Intermodal Flat Rack Test

Letter Report No. P10-001
Prepared for Raildecks, Inc.
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...a subsidiary of the Association of American Railroads
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Executive Summary

Transportation Technology Center, Inc. performed static lifting tests and impact tests on a 53-foot flat rack carrier, manufactured by Raildecks Inc. In addition, the flat rack was subjected to perturbations on the yaw and sway and twist and roll test zones. Tests were conducted according to the Longitudinal Ride Quality Specification requirements outlined in RP-803-99 of the Association of American Railroads (AAR) *Manual of Standards and Recommended Practices*.

- The test article met all requirements during the impact tests.
- The test article met all requirements during the Yaw and Sway Test.
- The test article met all requirements during the Twist and Roll Test.

Table of Contents

1.0 INTRODUCTION

The Transportation Technology Center, Inc. performed static lifting tests and impact tests on a 53-foot flat rack carrier, manufactured by Raildecks Inc. (Figure 1). In addition, the flat rack carrier was subjected to perturbations on the yaw and sway and twist and roll test zones located on the Precision Test Track at the Transportation Technology Center, Pueblo, Colo.

The on-track tests were conducted according to the Longitudinal Ride Quality Specification requirements outlined in RP-803-99 of the Association of American Railroads (AAR) *Manual of Standards and Recommended Practices*.

