

TECHNICAL REPORT



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Our Ref: **TRELF40539**
Date: 12 October 2011
Delivery Date: 10 October 2011
Test Dates: 11 October 2011

For the attention of Graham Hayward

SAMPLE(S) FOR TEST:

One, Metal Balusters 3.6m Rake Balustrade, American White Oak

TEST REQUIREMENTS:

BS 6180:2011: Barriers in and about buildings – Code of practice
- Light Commercial applications – Clause 6.4.1

RESULT:

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 3.6m Rake 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 use in light commercial 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 rake system set at a height of 900mm and a 3600mm handrail measured between centres of 90mm newels. Balustrade tested to 0.36kN per m/run and then taken to 0.74kN.

| | |
|--|---|
| Timber Species | American White Oak (Quercus alba) |
| System | Metal Balusters, domestic rake balustrade, American White Oak (Quercus alba) system. |
| Handrail 01-1002-004-0611 HRR3600WO | American White Oak (Quercus alba) Handrail 55mm x 65mm o/d |
| Handrail Length | 3600mm, twist bracket fixed into the newels |
| Spindle 01-1002-006-0511 MB02L | Metal balusters – 805mm 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 CWOFT160 | American White Oak (Quercus alba) 725mm x 90mm x 90mm |
| Base Rail 01-1002-003-0611 BRR3600WO | American White Oak (Quercus alba) 3600mm x 88mm x 28mm |
| Base Rail Length | 3600mm length fixed to the string |
| String Dimensions | Pine (Pinus sylvestris) string 3600mm 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 rake 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 through 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 3.6m rake Balustrade, American White Oak

Test Level: Domestic Applications

Initial Inspection: No apparent faults

Load Table

| | Domestic Level | DL x BS 5268-2:2002 Safety Factor |
|---------------------------|-----------------------|-----------------------------------|
| Load per Meter | 0.36 kN/m | 0.81 kN/m |
| UDL Required | 1296N | Not required |
| UDL Achieved | 324N 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 | 30mm |
| | | Deflection | Fail - 56mm |
| 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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TEST RESULTS

BS 6180:2011, Clause 6.4.1 Balustrade horizontal deflection test

Item: Metal Balusters 3.6m rake Balustrade, American White Oak

Test Level: Light Commercial Applications

Initial Inspection: No apparent faults

Load Table

| | Light Commercial Level | DL x BS 5268-2:2002 Safety Factor |
|---------------------------|------------------------|-----------------------------------|
| Load per Meter | 0.74 kN/m | 1.66 kN/m |
| UDL Required | 2670N | 6000N |
| UDL Achieved | 668N per cylinder | 1500N per cylinder |
| UDL to In-fill | 1.0 kN/m ² | Not required |
| UDL ² Required | | |
| UDL ² Achieved | | |
| PL Balusters Required | 0.5kN | Not required |
| PL Balusters Achieved | 500N | Not required |

Results Table

| | Test Requirements | | Result – Domestic level |
|-----------------------|-------------------|-----------------|-------------------------|
| Handrail stiffness | Design load | Initial loading | 31mm |
| | | Deflection | Fail - 64mm |
| Handrail strength | BS 5268-2:2002 | Initial loading | 31mm |
| | | After 15 mins | Pass - 129mm |
| In-fill strength | Design load | Initial loading | Not required |
| Strength of Balusters | | Initial loading | Pass - 50kg |

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CONCLUSION

When tested the Metal Balusters 3.6m Rake 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 3.6m Rake Balustrade, American White Oak is therefore considered to be suitable for light commercial applications when used in spans of 3600mm or less between the centres of newel posts.

