



# Large Scale Testing of Backfill Soil



NEES

Ashley Oertel -- University of California, Santa Barbara -- aqo@umail.uscb.edu – July 2010

REU site: University of California, Los Angeles -- PI: John Wallace, John Stewart – Mentors: Alberto Salamanca, Anne Lemnitzer

## Introduction

The abutment of a bridge consists of wingwalls, a backwall, and soil backfill. In the event of an earthquake, the bridge deck may strike against the backwall. The backfill resists the lateral displacement which, ideally, prevents extensive damage to the deck. The purpose of this experiment was to determine the maximum passive resistance of the backfill soil with an 8 foot backwall. In 2006, this test was performed with a 5.5 foot wall (Stewart et al. 2007). The stiffness of the soil was determined and questions arose about the resistance of the soil if a different backwall height was used. The experiment was repeated in 2009 with an 8 foot wall and, while the passive resistance increased significantly, the stiffness decreased (Lemnitzer et al., personal comm. 2009). The test was repeated in 2010 to correct this outcome.

## Methodology

The backwall specimen was simulated as a concrete block which was 2.6m high by 4.5m wide and 0.9m thick. While the specimen was a full height model, it was impractical to build it full width. Since the small width of the testing site could lead to excess friction from the wingwalls that wouldn't normally be present in bridge abutments, the wingwalls were lined with plastic to reduce the shear forces. Six actuators, shown in Figure 1, were placed to push the wall horizontally, and to minimize any vertical motion. Linear Variable Differential Transformers (LVDTs) were mounted to a fixed truss and measured the horizontal and vertical displacement of the backwall specimen. One of these sensors is shown in Figure 2. The backfill soil was then added in 8 inch lifts. Each lift was compacted and then sand cone testing was performed on each layer (Figures 3 and 4) to determine the compaction density and moisture content of each lift. After all the sand was added, holes were dug as seen in Figure 6 and a gypsum mixture was poured