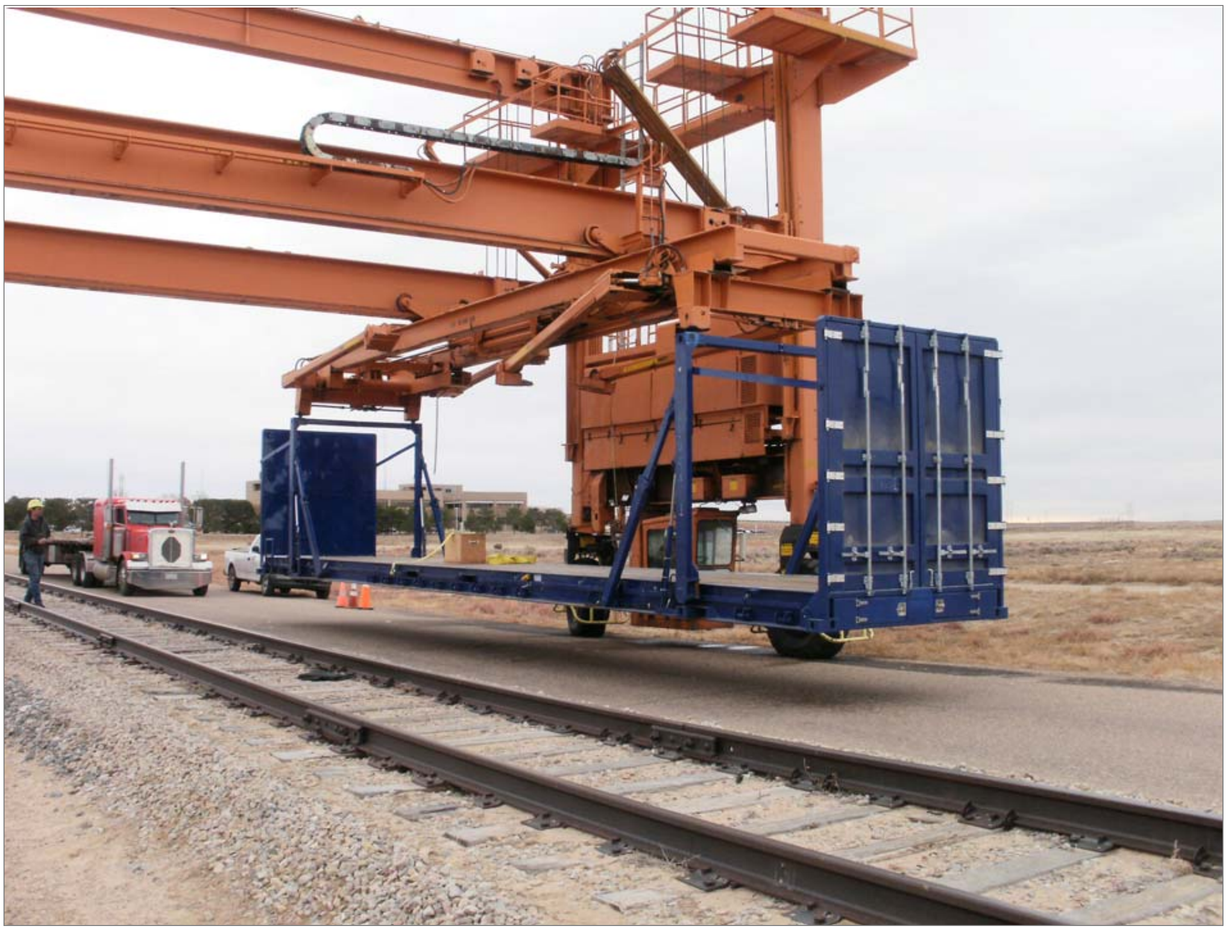

Figure 1. 53-Foot Flat Rack being lifted using a MiJack Crane

2.0 TEST OVERVIEW

Static lift tests were performed in the Rail Dynamics Laboratory using overhead cranes. The flat rack was loaded to 137,000 pounds; this reflects a load of 2 times its maximum rated load. The lading comprised of five 20-foot long concrete blocks and fifteen 18-foot, 136-pound/yard rail sticks (see Figure 2.)

A series of five lifts were performed in this configuration. Raildecks' personnel inspected the rack after each lift to determine if any damage had occurred. In addition, strain measurements from six strain gages were recorded using databricks to determine the maximum and minimum strain levels due to the load being lifted and lowered.

A second series of five lifts were performed after reducing the load on the flat rack to 58,400 pounds. This test required the addition of a loaded 40-foot container that was mounted on the top of the flat rack. The lifting procedure for this test involved lifting and lowering the 40-foot container on and off of the flat rack.

Impact tests at four different speeds and dynamic test runs over the yaw and sway and twist and roll test zones (Figures 3 and 4) were performed to assist Raildecks' engineers in establishing load limits and to determine if the 53-foot flat rack carrier met certain criteria outlined in the AAR RP803-99 specification.

Figure 2. Flat Rack Loaded to Twice its Maximum Capacity (137,000 pounds)

