Dynamic Passive Pressure on Abutments and Pile Caps – PI's Profs. Rollins and Gerber
Quarterly Report Feb-April 2006

During this quarter work was begun on Work Task 1 involving the literature review. We have collected a number of papers on pile-cap connection testing and design as well as papers on passive force-deflection. In addition, we have collected documents related to proposed design procedures for computing passive force-deflection at abutment walls.

In addition, work is progressing to reduce data from the field load test results conducted in connection with Work Task 3 of this study. The pile cap was 3.67 ft tall and 17 feet wide and backfill soil extended to a distance of approximately 15 feet from the pile cap face. The test data from the UCLA/NEES data acquisition system has now been turned over to BYU and the accelerometer data is being reduced to defined velocity and deflection time histories throughout the testing program. This will allow us to compute the natural frequency, dynamic stiffness and damping values for the tests performed at each deflection increment.

Basic passive force-deflection relationships were developed for the two tests involving silty sand compacted at 88% and 98% of the modified Proctor maximum unit weight as shown in Figure 1. The increased compactive effort produces considerable increase in passive resistance.

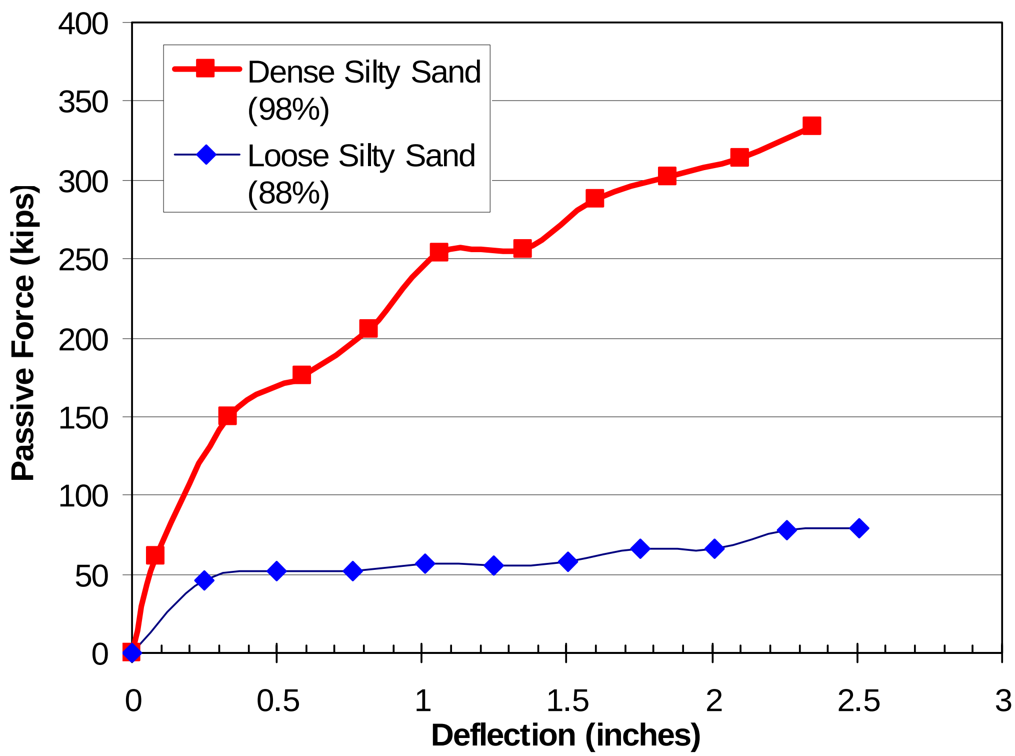


Figure 1. Measured passive force vs deflection relationships for two full-scale test with silty sand compacted to 88% and 98% of the modified Proctor maximum unit weight.

In contrast with prevailing views, less movement was required to reach the ultimate passive resistance for the loose silty sand than for the dense silty sand. Even though the initial slope of the force-deflection curve is flatter for the loose silty sand, the ultimate value is reached after only about 0.5 inch of movement. Preliminary analyses indicate that this behavior is predicted quite well using the Mokwa-Duncan approach along with the soil properties measured in the field.