Figure 1: Actuator Configuration

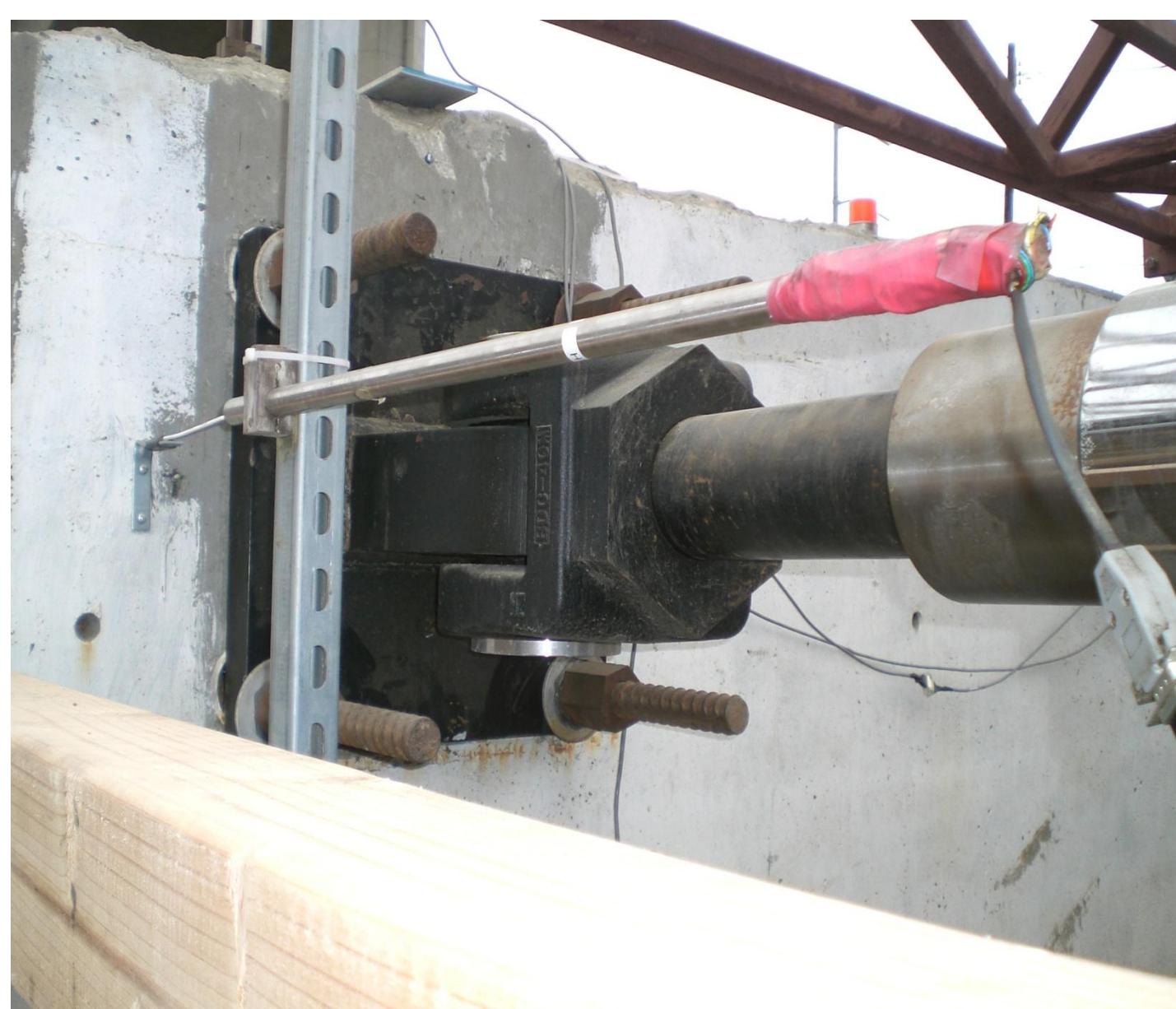


Figure 2: LVDT Sensor



Figure 3: Sand Cone Testing

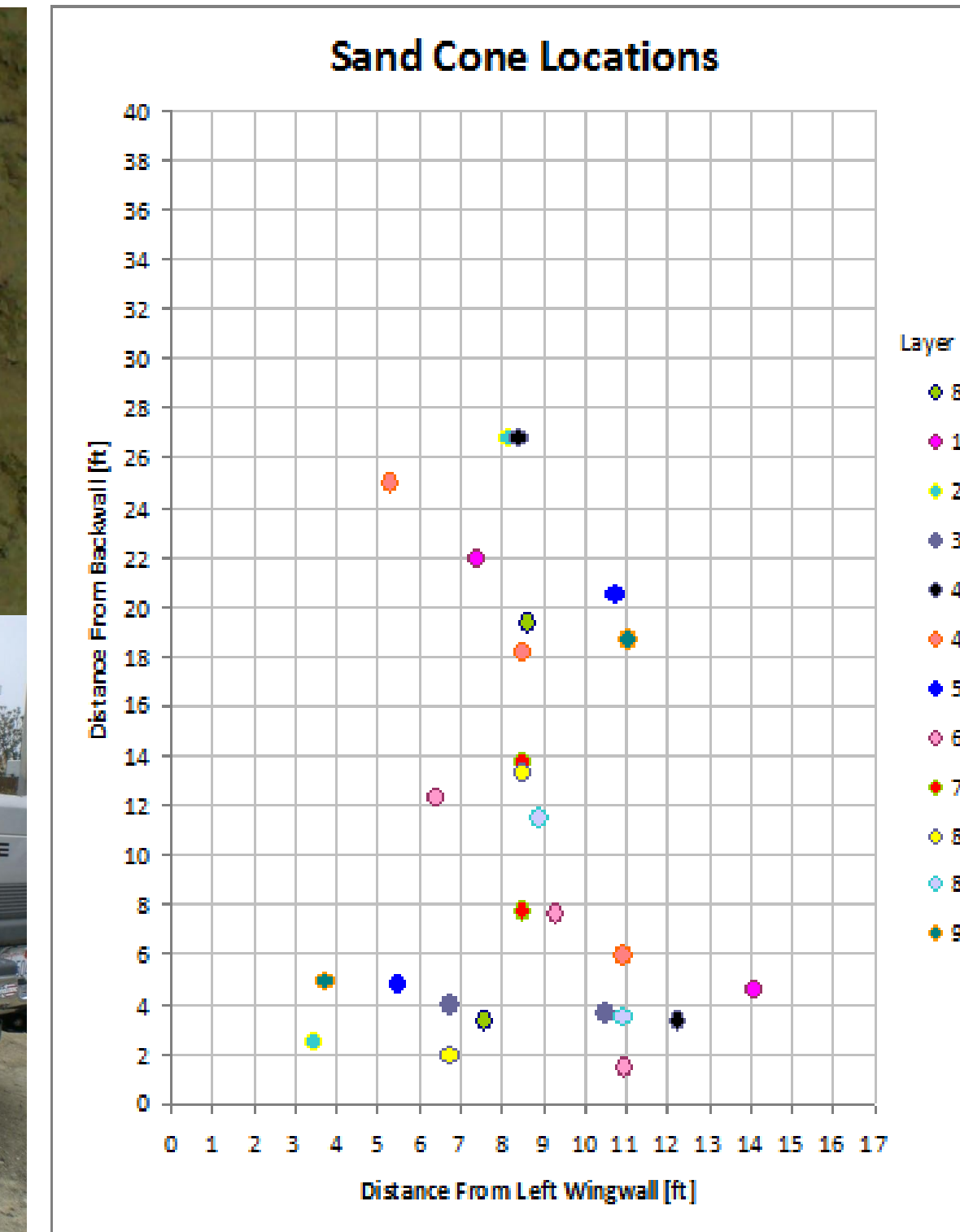


Figure 4: Sand Cone Locations

in. After hardening, these seven brittle gypsum columns would allow the fail planes to be easily seen once the soil was excavated after testing. Cone Penetration Testing (CPT) was attempted to plot the axial and shear forces against soil depth. This is shown in Figure 5. However, at a depth of 1 meter, the machine failed to go any deeper. A grid was painted on the surface of the backfill to complete the preparation for the test. A diagram of the test site is shown in Figure 7.



