Architectural Testing

STRUCTURAL PERFORMANCE TEST REPORT

Rendered to:

DIGGER SPECIALITIES, INC.

For:

8 ft by 42 in Westbury Style C10 Level Aluminum Guardrail Assembly

Report No: **79968.02-119-19**
Report Date: **04/04/08**
Revision 1: **04/10/08**

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Report No.:	79968.02-119-19
Test Date:	03/31/08
Report Date:	04/04/08
Revision 1:	04/10/08

Product: 8 ft by 42 in Level Aluminum *Westbury* Style C10 Guardrail Assembly with Balusters

Project Summary: Architectural Testing, Inc. was contracted by Digger Specialties, Inc. to conduct structural performance tests on 8 ft by 42 in level aluminum *Westbury* Style C10 guardrails. The systems were evaluated for the design load requirements of the following building codes:

IBC 2006 - *International Building Code*®

IRC 2006 - *International Residential Code*®

Structural tests were performed according to Chapter 17, *Structural Tests and Special Inspections* of IBC 2006.

All tests performed were to evaluate structural performance of the guardrail assemblies to carry and transfer imposed loads to the supporting structure. The test specimens evaluated included the balusters, rails and support brackets. The posts used in guardrail testing were for bracket anchorage only and were not within the scope of testing reported herein. Prior in-fill testing reported herein was originally reported in Architectural Testing, Inc. Test Report No. 79968.01-119-19.

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Test Specimen Description: The test specimen components were supplied by Digger Specialties, Inc. and assembled by Architectural Testing, Inc. according to the manufacturer's Installation Instructions. Refer to Appendix A for the instructions.

Top Rail: 1.39 in high by 1.75 in wide by 0.085 / 0.010 in wall by 83.5 in long 6005-T6 aluminum extrusion with internal longitudinal ribs

Bottom Rail: 1.25 in high by 1.74 in wide by 83.5 in long 6005-T6 aluminum extrusion with internal longitudinal ribs

Rail Insert: 1.0 in high by 0.5 in wide by 0.50 in thick by full rail length ridged PVC

Baluster: 0.75 in square by 0.05 in wall by 39.5 in long 6063-T52 aluminum extrusion

Baluster Attachment: Balusters inserted into 0.81 in square routed holes, 4.62 in on centers in top and bottom rails

Rail Saddle Brackets: 1.3 in high by 2.0 in wide by 1.2 in long A360 aluminum die casting

Rail Attachment to Brackets:

Top Rails were inserted into brackets and attached with two #8 x 3/4 in square pan-head stainless steel Tek screws

Bottom Rails were inserted into brackets with no mechanical fasteners

Bracket Attachment to Post: Two #8 x 3/4 in square pan-head stainless steel Tek screws, through bracket into post wall

Post: 2 in square by 0.12 in wall extruded aluminum

Bracket Covers: Snap-on decorative A 360 aluminum die castings

***Note**: See drawings in Appendix A and photographs in Appendix B for additional details.*

Test Equipment: The guardrail assemblies were tested in a self-contained structural frame designed to accommodate anchorage of the guardrail assembly and application of the required test loads. The test specimen was loaded using an electric winch mounted to a rigid steel test frame. High strength steel cables, nylon straps and load distribution beams were used to impose test loads on the specimen. Applied load was measured using an electronic load cell located in-line with the loading system. Electronic linear displacement transducers were used to measure deflections.

Set-Up: The guardrail assemblies were each installed and tested as a single railing section by directly securing the posts into vertical rigid steel stanchions. Transducers mounted to an independent reference frame were located to record movement of reference points on the guardrail system components (ends and mid-point) to determine net component deflections. See photographs in Appendix B for individual test setups.

Test Procedure: The test specimens were inspected prior to testing to verify size and general condition of the materials, assembly and installation. No potentially compromising defects were observed prior to testing. Each test specimen was preloaded up to a level not exceeding design load. After pre-loading, all load was released and any necessary fixture adjustments were made. An initial load, not exceeding 20% of design load, was applied and transducer(s) zeroed. Load was then applied at a steady uniform rate until reaching design load. The load was released. After allowing a minimum period of one minute for stabilization, load was reapplied to the initial load level used at the start of the load / deflection procedure and then increased at a steady uniform rate until reaching 2.5 times design load or until failure occurred. The applied load, deflections and time were continually recorded during the test.

Test Results: The following tests were performed on the guardrail assemblies for the design load requirements of the codes referenced. Deflection and permanent set were component deflections relative to their end-points. They were not overall system displacements. All loads and displacement measurements were horizontal.

