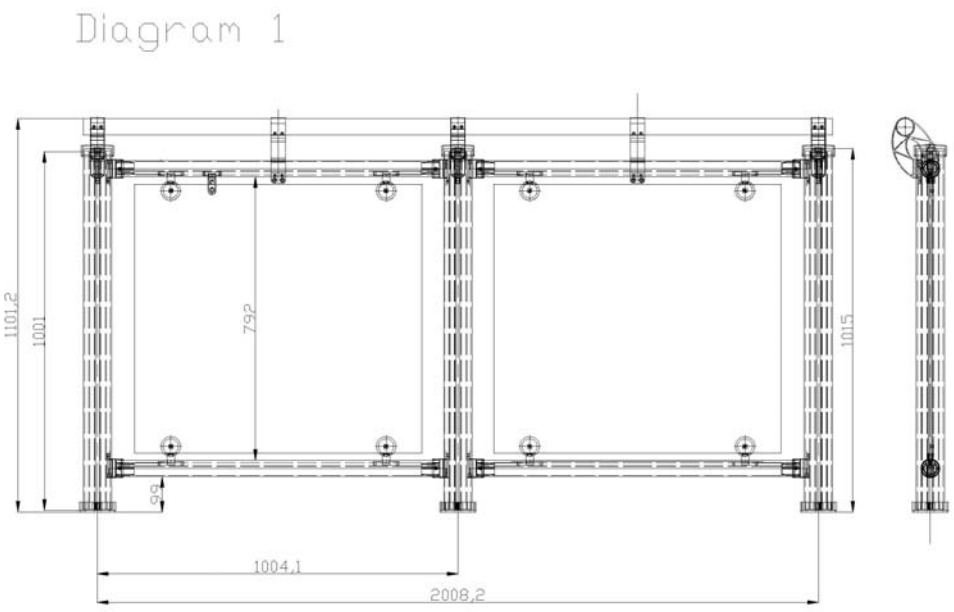

Plate 1: Drawing of Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS with 2.2 metre long handrail and large glass infill Panel

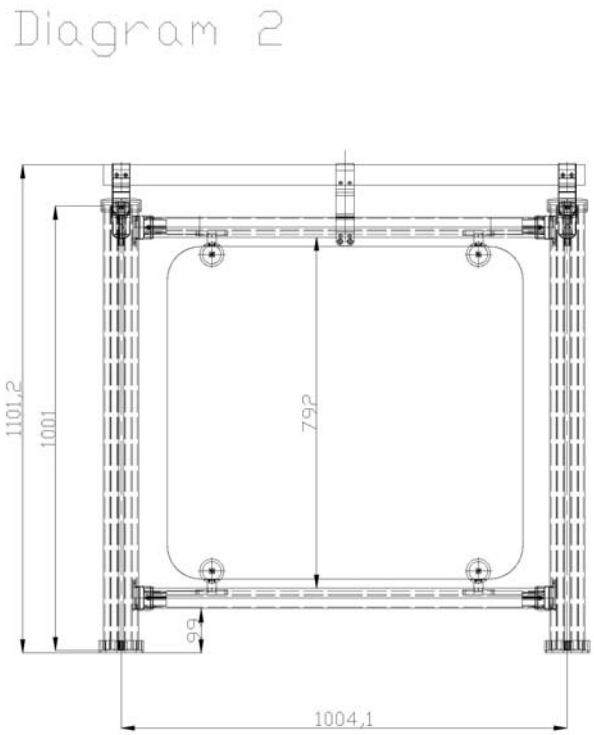

Plate 2: Drawing of Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS with 1.2 metre long handrail and large glass infill panel