Tests were also performed using the loose silty sand backfill along with a well-compacted zone of sandy gravel adjacent to the pile cap tests were performed with compacted zones which were 3 ft and 6 ft thick. These tests indicate that compacting relatively thin zones (3 to 6 ft wide) of sandy gravel around a pile cap can significantly increase the passive resistance as illustrated in Figure 2. In this case, replacing a 3 ft zone of loose silty sand around the pile cap with compacted gravel increased the lateral resistance on the pile cap from an initial value of 60 kips to over 180 kips which is an increase of over 200%. Crack patterns from the tests, shown in Figure 3, indicate that the gravel zones increase the effective width of the pile cap and reduce the pressure on the loose silty sand behind it thereby increasing passive resistance.

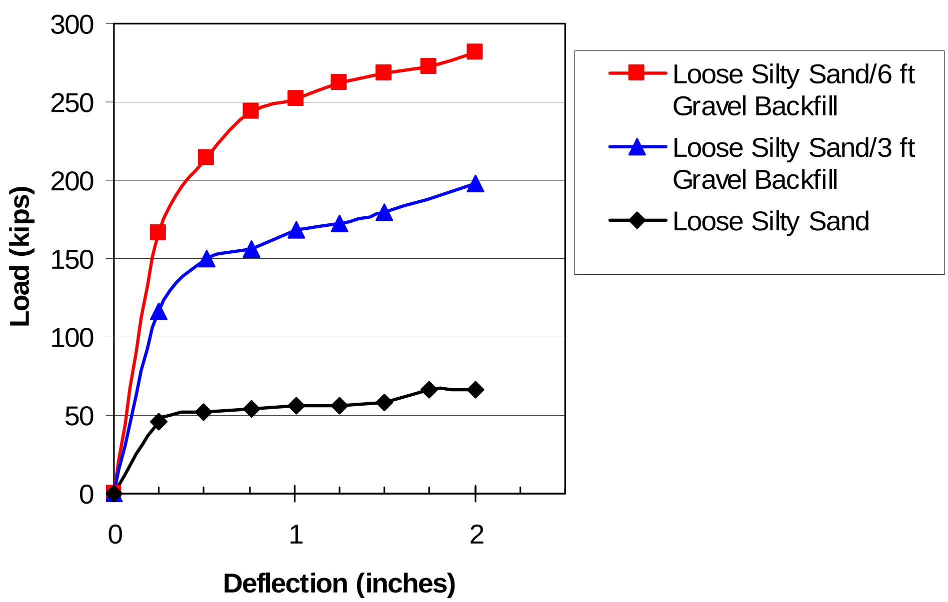
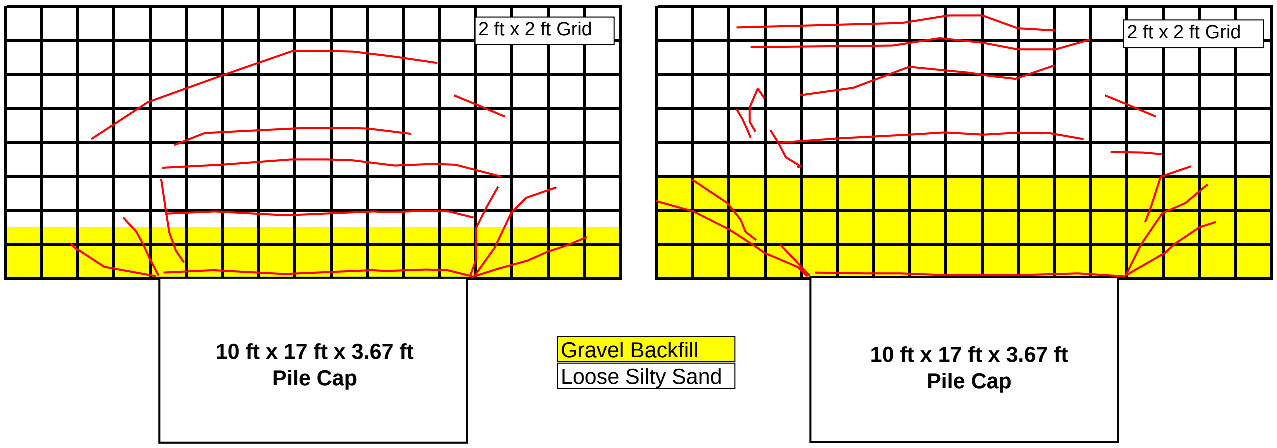


Figure 2. Passive force vs. deflection curves for loose silty sand against a 17 ft wide by 3.67 ft high pile cap and after excavation and replacement with 3 ft and 6 ft zones of compacted gravel backfill against the cap.



