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# TESTING OF SAMPLE STAIR AND LANDING RAIL ASSEMBLIES IN ACCORDANCE WITH THE PRINCIPLES OF BS 585: PART 2: 1985 AND BS 6180: 1995

Commercial in Confidence

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|---|---|---|
| **Report Number** | : | TMT/F95024 |
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| **Prepared By** | : | Product Testing Section |

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## 1. INTRODUCTION

As part of the TRADA Certification Ltd (TCL) Balustrade Product Conformity Scheme, TRADA Technology Ltd (TTL) was commissioned to undertake testing of a series of Richard Burbidge Ltd pre-assembled stair and landing rail units in accordance with the requirements of the following documents:

- BS 585: Part 2: 1985 "Wood Stairs - specification for performance requirements for domestic stairs constructed of wood based materials".
- BS 6180: 1995 "Barriers in and about buildings".
- Balustrade Product Conformity Scheme for timber and wood based sheet materials, Performance Requirements, reference 22/19, issue July 1995.

Specimen delivery, installation and testing was carried out during the period May to September 1995.

## 2. OBJECTIVES

### 2.2 Specimens for public use

2.2.1 Baluster point load test, BS 6180, clause 6.3.4, to be carried out on each baluster for landing and stair rail units.

2.2.2 Horizontal deflection test, BS 6180, clause 6.4.1, to be carried out on landing and stair rail units.

## 3. TEST SPECIMENS

A full specification for each unit tested is given in the relevant Appendices attached to the rear of this report. The following table shows the range of units which were tested.

**Table 2 Public Use**

| Specimen No | System ID | Material | Unit Type | Handrail Type | Spindle Section (mm) | Nom. Span (m) | Comments |
|---|---|---|---|---|---|---|---|
| 13 | STR | Oak | Landing | OHR | 41 | 2.4 | - |
| 15 | STR | Oak | Stair | OHR | 41 | 4.2 | Horizontal deflection re test |

## 4. TEST PROCEDURE

### 4.1 Specimens for domestic use

4.1.1 Baluster point load test

The complete assemblies were laid horizontally approximately 1m from the ground, supported at the newel posts.

A calibrated load bag with a hook attachment was suspended from the centre point of each baluster in turn. The applied load which each baluster was required to sustain was 25.5kg. The derivation of this load is given in Appendix I.

4.1.2 Landing rail horizontal deflection test

The landing rail was supported as for item 4.1.1. A simulated uniformly distributed load was applied to the handrail by calibrated load bags suspended from hooks at equal spacings along its length. The midspan deflection of the handrail was measured using a displacement transducer and digital display unit.

The specified design load of 0.36kN/m, to be applied to the handrail, was taken from Tables A1 and A2 of BS 6180. Under this load the recorded midspan deflection should not exceed 25mm as stated in clause 6.4.1 of BS 6180.

The performance requirements of the Product Conformity Scheme state that, where the deflection limit given above is exceeded, the unit will be deemed to have satisfied the requirements of the scheme provided that it is capable of supporting 2.5 times the design load given above, for a period of 15 minutes.

4.1.3 Balustrade static load test

The stair rail was mounted on a scaffolding rig with newel posts vertical. The upper newel was secured both top and bottom, while the lower newel was secured at the bottom only. The stringer was fixed at five positions along its length to scaffold bracing in order to simulate the stiffening effect of the stairs. A point load was applied horizontally to the handrail using calibrated load bags via a wire rope and pulley. The deflection of the assembly was measured using displacement transducers positioned at handrail midspan, stringer midspan and at the top of the lower newel post.

The design load to be applied as a point load to the handrail was 0.27kN/m x handrail length (m). Under this load the nett midspan deflection of the handrail should not exceed 25mm.

The performance requirements of the Product Conformity Scheme state that, where the deflection limit given above is exceeded, the unit will be deemed to have satisfied the requirements of the scheme provided that it is capable of supporting 2.5 times the design load given above, for a period of 15 minutes.

4.1.4 Balustrade impact load test

The stair rail remained mounted in the test rig as for item 4.1.3. A calibrated 30kg load bag, suspended from a point 2100mm above the midspan of the handrail, was raised 300mm above and aimed "uphill" at an angle of 45° to the rail. The bag was released and allowed to swing freely against the stair rail. This was repeated three times and the assembly was checked for damage after each impact.

