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FIELD MEASUREMENTS OF EARTH PRESSURE ON A CANTILEVER RETAINING WALL

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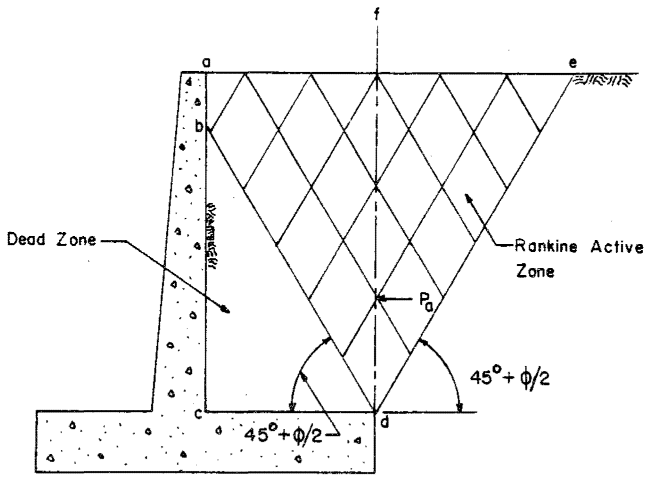

Failure of Sand Behind a Cantilever Retaining Wall

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Field Measurements of Earth Pressure on a Cantilever Retaining Wall

by

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A research report has been produced on the work and findings of the third year of a five-year study on "Determination of Earth Pressures for Use in Cantilever Retaining Wall Design." The report is summarized in these pages.

The broad objective of this study is to develop a more economical design procedure for cantilever retaining walls.

The limited objective of the third year of this study was to measure the pressures acting on a typical cantilever retaining wall and to compare measured pressures with theoretical pressures. Twelve earth pressure cells were used to measure lateral earth pressures and bearing pressures. Measurements of wall movement were made during and after the backfilling operation. Data are presented in the report for measured pressures and movements obtained over a period of 385 days.

Significant Aspects of the Research

Significant aspects of the study concerning long-term field measurements of earth pressures on a cantilever retaining wall at the end of the third year are listed below.

1. A standard cantilever retaining wall on a spread footing foundation with a protruding key was instrumented with twelve Terra Tec pneumatic earth pressure cells. The measured pressures showed some seasonal variation which was attributed to temperature changes. A temperature correction was applied which removed some of the seasonal variation. Eight of the original twelve pressure cells are currently operating properly.

2. Lateral earth pressure measurements were made for 385 days after the start of backfilling. The average ratio of the resultant thrust as determined from the measured lateral pressures to the thrust determined from a Culmann graphical solution is approximately 3.5, both before and after the clay backfill was added. The higher measured lateral pressures can be explained by considering the movement of the wall. During the sand backfilling, the wall rotated or tilted toward the backfill which should

create higher pressures. During the clay backfilling, the rotation was away from the backfill; but, there was very little movement in the lower part of the wall where the higher pressures were measured. Another possible explanation for the higher measured pressures in the lower part of the wall could be the dead zone phenomenon. The weight of dead zone material may be adding some additional pressures to the back of the wall. Also, since the material within the dead zone moves with the wall as if it were part of the wall, pressures closer to the at-rest condition could be measured against the lower part of the wall.

3. Bearing pressure measurements were made for 385 days after the start of the backfilling. The average ratio of the resultant as determined from the measured bearing pressures to the calculated resultant was approximately 0.84, both before and after the clay backfill was added. The points of application of the resultant forces of all the measured bearing pressures were located within the middle third of the base of the footing. The calculated and measured bearing pressures showed a higher intensity at the heel than at the toe after the sand backfill was placed. However, after the clay backfill was added, the calculated and measured bearing pressures showed a higher intensity at the toe than at the heel. The measured bearing pressure distributions agreed reasonably well with the calculated bearing pressure distributions.

4. Measurements for tilt or rotation of the wall were made. Provisions were made to measure translation movement; however, after day 27 sheet piling stockpiled in front of the wall prevented this measurement from being made. The plumb bob readings indicate that the wall tended to rotate toward the backfill during the placement of the sand backfill. This movement explains the measured bearing pressure distribution when only the sand backfill was considered. After day 148 site conditions prevented the measurements with the plumb bob apparatus. The inclinometer readings indicate that the wall rotated or tilted away from the backfill after the clay backfill was placed. This movement explains the shift in the higher pressure intensity from the heel to the toe.

5. There are not sufficient data to fully evaluate the effectiveness of the key. However, the data collected thus far indicate that the key caused an increase in passive resistance after the clay backfill was added. Also, the measured bearing pressures indicate that the key could be affecting the distribution of bearing pressures along the base of the footing.

6. The engineering properties of the backfill material were determined. A wide range in unit weights and void ratio existed in the backfill. The backfill is a fine-grained, subrounded to rounded, quartz sand. The average total unit weight is approximately 117 pcf (18.4 kN/m^3). Its gradation and plasticity were such that it was classified as a SP-SM according to the Unified Soil Classification System. The effective angle of internal shearing resistance for the average void ratio was 39°.

7. The soil conditions at the site were investigated by taking three borings. Two borings were performed by the SDHPT and tests on undisturbed samples were performed at the SDHPT laboratory. Another boring was drilled by the SDHPT drilling rig and the undisturbed samples were tested at the Texas A&M University laboratory. Two of the borings were supplemented with TCP tests at various depths.

Recommendations

The following recommendations are made concerning the research accomplished thus far and continued research in this program.

1. Continue measuring the earth pressures and wall movement. The effects of vehicular traffic on the measured pressures should be studied when this section of the highway is open.

2. The plumb bob and hook-to-reference-point measurements should be continued as soon as site conditions permit.

3. The comparison between measured field pressures and theoretical pressures should continue to be made so that the overall objective of verifying or modifying the existing retaining wall design procedures can be accomplished.

4. Any future instrumentation of retaining walls using Terra Tec pneumatic pressure cells should include the installation of thermocouples adjacent to the pressure cells.

5. Thicker plates should be mounted on the front of the wall for inclinometer measurements to try and eliminate warping of the plates. Also, instead of using epoxy to mount the plates on the wall, they should be bolted to the wall for the purpose of eliminating any temperature effects on the epoxy.

6. Provisions should be made to measure settlement of the retaining wall.

7. Alternative provisions should be made for obtaining

translation measurements in case obstructions prevent the use of the prime method.

8. Any future instrumentation of retaining walls with a protruding key should include a pressure cell mounted horizontally in the base of the key to examine the key's effect on the distribution of bearing pressures.

9. The feasibility of installing several additional pressure cells in backfill material, within the Rankine active zone, should be investigated.

The published version of the report may be obtained by addressing your request as follows:

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