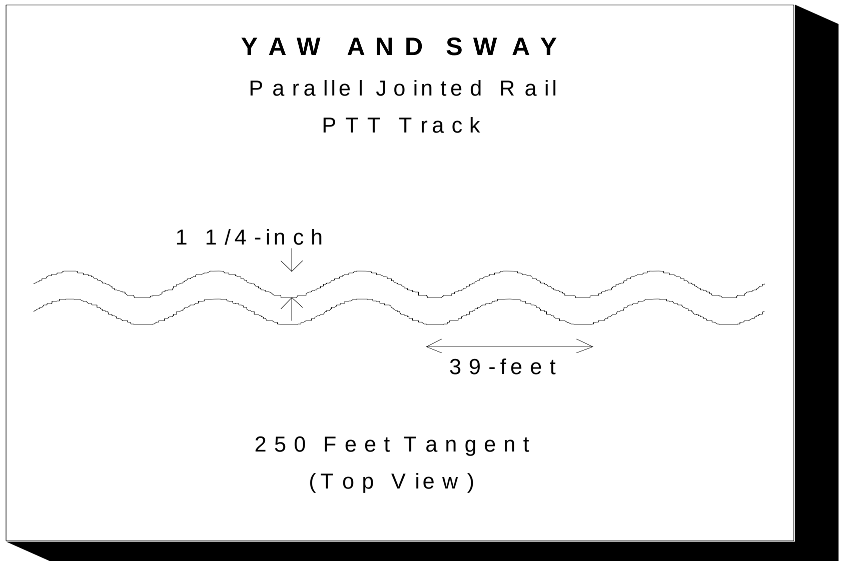

Figure 3. Yaw and Sway Test Zone

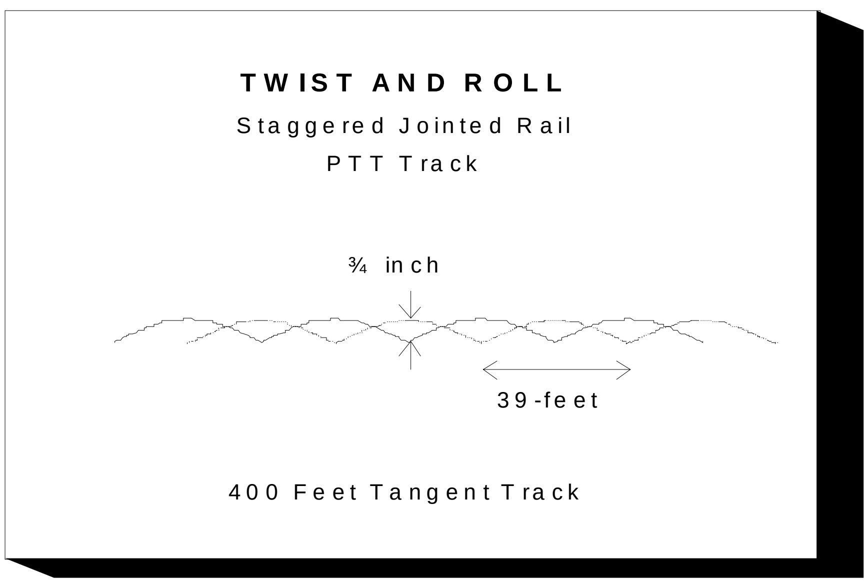

Figure 4. Twist and Roll Test Zone

2.1 Instrumentation

The instrumentation used to measure the physical parameters consisted of accelerometers, strain gages, and a radar-based speed gun. During the impact tests, all of the accelerometers were mounted in the longitudinal axis and were installed on the top corner posts of the flat rack (see Figure 5).

During the on-track testing, the accelerometers were changed to measure the lateral axis at the same location on the corner posts. Figure 6 shows the location of the strain gages.

The data collection system used during the lifting tests and the impact tests included databricks and a laptop computer. The databricks were configured to record burst data, and the data was uploaded to the computer after each run for analysis.

The data system used during the on-track tests consisted of Pacific signal conditioners and a laptop computer. The equipment used for these tests was housed in the AAR 112 instrumentation coach. The test consist was made up of a locomotive and the AAR 112 coach followed by a TTX 3-pack well car. The flat rack was mounted in the leading well of the 3-pack. The flat rack had a 67,000 pound, 40-foot container mounted on top (Figure 7).

