TECHNICAL REPORT

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RICHARD BURBIDGE LIMITED	Our Ref:	**TRELF40538**
Whittington Road	Date:	12 October 2011
Oswestry	Delivery Date:	10 October 2011
Shropshire	Test Dates:	10 October 2011
SY11 1HZ		

For the attention of Graham Hayward

SAMPLE(S) FOR TEST:

One, Metal Balusters 2.4m Horizontal Balustrade, American White Oak

TEST REQUIREMENTS:	**RESULT:**
BS 6180:2011: Barriers in and about buildings – Code of practice - Domestic applications – Clause 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 Metal Balusters 2.4m Horizontal Balustrade, American White Oak in accordance with the requirements of the following documents:

BS 6180:2011: Barriers in and about buildings – Code of practice

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

BS 5268-2:2002: 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 domestic applications. 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.

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TEST SPECIMEN(S)

Description of Specimen: Metal Balusters, domestic horizontal system set at a height of 900mm and a 2400mm handrail measured between centres of 90mm newels. Balustrade tested to 0.36kN per m/run.

Timber Species	American White Oak (Quercus alba)
System	Metal Balusters, domestic landing balustrade, American White Oak (Quercus alba) system.
Handrail 01-1002-004-0611 HRL2400WO	American White Oak (Quercus alba) Handrail 55mm x 65mm o/d
Handrail Length	2400mm, twist bracket fixed into the newels
Spindle 01-1002-006-0511 MB02L	Metal balusters – 855mm x 14mm
Newel Base Dimensions 01-0000-974-G1109 WONB510	American White Oak (Quercus alba) 510mm x 90mm x 90mm
Newel Turning 01-0000-970-F0709 CWOFNT160	American White Oak (Quercus alba) 725mm x 90mm x 90mm
Base Rail 01-1002-003-0611 BRL2400WO	American White Oak (Quercus alba) 2400mm x 88mm x 28mm
Base Rail Length	2400mm length fixed to the string
String Dimensions	Pine (Pinus sylvetris) string 2400mm x 200mm x 38mm
Fixings Used	4.2mm x 50mm, flat head, csk (A4) Stainless steel screw. Twist bracket (A2) Stainless steel. Tapered screw (A2) Stainless steel. 4.2mm x 19mm, flat head, csk (A2) Stainless steel screws. No-nails multi purpose adhesive

Product descriptions produced by FIRA International Ltd give basic Construction, Material and Dimensional information and are not intended to represent a complete product specification. Overall product dimensions will be recorded accurately. Where variations in material thickness occur, dimensions will be taken as standard thickness.

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TEST PROCEDURE

The landing balustrade is laid horizontally and mounted in a universal test rig with both end newels fully supported by and clamped to Aluminium channel sections.

Balustrade Handrail Stiffness Test

A uniformly distributed load is applied to the handrail using hydraulic rams and a calibrated compression load cell.

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 hydraulic rams and a calibrated compression load cell. 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-fill. 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.

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TEST RESULTS

BS 6180:2011, Clause 6.4.1 Balustrade horizontal deflection test

Item: Metal Balusters 2.4m Horizontal Balustrade, American White Oak

Test Level: Domestic Applications

Initial Inspection: No apparent faults

Load Table

	Domestic Level	**Design Load x BS 5268-2:2002 Safety Factor**
Load per Meter	0.36 kN/m	0.81 kN/m
UDL Required	864N	Not required
UDL Achieved	216N per cylinder	Not required
UDL to In-fill	0.5 kN/m^2	Not required
UDL^2 Required		
UDL^2 Achieved		
PL Balusters Required	0.25kN	Not required
PL Balusters Achieved	250N	Not required

Results Table

	Test Requirements		**Result – Domestic level**
Handrail stiffness	Design load	Initial loading	27mm
		Deflection	Pass - 9mm
Handrail strength	BS 5268-2:2002	Initial loading	Not required
		After 15 mins	Not required
In-fill strength	Design load	Initial loading	Not required
Strength of Balusters		Initial loading	Pass - 25kg

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CONCLUSION

When tested the Metal Balusters 2.4m Horizontal Balustrade, American White Oak supplied by Richard Burbidge Ltd satisfied the selected combined rules of BS 6180:2011: Barriers in and about buildings and BS 5268:-2:2002: Structural use of timber – Code of practice for permissible stress design, materials and workmanship.

The Metal Balusters 2.4m Horizontal Balustrade, American White Oak is therefore considered to be suitable for domestic applications when used in spans of 2400mm or less between the centres of newel posts.

NOTE(S) A is the full range of applications for which the products are suitable as specified by BS 6399-1:1996. For more information see ANNEX B.

