CENTER FOR ADVANCED MINERAL, METALLURGICAL AND MATERIALS PROCESSING

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ASCE Testing of 6in and 4in Rails

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PREPARED FOR:

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The Center for Advanced Mineral, Metallurgical and Materials Processing (CAMP) was contracted by Western Spindle to characterize two sets of rails. All testing was performed within the CAMP Wood Structures Lab, located on the Montana Tech campus in Butte, Montana. The two rails were referred to as the 6in and 4in hand rail and are identified in Table 1.

Table 1: Test Material Identification

Sample Identity	Sample Attributes
6in Rail	12ft, 6in top rail, 7 ¾" x 7 ¾" post
4in Rail	12ft, 4in top rail, 5 ¼" x 5 ¼" post

The two rails were tested in accordance to ASCE Standard for "Minimum Design Loads for Buildings and Other Structures" section 4.5.1 *Loads on Handrail and Guardrail Systems*. The standard outlined three tests, a 50lb/ft. distributed load, a 50lb on a 12in x 12in max section on the spindles, and a 200lb single pt. at worst case, the tests where done in the order mentioned. The rail was considered to pass if no catastrophic failure occurred during the loading/unloading, damage to the structure or the hardware that was not catastrophic was deemed acceptable.

The rails were mounted in a horizontal position so the team could use gravity to simulate the distributed load. The other two test pulled the rail in the opposite direction of gravity, the fixture used and set-up is depicted in Figure 1.

Figure 1: Set-up & fixture for rail testing

50lb/ft. Distributed Load

The distributed load was simulated by using 12 - 50lb sand bags, with two bags being added at a time and 10-15 seconds for the structure to settle and data collected before the next sand bags where added. The sand bags were first added at the center of the rail, and then placed further from center as the number of bags increased. The displacement at both ends of the rail as well as the center were measured using LVDT's, the two ends were averaged to be reported. The max displacement of the LVDT's were 5in, therefore any deflection reporting 5.00 means the actual deflection was 5.00in or greater. Due to the means for calibration, the low end accuracy is poor and is reflected by the values being greater than zero at no load. Table 2 and 3 depict the deflection from the load at the mid and full span for the 6in and 4in rail respectively.

Table 2: Deflection of the 6in rail - 50lb/ft. distributed load

Load (lb.)	Mid Span Deflection (in)	Avg. Full Span Deflection (in)
0	0.18	0.19
100	0.34	0.19
200	0.86	0.24
300	1.50	0.44
400	2.19	0.86
500	3.30	1.78
600	>5.00	3.56

Table 3: Deflection of the 4in rail - 50lb/ft. distributed load

Load (lb.)	Mid Span Deflection (in)	Avg. Full Span Deflection (in)
0	0.18	0.19
100	0.84	0.28
200	1.74	0.52
300	3.09	1.24
400	>5.00	2.93
500	>5.00	4.72
600	>5.00	>5.00

Figure 2 & 3 are the 6in and 4in respectively at the full load during the distributed load test. Both rails had hardware deformation and cracking in the posts. Due to the lack of catastrophic failure the rails were deemed to have passed.

Figure 2: 6in rail at full load of 600lbs during the distributed load test

Figure 3: 4in rail at full load of 600lbs during the distributed load test

50 lbs. on a 12in x 12in Section of the Spindles

A 12” x 12” plywood plate was placed under a section of spindles, which covered three spindles for both the 6in and 4in rails, and a 50lb proof load was applied in the upward direction. Both rails passed with no cracking or major distortion of spindles or hardware. The test was continued to record the load required to break the spindles. The 6in rail spindles did not failure due to fear of failing the whole rail prior to the 200lb worst case proof load test and was stopped at 900lbs. Table 4 summarizes the spindle tests while Figure 4 shows the test set-up.