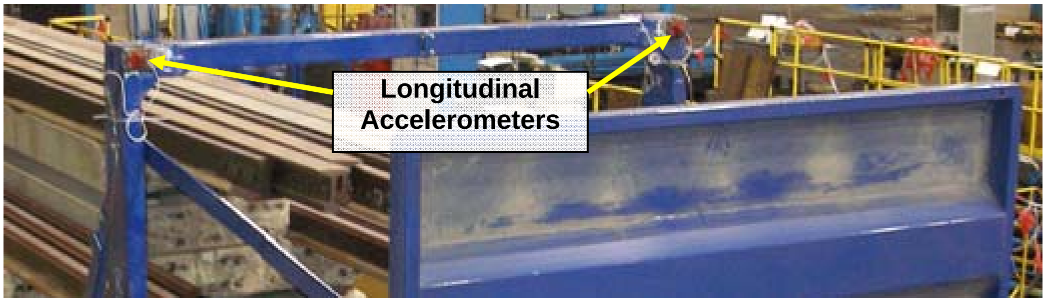

Figure 5. Accelerometers Mounted on Corner Posts

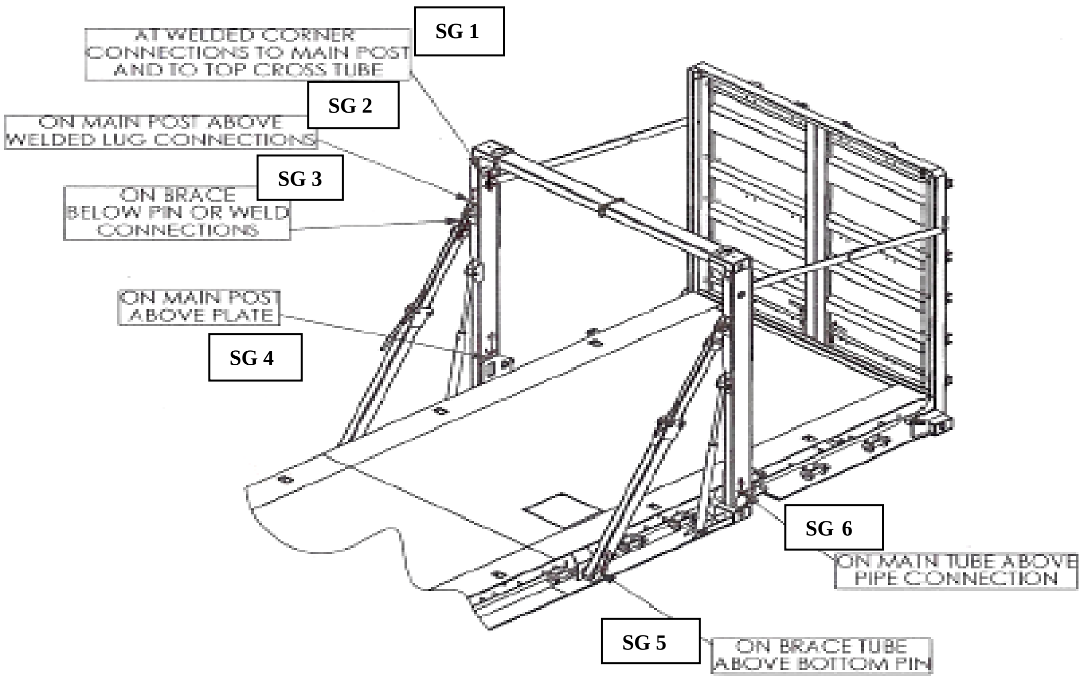

Figure 6. Strain Gage Locations

Figure 7. On-track Test Consist

3.0 RESULTS

This section provides results for each of the tests conducted according to the previously mentioned specifications. Any variances from the specifications are noted. The Raildecks flat rack was configured with 58,400 pounds of lading consisting of 20-foot-long concrete blocks and 136-pound per yard rail sticks. Each of the concrete blocks weighed approximately 22,000 pounds, and each rail stick weighed approximately 1,800 pounds. The loaded weight of the flat rack was 58,400 pounds. This load configuration remained the same for all impact tests.

3.1 Static Lifting Tests

The static lifting portion of the test was divided into two different configurations. The first configuration, known as the maximum load lifting test, required that the flat rack be loaded to the maximum rated capacity of 137,000 pounds. The second configuration involved reducing the maximum load to 58,400 pounds on the flat rack. In addition, a 67,000-pound, 40-foot container was loaded on top of the flat rack.

3.1.1 Test Description

In the first static lift test, the flat rack was loaded with five concrete blocks each weighing 22,000 pounds each. The remaining weight was made up of 15 rail sticks. Each rail stick weighed approximately 1,800 pounds. The flat rack was then subjected to five lifts using overhead cranes. After each lift, Raildecks' engineers inspected the flat rack for any damage or anomalies.

During the second lift test, the rack load was reduced to 58,400 pounds. The load included two of the 22,000-pound concrete blocks and eight rail sticks.

Databricks were used to record strain data during each lift. The databricks were configured to sample data at 5,000 samples per second. The databricks were triggered manually before each lifts. The data was then uploaded after each lift and analyzed.

3.1.2 Test Results and Observations

Table 1 provides the maximum and minimum strain levels for each strain gage.

Table 1. Maximum or Minimum Static Strains during Lift

Load (Pounds)	Measurement Description	SG1 (uStrain)	SG2 (uStrain)	SG3 (uStrain)	SG4 (uStrain)	SG5 (uStrain)	SG6 (uStrain)
137,000	Lifting Strain	773	-220	-12	561	-52	-71
58,000	Lifting Strain	597	-139	-4	528	-26	-73

3.2 Impact Test

3.2.1 Test Description

The Impact Test is designed to ensure the satisfactory operation of the flat rack during yard handling operations. The flat rack was subjected to four slow speed impacts. The test matrix included impact speeds of 2.2, 3.7, 5.1, and 6.9 mph. The speed was measured using a radar-based speed gun. The test specimen was allowed to free roll into the anvil string that was made up of four empty 70-ton capacity hopper cars. The cars in the anvil string had the hand brakes applied.