Figure 5: CPT Testing

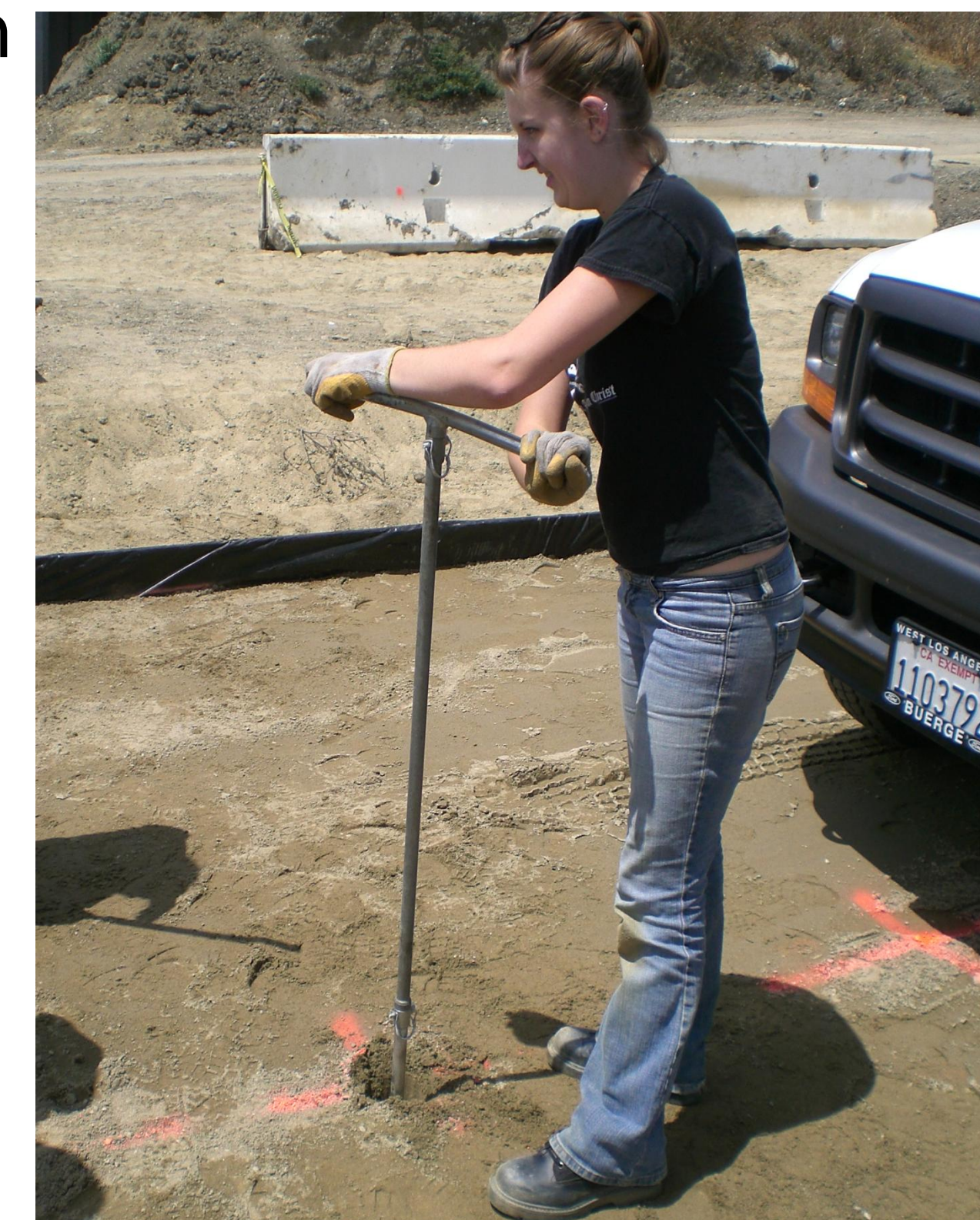


Figure 6: Drilling Holes

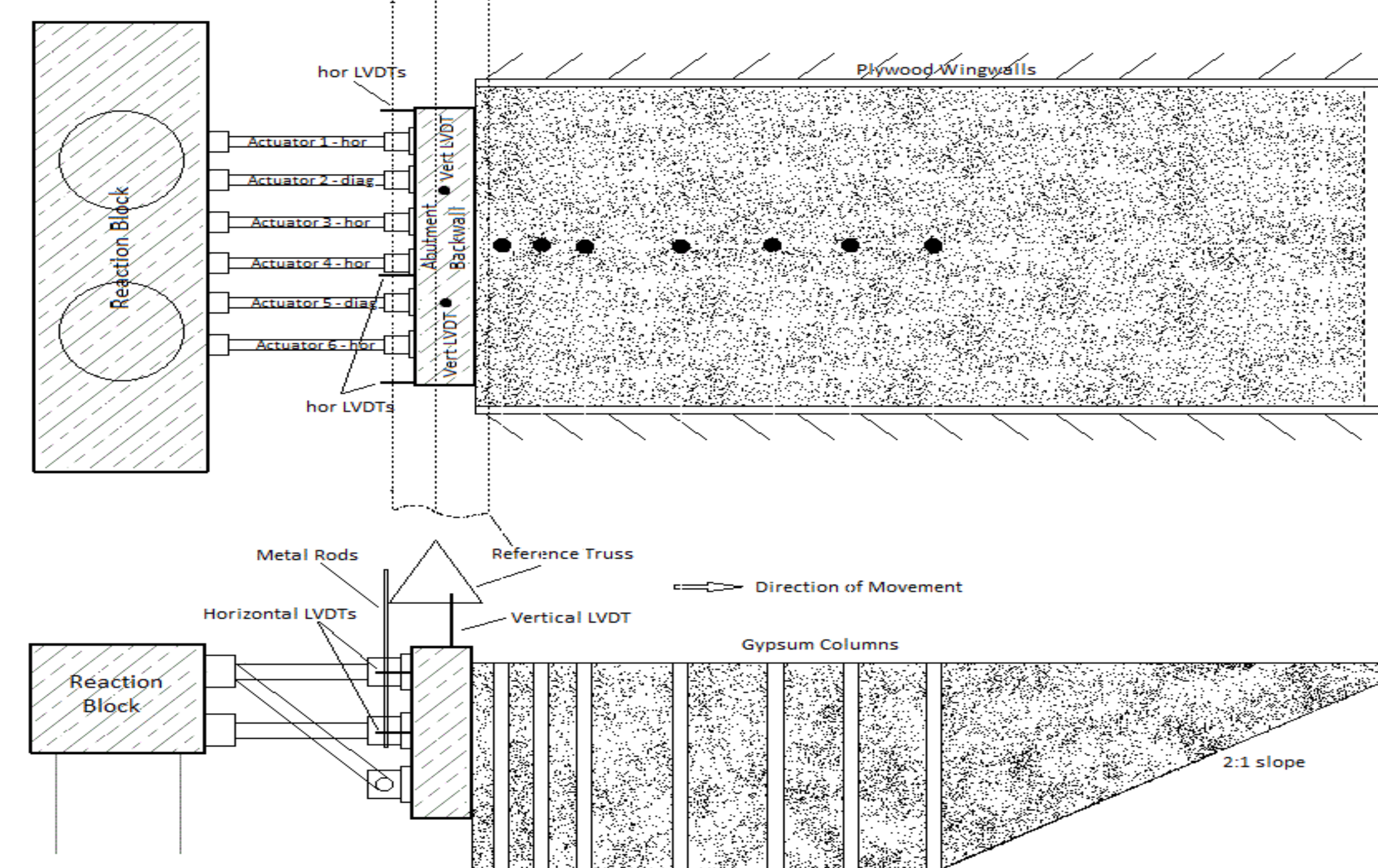


Figure 7: Layout of Test Site

## Testing

During the testing, data collected showed that the problem with the stiffness encountered in 2009 had been resolved. The load was increasing rapidly, indicating that the maximum passive resistance was much higher than in 2006 with the 5.5 foot wall. However, the maximum was never determined as the loads required to fail the soil were much larger than anticipated and both the backwall and reaction block failed before the backfill soil showed cracking.

## Results and Conclusions

Figure 9 shows the cyclic forces that were applied by each actuator during the test. The average force vs. horizontal displacement (Figure 10) was plotted and the stiffness determined was 52-72 kips/in/ft, which is this soil's expected stiffness. In Figure 11, the vertical displacement was held fairly constant by the diagonal actuators. The movement around 1.4 inches is due to the backwall failing. Figure 12 is a comparison to the past tests and predictions. While the maximum passive resistance couldn't be determined before failure, the data shows that it is much higher than the 5.5 foot case, which is what this experiment intended to prove.

