

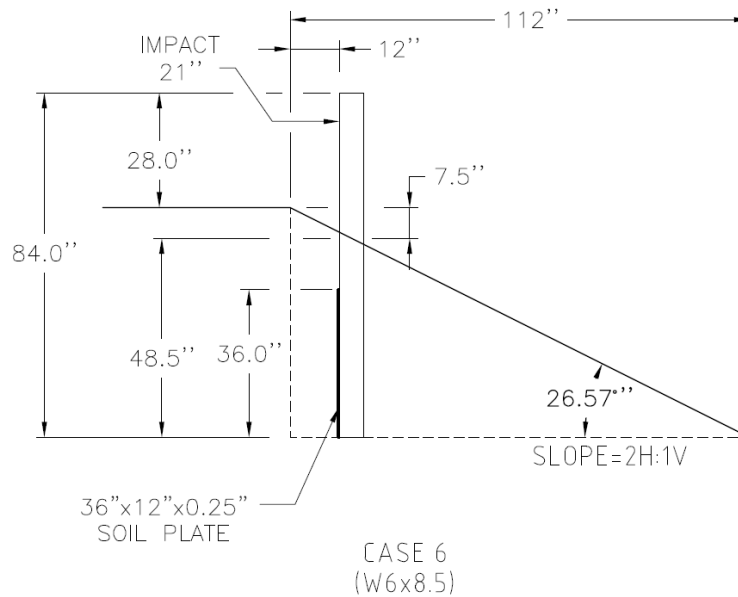
**Project Title:** Placement of Guardrail on Slopes  
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**TTI Project Manager:** Akram Abu-Odeh  
**Project Contract Period:** 4/01/2006-2/28/2008  
**Reporting Period:** 7/01/2007-9/30/2007

### Project Objective

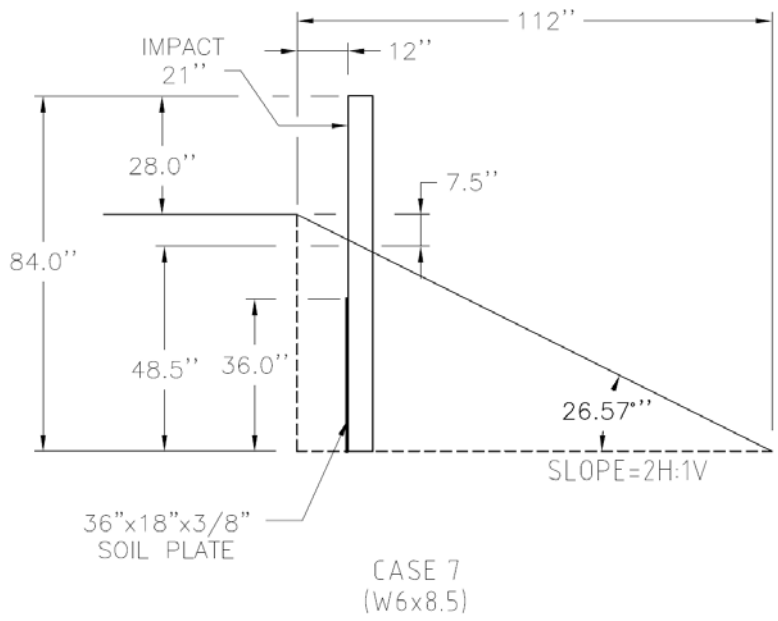
Develop a guardrail design that meets NCHRP Report 350 TL-3 crash test criteria and can be installed with the face of the beam element aligned with the slope break.