Data was collected from four accelerometers and six strain gages using a databrick during each impact. The databrick was configured to automatically trigger upon impact capturing 0.5 seconds of pre-triggered data and 4.5 seconds of post-triggered data. The 5-second burst of data was then uploaded to a laptop computer and statistical analysis was performed. Tables 2 and 3 provide the statistical data for each transducer.

Table 2. Impact Accelerations

Impact Matrix (Speed mph)	Measurement Description	Leading Left (g's)	Leading Right (g's)	Trailing Left (g's)	Trailing Right (g's)
2.2	Max. Longitudinal Acceleration	44.94	9.58	26.24	67.92
2.2	Min. Longitudinal Acceleration	-37.36	-12.63	-41.67	-57.29
3.7	Max. Longitudinal Acceleration	19.38	31.67	60.75	83.08
3.7	Min. Longitudinal Acceleration	-11.55	-44.91	-37.50	-44.84
5.1	Max. Longitudinal Acceleration	9.72	19.53	54.86	56.71
5.1	Min. Longitudinal Acceleration	-10.21	-29.74	-46.83	-52.12
6.9	Max. Longitudinal Acceleration	59.49	33.49	61.98	84.19
6.9	Min. Longitudinal Acceleration	-26.48	-41.75	-63.41	-58.52

Table 3. Impact Strains

Impact Matrix (Speed mph)	Measurement Description	SG1 (uStrain)	SG2 (uStrain)	SG3 (uStrain)	SG4 (uStrain)	SG5 (uStrain)	SG6 (uStrain)
2.2	Max. Strain	342	490	291	64	31	58
2.2	Min. Strain	-123	-53	-29	-422	-532	-115
3.7	Max. Strain	37	76	75	47	-13	88
3.7	Min. Strain	-118	-64	-65	-767	-881	-92
5.1	Max. Strain	616	1103	793	55	-93	93
5.1	Min. Strain	-124	-130	-75	-875	-955	-118
6.9	Max. Strain	894	1460	1142	271	367	63
6.9	Min. Strain	-182	-27	-120	-1130	-957	-131

3.2.2 Test Results and Observations

The flat rack was inspected after each impact and no damage or anomalies were found.

3.3 Yaw and Sway Test

3.3.1 Test Equipment and Lading Description

The 53-foot flat rack was mounted inside the leading well of a TTX 3-pack intermodal car. The rack had a 67,000 pound, 40-foot container mounted on top. Data was collected from four lateral accelerometers mounted on the top of the flat rack corner posts and six strain gages using a TTCI data system housed in the AAR 112 coach.

3.3.2 Test Description

The test matrix included runs over the yaw and sway test zone from 45 to 70 mph in 5-mph increments. The data was analyzed after each run to determine the peak to peak values on each accelerometer. Because the data confirmed that the vehicle performance was within allowed limits, an additional test run at 75 mph was performed.

3.3.3 Test Results and Observations

The test specimen successfully negotiated all of the test speeds over the yaw and sway test zone. Tables 4 and 5 provide the statistical data for each transducer.