## 4.2 Specimens for public use

4.2.1 Baluster point load test

The complete assemblies were supported and tested as described in item 4.1.1.

The applied load which each baluster was required to sustain without damage was 50kg and the derivation of this load is given in Appendix I.

4.2.2 Horizontal deflection test - landing rails

The landing rail was supported and tested as described in item 4.1.2.

The specified design load of 0.74kN/m was taken from Tables A1 and A2 of BS 6180. The deflection of the handrail under this load should not exceed 25mm.

4.2.3 Horizontal deflection test - stair rails

The stair rail was laid horizontally and mounted in a universal test rig with both newels fully supported on steel channel sections. The upper newel was clamped to the supporting steelwork at the top and bottom while the lower newel was clamped at the bottom only. The newels were clamped in this manner in order to simulate as closely as possible the fixing to be used in practice. A pair of 100mm x 100mm softwood members was fixed to the stringer along its length in order to simulate the stiffening effect of the stairs.

A simulated uniformly distributed load was applied to the handrail using hydraulic cylinders and a series of hardwood load spreaders. The applied load was measured using a slave cylinder and calibrated dynamometer. The deflection of the assembly was measured at the handrail and stringer midpoints using displacement transducers and a digital display unit.

The design load and deflection limit was as given for item 4.2.2.

Where the handrail deflection exceeded the 25mm limit, the strength test given in the performance requirements of the Product Conformity Scheme was followed, as outlined in item 4.1.3.

## 5. RESULTS

Full test results for each specimen, together with any comments, observations and photographs, are presented in Appendices II to XVI at the rear of this report. The following tables provide a summary of the performance of each specimen against the requirements of the individual tests conducted, together with an overall pass/fail in respect of BS 585, BS 6180 and the performance requirements of the Product Conformity Scheme, where appropriate.

**Table 4 Results summary - specimens for public use**

| Specimen No | BS 6180 cl. 6.3.4 | BS 6180 cl. 6.4.1 | Overall |
|---|---|---|---|
| 13 | pass | pass | pass |
| 15 | pass | pass | pass |

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8 November 1995
Date

# APPENDIX I

# DERIVATION OF MINIMUM PERMISSIBLE FAILURE LOAD

APPENDIX I

## DERIVATION OF MINIMUM PERMISSIBLE FAILURE LOAD

General

BS 5268: Part 2: 1991, the structural timber design code, states under Section 8, clause 57 that "load testing is ..... an equally acceptable alternative to calculation and in certain cases can be a more positive method of establishing the adequacy of a particular design". Furthermore, where a component or assembly is tested, the design should be regarded as satisfactory if the ultimate load recorded is 2.5 times design load or, in the case of 5 or more identical items, if the lowest ultimate load recorded is at least 2.0 times design load (clause 6.2.3 and Table 91).

Landing and stair rail balusters

BS 6180 clause 6.3.4 states that "..... each baluster should be designed to resist half the concentrated load given in annex A, applied at mid-height". The half load of $\frac{0.25}{2}$kN = 0.125kN for domestic use and $\frac{0.50}{2}$kN = 0.25kN for public use, is the design load. The minimum permissible failure load for more than five identical balusters would therefore be design load times factor of safety or 0.125 x 2 = 0.25kN for domestic use and 0.25 x 2.0 = 0.50kN for public use.

Landing and stair rail assembly

For landing and stair rail assemblies, the factor of safety to be applied to the design load to give the minimum permissible failure load would be 2.5 where one specimen is tested and 2.3 where two identical specimens are tested.

# APPENDIX XIV

## SPECIMEN NUMBER 13

SPECIFICATION

| | |
|---|---|
| Species | Oak |
| System | Straight |
| Handrail section (mm) | 70 (w) x 55 (d) |
| Handrail length between newels (mm) | 2300 |
| Baluster section (mm) | 41 x 41 |
| Bluster length between handrail and stringer (mm) | 1023 |
| Baluster turning length (mm) | 464 |
| Newel cross section (mm) | 90 x 90 |
| Stringer cross section (mm) | NA |
| Handrail to newel joint | Glued and single doweled stopped mortice and tenon. Tenon dimensions 18mm x 30mm softwood loose tenon. |

RESULTS

Baluster point load test

All balusters withstood the applied load without damage.