### Work Performed to Date

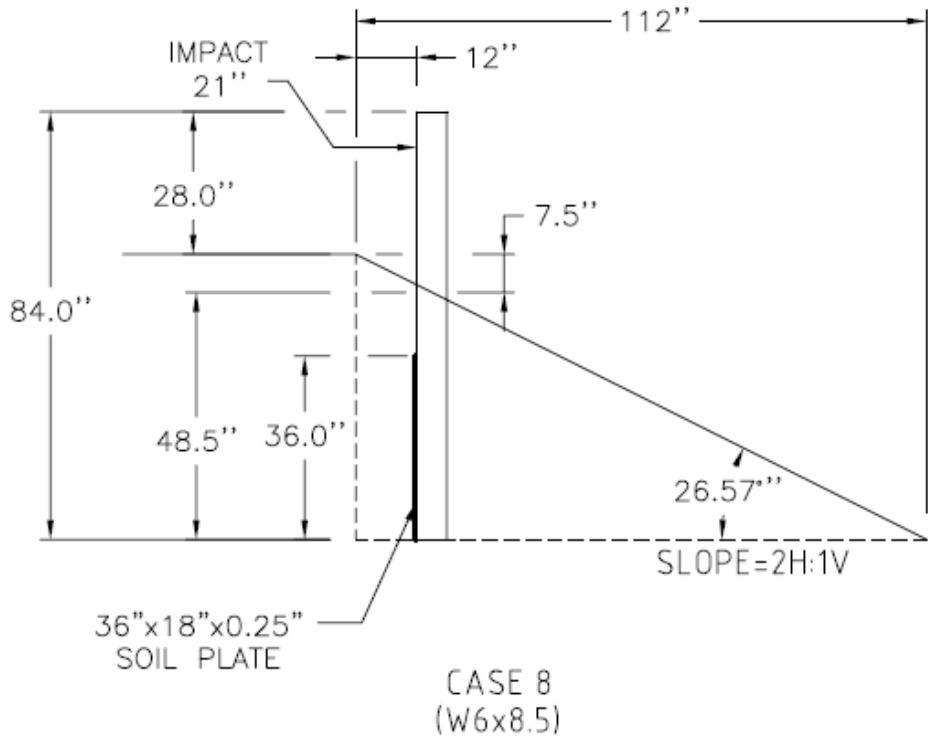
Per the recommendation of the state technical representative, a new post design was identified for further analysis and testing. The design utilizes a 7-ft long W6x8.5 steel post placed 1-ft beyond the break point on a 2H:1V slope. A soil plate is welded to post on the front flange in order to increase the overall post stiffness. One variation (Case 6) uses a 36"x12" by 1/4" thick plate, the second variation (Case 7) uses 36"x18" by 3/8" thick plate and the third variation uses 36"x18" by 1/4" thick plate. Figures 1, 2 and 3 depict Case 6, Case 7 and Case 8 variations of this design respectively.



**Figure 1 Placement of the new post design (Case 6).**



**Figure 2 Placement of the new post design (Case 7).**

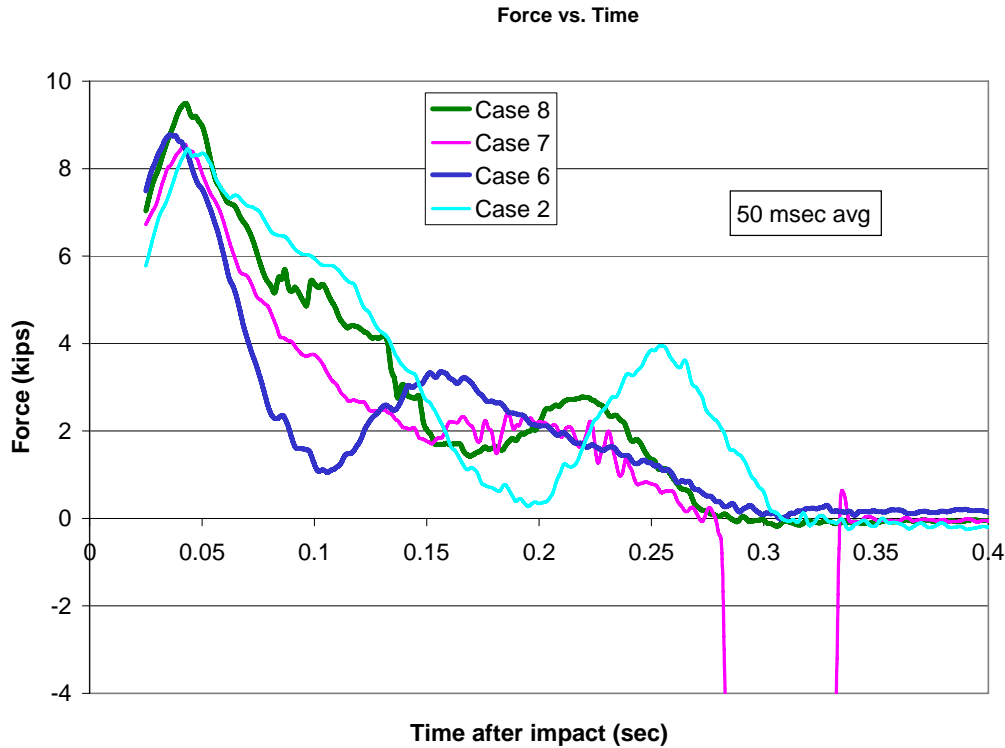


**Figure 3 Placement of the new post design (Case 8)**

These posts were fabricated and installed on the 1V:2H slope and then were impacted with the 849 kg (1871 lb) crushable nose bogie.

### Results of Work Performed

Impact force histories of these tests along with that of the earlier test of the 7-ft post without a soil plate are shown in figure 4 below.