Table 4. Yaw and Sway Test Accelerations

Speed (mph)	Measurement Description	Leading Left (g's)	Leading Right (g's)	Trailing Left (g's)	Trailing Right (g's)
45	Max. Longitudinal Acceleration	0.399	0.374	0.388	0.321
	Min. Longitudinal Acceleration	-0.027	-0.179	-0.208	-0.263
50	Max. Longitudinal Acceleration	0.335	0.267	0.310	0.248
	Min. Longitudinal Acceleration	-0.005	-0.156	-0.150	-0.214
55	Max. Longitudinal Acceleration	0.097	0.243	0.208	0.189
	Min. Longitudinal Acceleration	-0.265	-0.204	-0.184	-0.204
60	Max. Longitudinal Acceleration	0.130	0.263	0.208	0.190
	Min. Longitudinal Acceleration	-0.248	-0.209	-0.170	-0.180
65	Max. Longitudinal Acceleration	0.092	0.224	0.169	0.151
	Min. Longitudinal Acceleration	-0.313	-0.277	-0.165	-0.175
70	Max. Longitudinal Acceleration	0.167	0.316	0.194	0.180
	Min. Longitudinal Acceleration	-0.286	-0.272	-0.184	-0.189
75	Max. Longitudinal Acceleration	0.103	0.248	0.204	0.185
	Min. Longitudinal Acceleration	-0.346	-0.331	-0.184	-0.195

Table 5. Yaw and Sway Test Strain Levels

Speed (mph)	Measurement Description	SG1 (uStrain)	SG2 (uStrain)	SG3 (uStrain)	SG4 (uStrain)	SG5 (uStrain)	SG6 (uStrain)
45	Max. Strain	-309	1	3	701	109	724
	Min. Strain	-970	0	-9	166	-9	246
50	Max. Strain	-262	1	4	580	113	667
	Min. Strain	-875	0	-2	167	44	229
55	Max. Strain	-283	0	3	504	121	638
	Min. Strain	-750	0	-4	178	39	268
60	Max. Strain	-358	0	3	531	150	671
	Min. Strain	-792	0	-7	212	50	339
65	Max. Strain	-314	0	4	534	108	665
	Min. Strain	-827	0	-9	166	11	299
70	Max. Strain	-258	0	5	553	134	676
	Min. Strain	-886	0	-7	191	45	234
75	Max. Strain	-78	0	4	560	133	694
	Min. Strain	-916	0	-6	72	48	72

3.4 Twist and Roll Test

3.4.1 Test Equipment and Lading Description

The 53-foot flat rack was mounted inside the leading well of a TTX 3-pack intermodal car. The rack had a 67,000 pound, 40-foot container mounted on top. Data was collected from four lateral accelerometers mounted on the top of the flat rack corner posts and six strain gages using a TTCI data system housed in the AAR 112 coach.

3.4.2 Test Description

The test matrix included runs over the twist and roll test zone from 14 to 20 mph in 2-mph increments. The data was analyzed after each run to determine the peak to peak values on each accelerometer.

3.4.3 Test Results and Observations

The test specimen successfully negotiated all test speeds over the twist and roll test zone. Tables 6 and 7 provide the statistical data for each transducer.

Table 6. Twist and Roll Test Accelerations

Speed (mph)	Measurement Description	Leading Left (g's)	Leading Right (g's)	Trailing Left (g's)	Trailing Right (g's)
14	Max. Longitudinal Acceleration	0.254	0.292	0.296	0.282
	Min. Longitudinal Acceleration	-0.275	-0.355	-0.388	0.385
16	Max. Longitudinal Acceleration	0.340	0.394	0.296	0.292
	Min. Longitudinal Acceleration	-0.211	-0.306	-0.344	-0.331
18	Max. Longitudinal Acceleration	0.205	0.243	0.160	0.166
	Min. Longitudinal Acceleration	-0.146	-0.195	-0.325	-0.321
20	Max. Longitudinal Acceleration	0.265	0.306	0.179	0.185
	Min. Longitudinal Acceleration	-0.103	-0.151	-0.252	-0.253

Table 7. Twist and Roll Test Strain Levels

Speed (mph)	Measurement Description	SG1 (uStrain)	SG2 (uStrain)	SG3 (uStrain)	SG4 (uStrain)	SG5 (uStrain)	SG6 (uStrain)
14	Max. Strain	647	183	2	289	71	189
	Min. Strain	-446	-213	-13	-337	-179	-477
16	Max. Strain	528	229	6	285	86	189
	Min. Strain	-445	-188	-16	-302	-199	-386
18	Max. Strain	549	197	4	241	66	172
	Min. Strain	-396	-208	-15	-313	-131	-432
20	Max. Strain	575	182	7	230	54	162
	Min. Strain	-384	-211	-15	-332	-172	-446