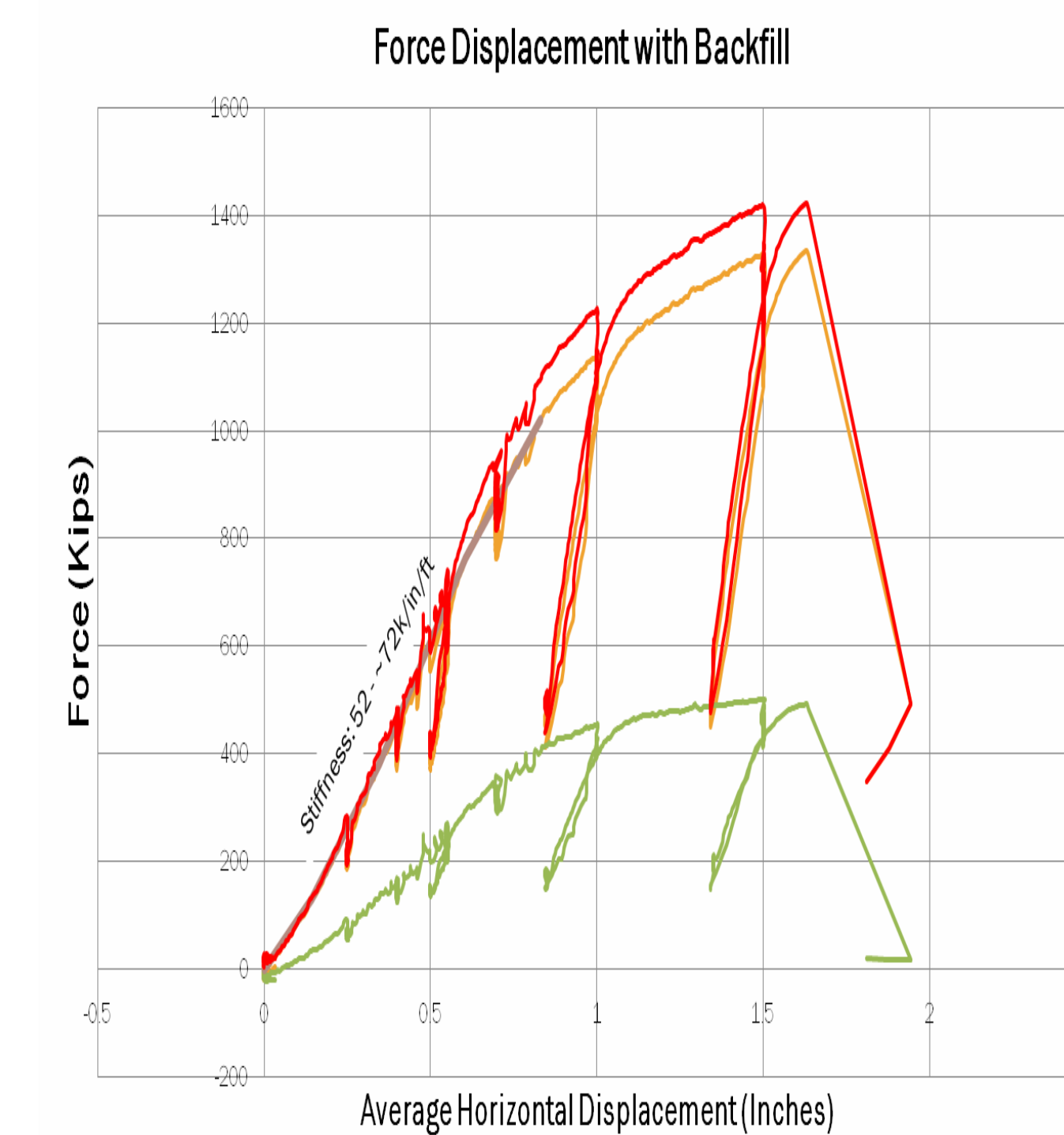


Figure 9: Force Displacement with Backfill

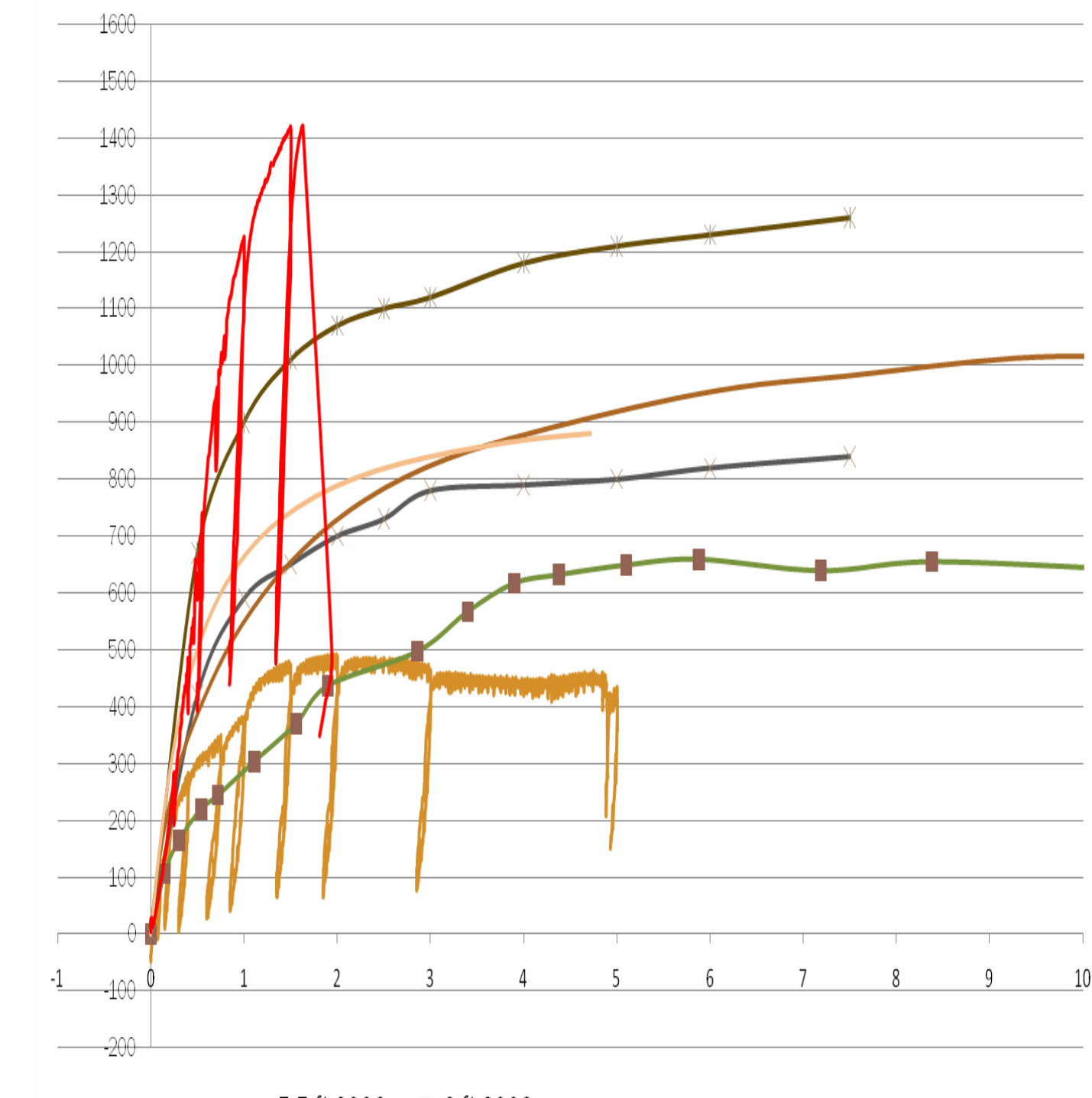


Figure 10: Average Force vs. Disp.

## Literature Cited

Stewart, Jonathan P.; Taciroglu, Ertugrul; Wallace, John W.; Ahlberg, Eric R.; Lemnitzer, Anne; Rha, Changsoon; Tehrani, Payman; Keowan, Steve; Nigbor, Robert L.; Salamanca, Alberto [2007]. "Full Scale Cyclic Testing of Foundation Support Systems fro Highway Bridges. Part II: Abutment Backwalls"

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## Further Information

For more information, contact Anne Lemnitzer at alemnitz@gmx.de