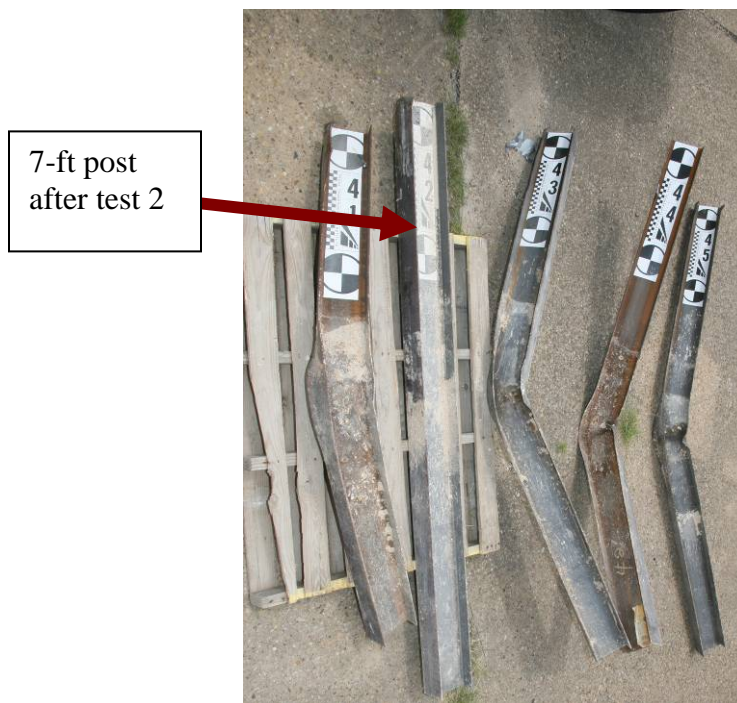
**Figure 4 Force histories of the 7-ft long post without soil plate (case 2) and with soil plate (cases 6, 7 and 8)**

The graph indicates that all tests are practically equal in terms of their maximum force capacity. This means that adding the soil plate to the post resulted in little increases of the maximum force sustained by the post upon impact.

However, upon inspecting the posts after the tests, all posts with soil plates yielded at the point right above the soil plate top edge as shown figure 5 below. This is in contrast to the almost undeformed 7-ft post tested earlier as shown in figure 6 below.



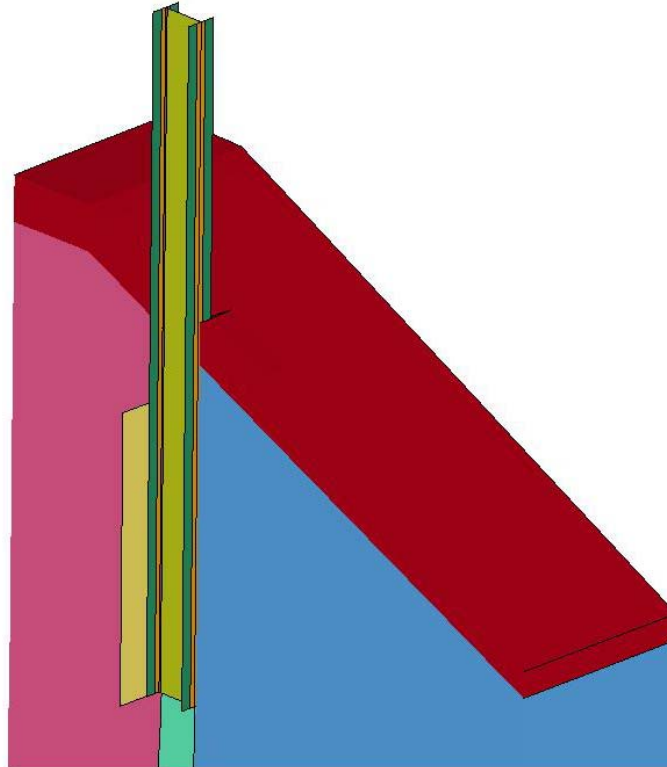
**Figure 5 Deformed posts after test 6, 7 and 8.**



**Figure 6 Pull posts from test 1,2,3,4 and 5.**

This indicates that adding a soil plate would facilitate the creation a plastic hinge in the post in contrast to a post without a soil plate under similar placement condition. Hence, adding the soil plate does help the interaction between the embedded depth of the post

and the soil. Consequently, a model of the post with soil plate was constructed and the full scale model of the system was updated to include a 7-ft posts with soil plate spaced at 6'-3" a part. The model of such configuration is shown in figure 7 below.



**Figure 7 Model of steel post with soil plate.**

### **Work Remaining to be Completed**

The post with soil plate model will be validated using exiting bogie tests and then incorporated into the full system model of the guardrail on slope system. A full scale finite element analysis will be conducted to simulate NCHRP Report 350 TL 3-11 impact scenario. The results and recommendations will be forwarded to the pool fund states for review and approval. Once the final design of the guardrail system is approved, a full-scale crash test will be conducted to verify impact performance