8 ft by 42 in Level Guardrail with 3/4 in Square Balusters
Posts Rigidly Restrained in Stanchions

Test No. 1 - 01/23/08 **Design Load: 50 lb / 1 Square Ft of In-Fill at Center**						
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Displacement (in)**			
			End	**Mid**	**End**	**Net [1]**
Initial Load	20	00:00	0.00	0.00	0.00	0.00
2.0x Design Load	101-106	0:22 - 0:50	0.02	0.43	0.03	0.41
Initial Load	24	3:53	0.00	0.02	0.00	0.02
2.5x Design Load	125 - 131	4:27 - 5:03	95% Recovery			

[1.] *Net displacement was the baluster displacement relative to the top and bottom rails*

Test Results (Continued)

8 ft by 42 in Level Guardrail with 3/4 in Square Balusters
Posts Rigidly Restrained in Stanchions
(Continued)

Test No. 2 - 01/23/08 **Design Load: 50 lb / 1 Square Ft of In-Fill at Bottom**						
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Displacement (in)**			
			End	**Mid**	**End**	**Net [1]**
Initial Load	22	00:00	0.00	0.00	0.00	0.00
2.0x Design Load	100 - 102	0:14 - 0:16	0.28	0.61	0.33	0.31
Initial Load	22	4:34	0.01	0.01	0.00	0.00
2.5x Design Load	125 - 128	5:38 - 5:53	99% Recovery			

[1] *Net displacement was the baluster displacement relative to the top and bottom rails*

Test No. 3 - 02/04/08 **Design Load: 50 plf x 8 ft = 400 lb Horizontal Uniform Load on Top Rail [1]**						
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Rail Displacement (in)**			
			End	**Mid**	**End**	**Net [2]**
Initial Load	21	00:00	0.00	0.00	0.00	0.00
1.0 x Design Load	400	1:02 - 1:03	0.22	1.68	0.18	1.48
Initial Load	19 - 21	1:38 - 2:55	0.03	0.07	0.02	0.05
1.25 x Design Load	500 - 508	3:24 - 3:27	0.30	2.18	0.25	1.90
2.0 x Design Load	806	13:58	-	-	-	-
2.5 x Design Load	1,003 - 1,059	14:31 - 17:48	-	-	-	-
Zero Load	0	-	0.00	0.89	0.00	0.89

[1] *Uniform Load was simulated with 4 equal load points at L/8, L/4, L/4, L/4 & L/8 spacing*
[2] *Net displacement was mid-rail displacement relative to the rail at the support posts*

Summary: In Test No. 3, top rail deflections were not captured at 2.0 times design load nor at 2.5 times design load. As a worse case evaluation, deflection recovery from 2.5 times design load was calculated as follows. Net deflection (Δ_N) from initial load (20 lb) to 500 lb load can be linearly extrapolated to 1,000 lb as follows:

$$\Delta_N = 0.05 \text{ in} + ((1000 \text{ lb} - 20 \text{ lb}) / (500 \text{ lb} - 20 \text{ lb}) \times (1.90 \text{ in} - 0.05 \text{ in})) = 3.83 \text{ in.}$$

This is a conservative approach as actual deflection would have been greater which would result in a higher recovery percentage. Residual net deflection at zero load after loading to 1,059 lb (2.65 times design load) was measured as 0.89 in. Deflection recovery (Δ_R) would be as follows:

$$\Delta_R = (3.83 - 0.89) / 3.83 = 77\%$$

Deflection recovery from 800 lb (2.0 times design load) would not have been less than 77%.

Conclusions: Using the performance criteria of withstanding 2.5 times design load and 75% deflection recovery from 2.0 times design load, the 8 ft by 42 in railing assemblies reported herein met the structural performance requirements of the referenced building codes as installed between adequate supports. The posts used in guardrail testing were for bracket anchorage only and were not a tested component. In-fill testing was originally reported in Architectural Testing, Inc. Report No. 79968.01-119-19.

Closing: Detailed drawings, data sheets, representative samples of test specimens, a copy of this test report, and all other supporting evidence will be retained by Architectural Testing, Inc. for a period of four years from the original test date. At the end of this retention period, said materials shall be discarded without notice, and the service life of this report by Architectural Testing, Inc. shall expire. Results obtained are tested values and were secured using the designated test methods. This report neither constitutes certification of this product nor expresses an opinion or endorsement by this laboratory; it is the exclusive property of the client so named herein and relates only to the tested specimens. This report may not be reproduced, except in full, without the written approval of Architectural Testing, Inc.

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