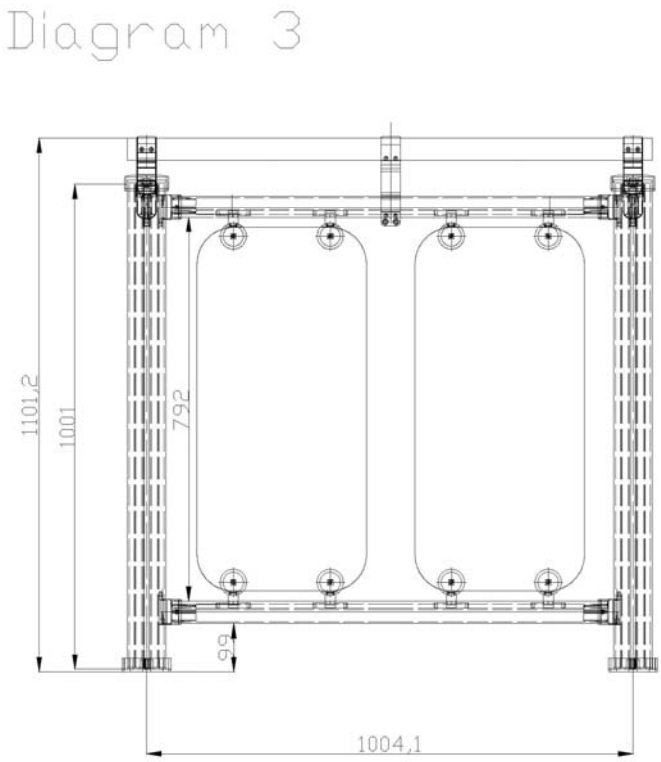

Plate 3: Drawing of Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS with 1.2 metre long handrail and small glass infill panels

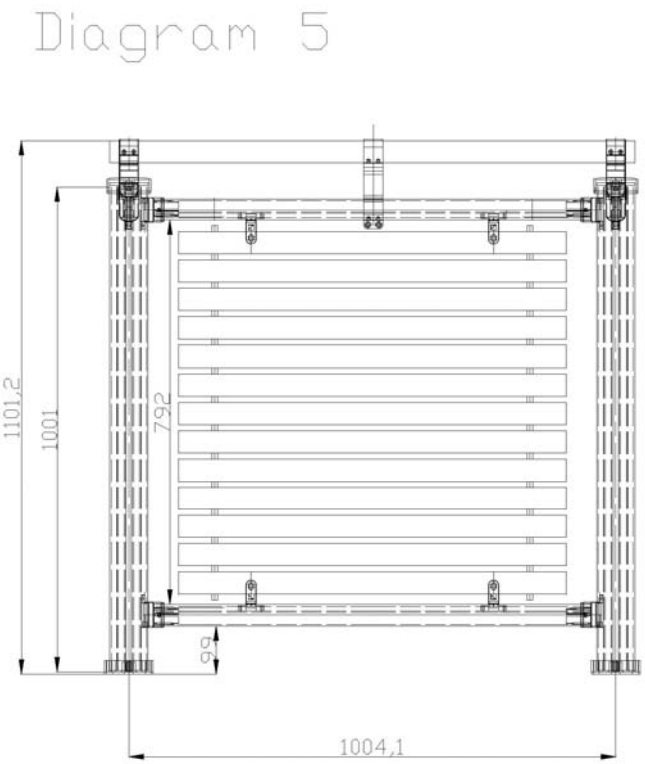

Plate 4: Drawing of Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS with 1.2 metre long handrail and slatted hardwood infill panel

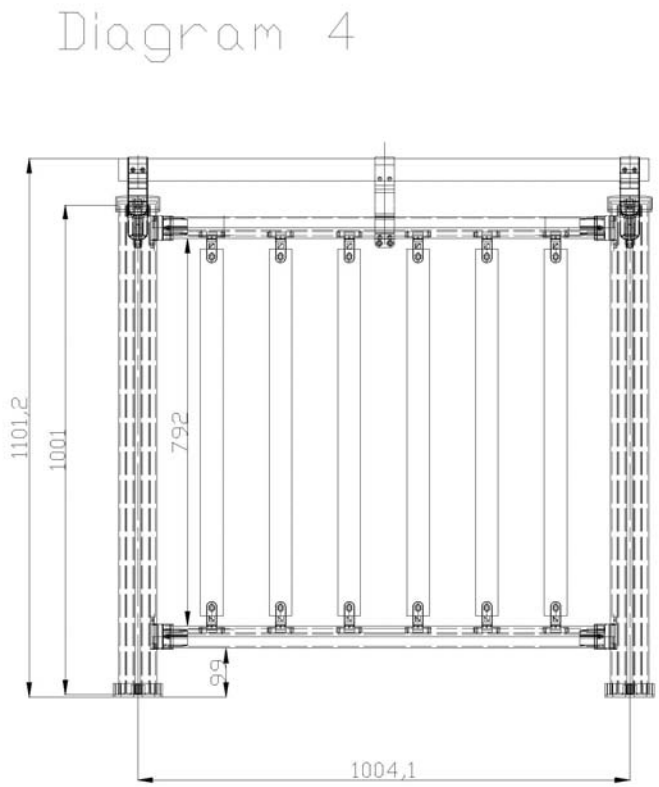

Plate 5: Drawing of Balustrade Handrail Ref: FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS with 1.2 metre long handrail and hardwood balusters