Table 4: 12” x 12” spindle failure loads

Rail	# of spindles	Spindle Max Load (lb.)
6in	3	900*
4in	3	328

*Not a Failure

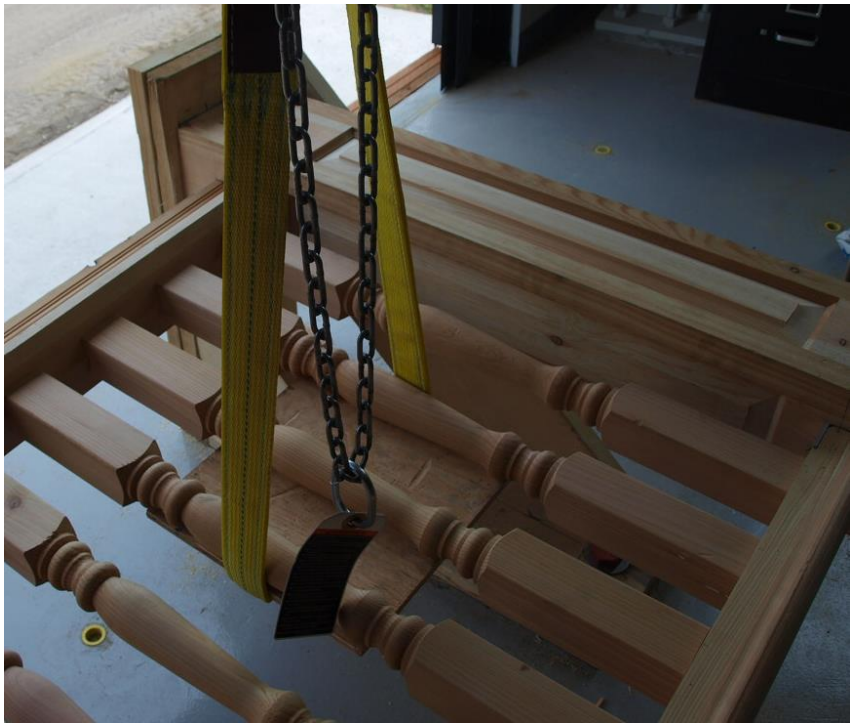

Figure 4: Set-up for the 50lb – 12” x 12” spindle tests

200lb Point Load at Worst Case Scenario

The ASCE standard calls for a 200lb worst case scenario point load, this load was applied in the vertical direction at the mid span, at the hand-rail, putting the load the furthest from the support to maximize the stresses. Both the 6in and 4in passed the 200lb proof load and the test continued to record the max load. Table 5 indicates the max loads and the failure mechanism for both rails, while Figure 5 depicts the test set-up.

Table 5: Summary of full load, worst case testing

Rail	Max Load (lb.)	Failure Mechanism
6in	860	Post member failure and separation
4in	380	Weld fail at nut of mounting hardware

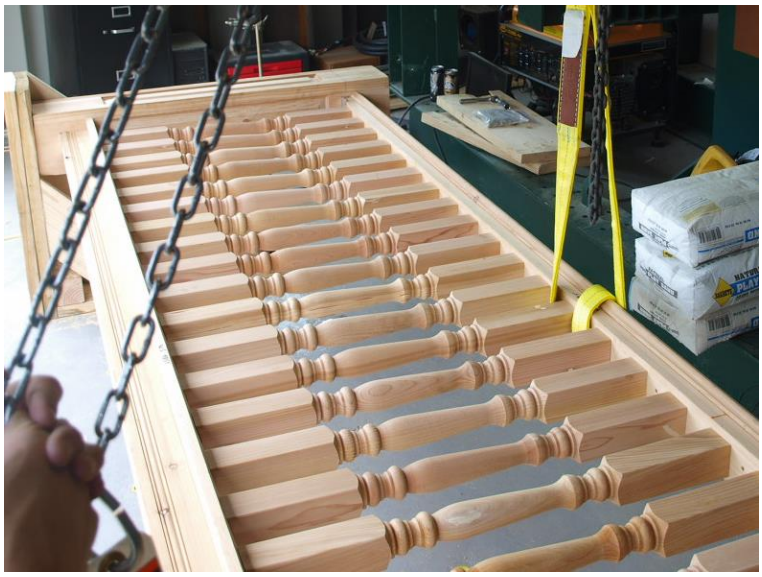

Figure 5: Set-up of worst case scenario testing

Summary of Rail Testing

Test type	Load (lb.)	Pass / Failure
6in Rail		
50lb/ft. Dist. Load	600	Pass
50lb / 12”x12” Spindle	900 min	Pass
Worst Case Pt. Load	860	Pass
4in Rail		
50lb/ft. Dist. Load	600	Pass
50lb / 12”x12” Spindle	328	Pass
Worst Case Pt. Load	380	Pass

All results and material properties pertain only to the samples submitted by Western Spindle. If any questions or feedback arise concerning the testing or this report, please contact Taylor O. Winsor at 206.819.6309 or by email at twinsor@mtech.edu.

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