Landing rail horizontal deflection test

The midspan deflection of the handrail after 15 minutes at full design load was 20.0mm.

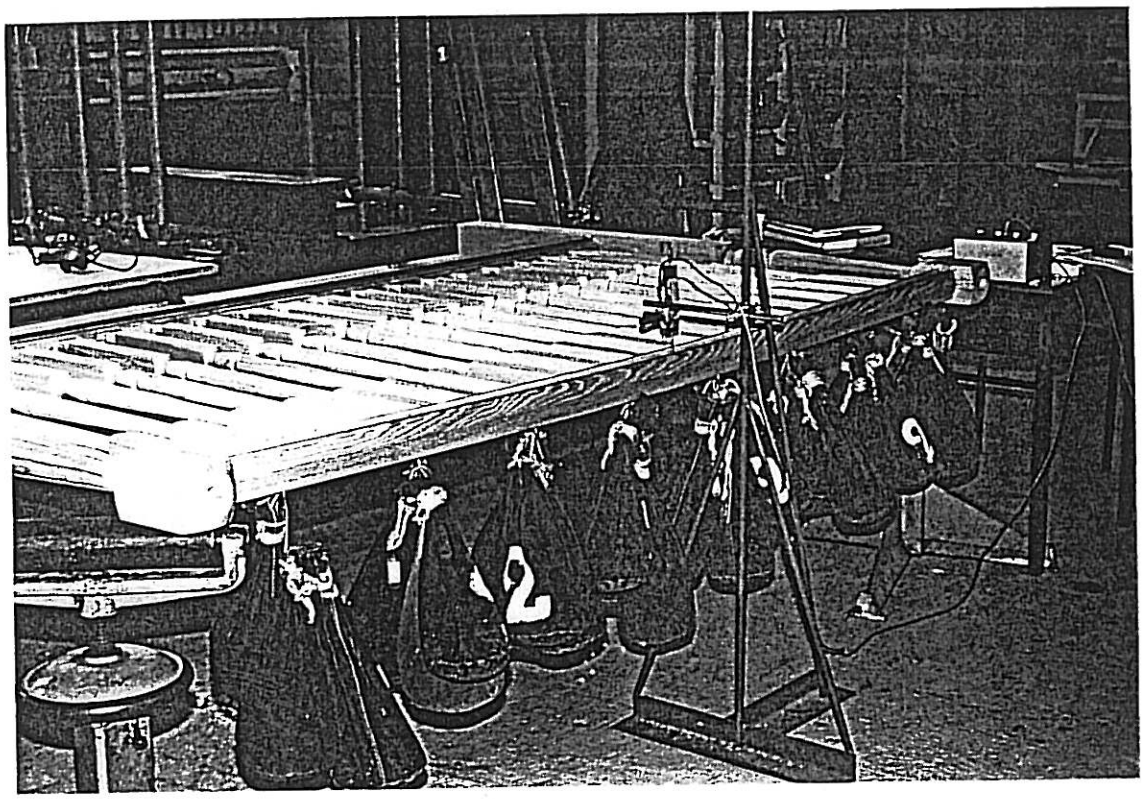

**Figure XIV.1 Landing rail horizontal deflection test**

# APPENDIX XVI

## SPECIMEN NUMBER 15

### SPECIFICATION

| | |
|---|---|
| Species | Oak |
| System | Straight |
| Handrail section (mm) | 70 (w) x 50 (d) |
| Handrail length between newels (mm) | 4130 |
| Baluster section (mm) | 41 x 41 |
| Bluster length between handrail and stringer (mm) | 768 |
| Baluster turning length (mm) | 464 |
| Newel cross section (mm) | 90 x 90 |
| Stringer cross section (mm) | 28 x 218 |
| Handrail to newel joint | Glued and single doweled stopped mortice and tenon. Tenon dimensions 35mm x 50mm. |

### RESULTS

Baluster point load test

All balusters withstood the applied load without damage.