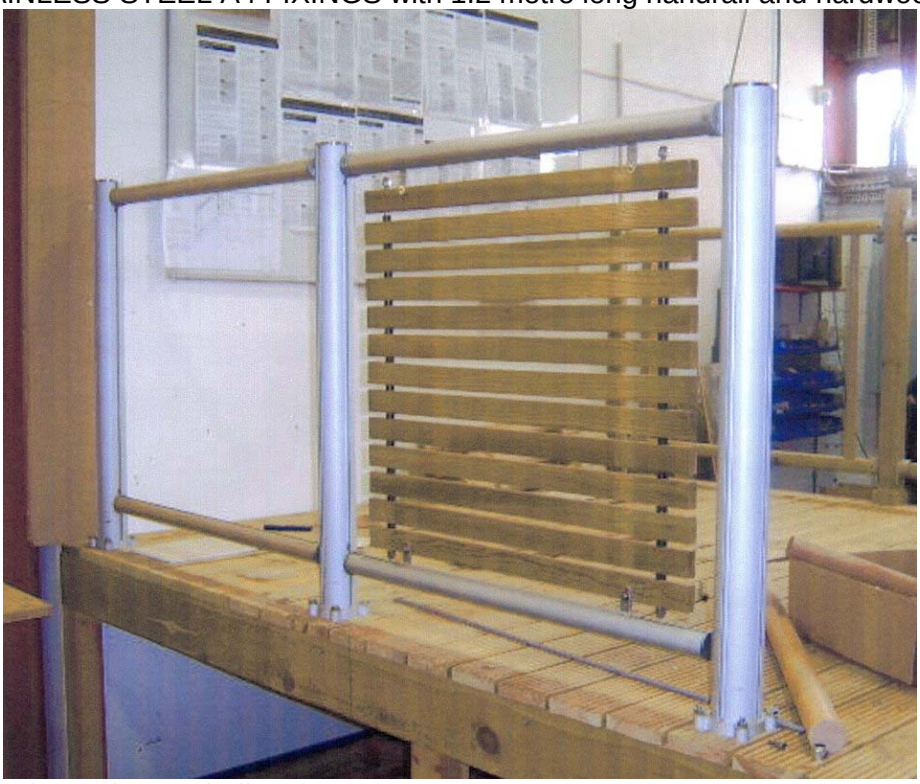

Plate 6: Balustrade Handrail Ref FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS

Plate 7: Balustrade Handrail Ref FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS - on test

Plate 8: Balustrade Handrail Ref FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS with 1.2 – infill test

Plate 9: Balustrade Handrail Ref FUSION COMMERCIAL ALUMINIUM SYSTEM USING STAINLESS STEEL A4 FIXINGS – baluster test

ANNEX A

Test Requirements

Hand rail test

Stiffness test

Initially a stiffness test is to be carried out by applying the test loads for 15 minutes checking that the net deflection of the handrail at mid length between supports is less than 25mm. In accordance with BS 6180, the test loads were taken from BS 6399-1, table 4. These are based on the building-use categories, which are defined in Table 6.2.

The net handrail deflection is defined as:

$d_{h,net}$ = $d_{h,total} – d_{newel} - d_{stringer}$, where

$d_{h,total}$ = Total deflection at mid span of handrail in the direction of the load

d_{newel} = Deflection of the newel in the direction of the load. Deflection is to be measured at the crossing point between centreline of hand rail and centre line of newel.

$d_{stringer}$ = Deflection of mid span of the stringer in the direction of load. Deflection is to be measured at mid span of the stringer. This measurement is not applicable to balustrades with cut stringers (raised bottom rail).