(a) 3 ft sandy gravel zone plus loose silty sand backfill

(b) 6 ft sandy gravel zone plus loose silty sand backfill

Figure 3 Plan view of crack patterns behind a pile cap after excavation and replacement of loose silty sand with (a) a 3 ft and (b) a 6 ft zone of compacted sandy gravel behind the pile cap.

Data reduction efforts are also being carried out on the pressure plate and Tekscan pressure sensitive film data. Figure 4 shows data from the upper and lower Tekscan sensor pads at four different load levels. As the applied load increases, the pressures clearly increase and there is also a trend for the pressure to increase with depth. During the next quarter comparisions witill be made between the pressure measured by the pressure plates and the Tekscan sensors.

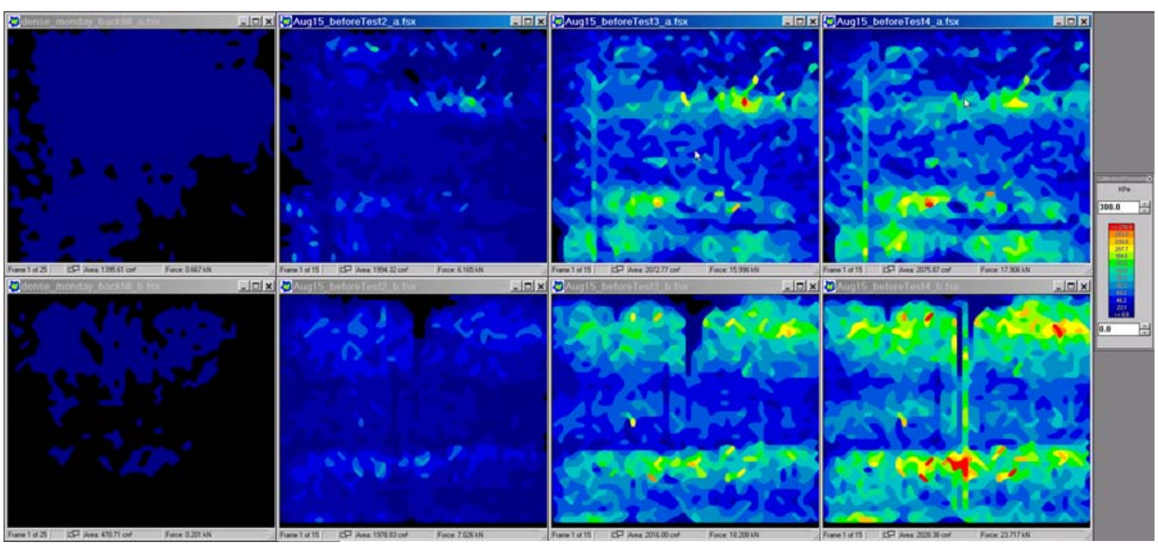


Figure 4. Color contours plots of pressure upper and lower Tekscan pressure panels at four different applied load levels.

Budget Considerations

During this quarter funds were expended to pay for the construction of the pile cap used in the field testing and for travel and per diem expenses incurred by UCLA personnel in performing the eccentric mass shaker tests for the field testing. In addition, the cost of materials and compaction for the field testing was reimbursed. Finally, graduate student salary associated with the project was paid. The project is within budget limits.

Plans for Upcoming Quarter

During the upcoming quarter we anticipate that the test data from the first set of field experiments will be reduced and basic test results can be reported. Analyses will also be undertaken to determine basic dynamic properties (natural frequency, stiffness, and damping) throughout each of the test procedures. Comparisons will also be made between the measured response and that expected based on code provisions and various design approaches.

Plans for the pile cap/pile connection testing associated with Work Task 4 will be completed this quarter and the test caps will be constructed at the South Temple test site. Approval for this testing will need to be provided by UDOT. Field testing will likely take place in June. Final approval for the field testing at the Salt Lake Airport has been granted. Final plans for the test structures to be used for Work Tasks 5 and 6 will be completed this quarter with construction beginning in June. Field testing will likely take place in late July and August.