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SUBJECT: Guardrail Evaluation
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QS Pro Railing System Evaluation

Introduction

The purpose of this investigation was to evaluate the load carrying capacity of a vinyl guardrail system provided by QS Pro Rail Systems of Livonia Michigan. QS Pro delivered to the Wood Materials and Engineering Laboratory at Washington State University a rail system for evaluation according to the current ICC-ES acceptance criteria for guardrails (AC174). The guardrail system consisted of vinyl sleeves over solid wood 4x4 posts on an 8-foot spacing. DeckLok connectors were used to fasten the posts to the joist system as shown in Figure 1. Between the posts was a vinyl top rail that contained an aluminum channel. Top rail height was constructed to be 36” above the deck surface. The vinyl bottom rail contained no aluminum reinforcement. Both rails were fastened to the posts with Stallion Fence Accessories brackets. Between the top and bottom rails, vinyl balusters were inserted into pre-routed holes that snuggly accepted each baluster (Figure 2).

Figure 1. Post to joist connection

For this test the IBC required loadings according to AC174 were used. Load was recorded continuously through a load cell attached in-line with the loading device. Deflection was recorded using string potentiometers attached to three locations (center of each post and center of top rail) at the 36 inch rail height.

A series of tests are performed on the same guardrail system. The first test is an In-fill test, followed by a Uniform load test, and concluding with two concentrated load tests.

In-Fill Test

The IBC load requirement is 125 lbf applied through a 1 ft^2 plate. The condition of acceptance is no failure or disengagement of the rail components. The actual applied load was 127.1 lbf. This load was held for one minute and released. Although deflection is not a requirement for the in-fill test, at the fully loaded condition, the posts deflected 0.172 and 0.109 inches, while the center of the top rail deflected 0.414 inches. The net top rail deflection (removing post deflection) was 0.247 inches. The acceptance criteria were met, allowing the second test in the series to be performed.

Figure 2. Guardrail setup for the in-fill test

Top Rail Uniform Load Test (Vector Test)

The uniform load test is one where a combined load scenario (vertical and horizontal components) is approximated using quarter-point load head system (Figure 3). The IBC load specifies equal vertical and horizontal components of load, each 125 plf. This equates to a 176.8 plf load at a 45 degree angle. For an eight-foot post spacing the total load to be applied at 45 degrees is 1414 lbf.

A load of 1414.1 lbf was applied and held for one minute. Although the guardrail accommodated the code prescribed load without failure, the joist system (to which the guardrail was attached) sustained significant non recoverable deformation.

Figure 3. Uniform load test setup

Because this investigation had the dual purpose of assessing the guardrail system and method of rail attachment to the substructure, it was decided to continue to the next test in the series regardless of the deformed support structure. In other words, it was deemed appropriate to see what capacity remained in the guardrail system after the substructure sustained damage.

Top Rail Concentrated Load Test

Typically concentrated loads are placed separately at the top of the posts and at the midspan of the top rail. For this investigation, however, only the concentrated load at midspan of the top rail was tested. The load was continually applied until the load carrying capacity of the guardrail system began to diminish. At which time the load was released. The maximum load was 924 lbf. An additional criterion is the deflection of the top rail at the design load of 200 lbf. This deflection was calculated to be 0.815 inches. This is considerably less deflection that allowed in AC174.

Figure 4. Concentrated top rail load test

Summary

From this preliminary study the following can be stated. The guardrail system met the in-fill and uniform (vector) load requirements of AC174. The guardrail system also met the concentrated midspan top rail load requirement; with a maximum load carrying capacity nearly twice the code requirement.