For balustrades with glass components, the maximum deflection is L/65 or 25 mm which ever is the smaller. The definition of L should be sought in sections 8.3, 8.4 or 8.5 in BS 61800, as it is dependent on the actual design.

If the balustrade fails the deflection test, without experiencing permanent damage, it is suggested that a strength test be carried out.

Strength test

BS 6180 “Code of practice for barriers in and about buildings” only refers to a maximum deflection limit under design load. However for timber balustrades this limit has proven difficult to comply with although timber balustrades have been used safely for many years.

TRADA has taken a practical view on this and suggests that the overall defection is of less importance providing the balustrade passes a strength test in accordance with Section 8 of BS 5268-2.

In accordance with this method the balustrade is to be loaded with an ultimate load of design load multiplied with the product of K_{73} and K_{85} of BS 5268-2. The balustrade is to sustain this load for 15minutes without failing (breaking).

As per guidance in BS 6180, the design loads have been taken from Table 4 in
BS 6399-1.

TRADA suggests that loads on stairs can be considered “medium term”, which means that the overall load safety factor (K_{73} x K_{85}) will range from 1.79 (if five identical balustrades are tested) and 2.24 (if only one balustrade is tested).

The Q-mark scheme was set up when an earlier version of BS 5268-2 was governing. At that time the safety ranged between 2 (for five tests) and 2.5 (for one test). These are equivalent to the overall load safety factor (K_{73} x K_{85}) for “long term” loads on the current version of BS 5268-2. For consistency these factors are still used for the Q-mark tests.

It is suggested that initially the “medium term” loads (given as “5268” loads in table 6.1 is applied for 15 minutes. If the rail passes, additional load to fulfil the Q-mark regulations is applied and the whole load is held for another 15 minutes.

If the balustrade fails to withstand the 15 minutes with “Q-mark” loading, but passes the “5268” load the client will not be able to have the balustrade Q-mark certified, but can receive a test report claiming compliance with combined rules of BS 6180 and 5268-2.

Spindle / infill tests

Individual spindles

BS 6180 does not give a deflection limit for spindles, which means that a strength test is required unless calculations can prove that the spindles can withstand the design load given in BS 6399-1, Table 4. Clause 6.3.1 in BS 6180 allows the design load to be halved when the infill "consist of successive balusters".

As these tests are relatively "quick and easy" to do, it is suggested that a minimum of 5 balusters are tested, giving a safety factor of 1.79 for "5268" loads and 2.00 for Q-mark loads. The test loads to be applied are given in table 6.2 in Annex B. It should however be noted that the Q-mark scheme requires all spindles to be tested.

ANNEX B

Table 6.2 Use of buildings or part buildings

Taken from BS 6399: Part 1: 1996: Loading for buildings - Code of practice for dead and imposed loads.

Building-Use category	Type of occupancy for part of the building or structure	Descriptive title
A	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 (see C3 ix)
		(ii) Other residential, (but also see C)
B and E	Offices and work areas not included elsewhere including storage areas	(iii) Light access stairs and gangways not more than 600 mm wide (not applicable to stair rails)
		(iv) Light pedestrian traffic routes in industrial and storage buildings except designated escape routes
		(v) Areas not susceptible to overcrowding in office and industrial buildings also industrial and storage buildings except as given above
C	Areas where people may congregate	
C1/C2	Areas with tables or fixed seating	(vi) Areas having fixed seating within 530 mm of the barrier, balustrade or parapet
		(vii) Restaurants and bars
C3	Areas without obstacles for moving people and not susceptible to overcrowding	(viii) Stairs, landings, corridors, ramps
		(ix) External balconies and edges of roofs. Footways and pavements within building curtilage adjacent to basement/sunken areas
C5	Areas susceptible to overcrowding	(x) Footways or pavements less than 3 m wide adjacent to sunken areas
		(xi) Theatres, cinemas, discotheques, bars, auditoria, shopping malls, assembly areas, studio. Footways or pavements greater than 3 m wide adjacent to sunken areas
		(xii) Grandstands and stadia
D	Retail areas	(xiii) All retail areas including public areas of banks/building societies or betting shops. For areas where overcrowding may occur, see C5
F/G	Vehicular	(xiv) Pedestrian areas in car parks including stairs, landings, ramps, edges or internal floors, footways, edges of roofs
		(xv) Horizontal loads imposed by vehicles