Tested by: Paul Greenbank

Reported by: Paul Greenbank

Approved by: P Greenbank

P Greenbank

Technical Specialist – Related Testing

Plate 1: Metal Balusters 2.4m Horizontal Balustrade, American White Oak before Test

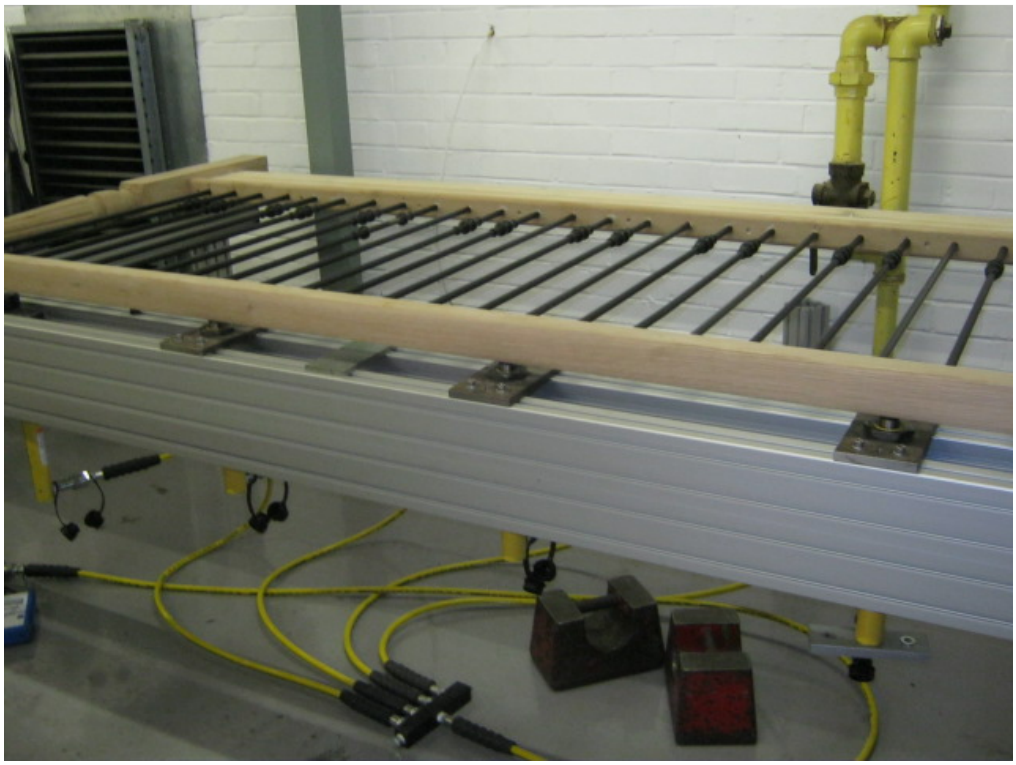

Plate 2: Metal Balusters 2.4m Horizontal Balustrade, American White Oak on Test

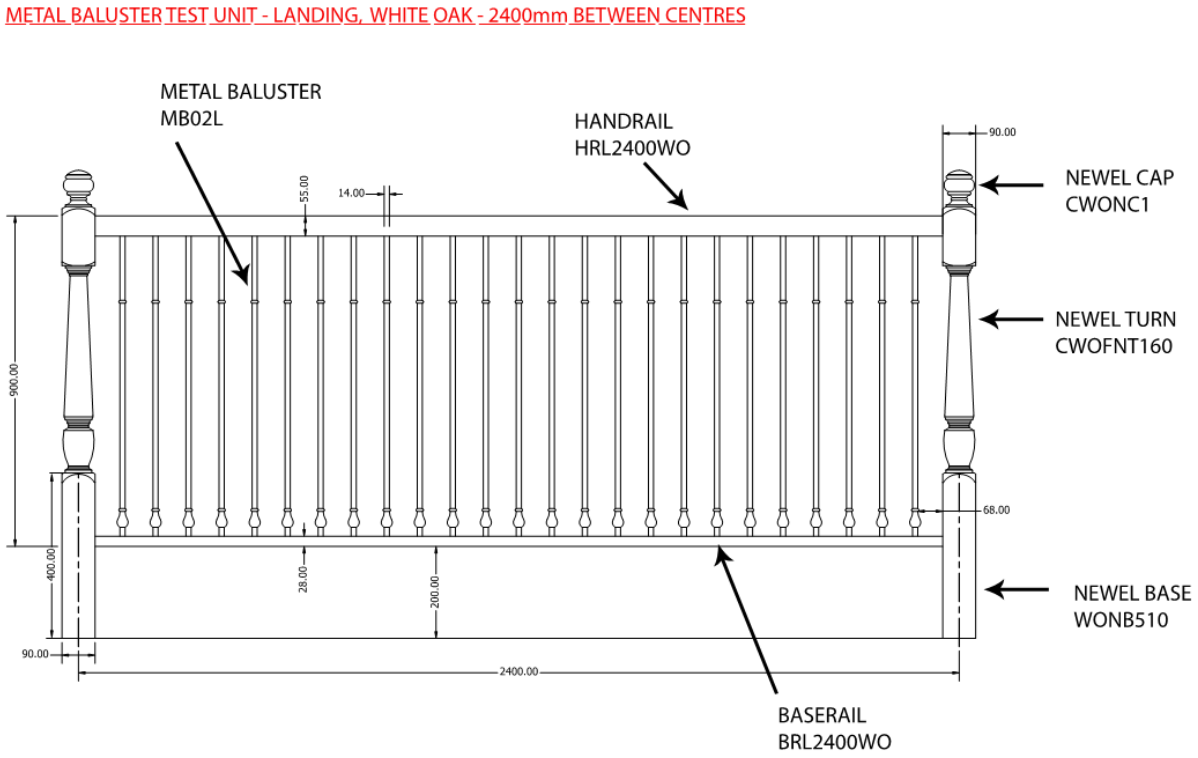

Plate 3: Drawing of Metal Balusters 2.4m Horizontal Balustrade, American White Oak

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 whichever is the smaller. The definition of L should be sought in sections 8.3, 8.4 or 8.5 in BS 6180, 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 6399-1:2011: 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