Stair rail horizontal deflection test

Deflection and strength test results are presented below:

| Applied load kN | Deflection (mm) Handrail | Deflection (mm) Stringer | Nett handrail deflection (mm) | Permissible deflection (mm) |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | |
| 1.0 | 10.9 | 0 | 10.9 | |
| 2.0 | 33.4 | 0.2 | 33.2 | |
| Design 3.06 | 57.1 | 0.5 | 56.6 | |
| Design +15mins | 59.0 | 0.6 | 58.4 | 25.0 |
| 4.0 | ok | - | | |
| 5.0 | ok | - | | |
| 6.0 | ok | - | | |
| 7.0 | ok | - | The unit sustained 7.65kN total load (2.5 x design load) for a period of 15 minutes without damage. | |
| 2.5 x design +15mins | ok | - | | |
| | ok | - | | |

Total design load = 0.74kN/m x 4.13m = 3.06kN

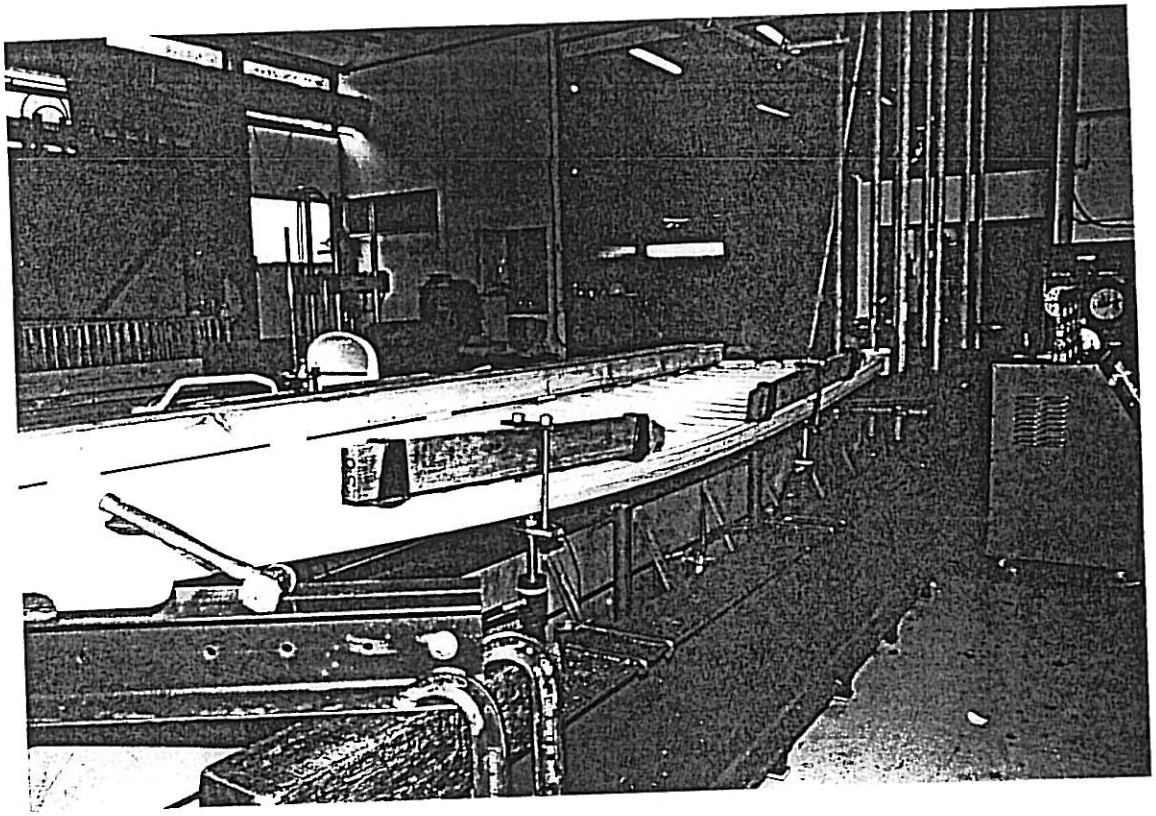

**Figure XVI.1 Stair rail horizontal deflection test**