NOTE(S) A, B, C3 & E are 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

Technical Specialist – Related Testing

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Plate 1: Metal Balusters 3.6m Rake Balustrade, American White Oak before Test



Plate 2: Metal Balusters 3.6m Rake Balustrade, American White Oak on Test

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METAL BALUSTER TEST UNIT - RAKE, WHITE OAK - 3600mm BETWEEN CENTRES

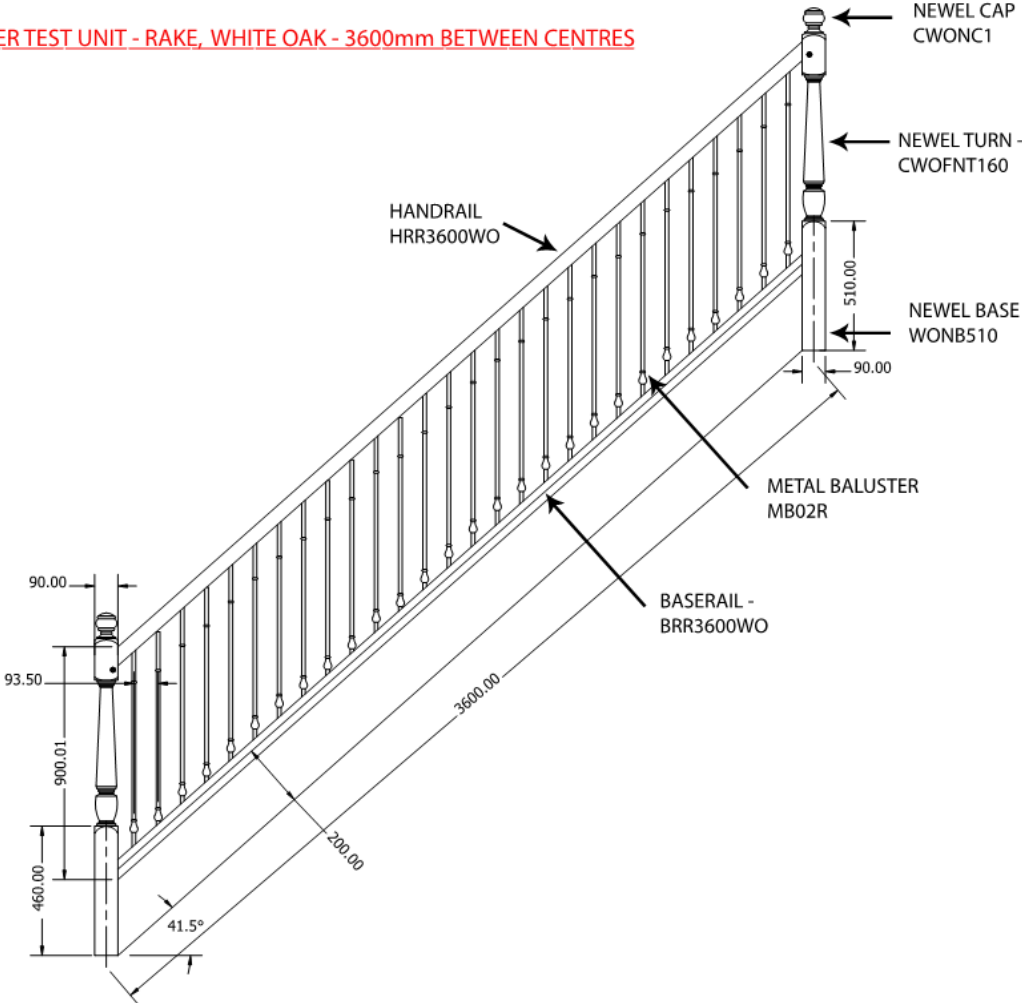


Plate 3: Drawing of Metal Balusters 3.6m Rake Balustrade, American White Oak

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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:

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

$d_{h,total}$ = 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 deflection 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 15 minutes 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 ($K_{73} \times K_{85}$) will range from 1.79 (if five identical balustrades are tested) and 2.24 (if only one balustrade is tested).

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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 ($K_{73} \times K_{85}$) 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.

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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 |