Effect of Surcharge Load on the Magnitude and Distribution of Lateral Earth Pressure against Rigid Retaining Wall

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Introduction

Retaining walls, which are used to promote deep excavations, deep embankments, and basements etc., is one of the essential components of different infrastructural projects. In deciding the cross-sectional dimensions of the retaining wall, the earth pressure has an important role. In this study the experimental investigation was performed to see the influence of surcharge load on the active earth pressure due to a sand backfill (Toyoura sand) behind the rigid wall rotating about the base. The aim of this research is to assess the change of magnitude and distribution of earth pressure from at rest to an active case. Also, to evaluate the effect of surcharge load location that; the surcharge load within the Rankin's active failure zone and extended further from the boundary active. The results show the distribution was found to be nonlinear and the center gravity of the distribution differs due to the changing of surcharge load position.

Experimental setup

Figure (1). shows the details of the experimental box, retaining wall and their installation. The retaining wall was made of stainless steel plate, which is 50 cm in height, 30 cm width, and 16 mm thickness. A total of 4 lateral pressure transducers (SPT) were installed on the retaining wall at [5, 15, 25 and 35 cm] from the soil surface. And it was installed on a test box of 80 cm length, 31 cm width, and 66 cm depth. A motor was attached to the steel plate [retaining wall] that allows for lateral movement of the wall in the passive and active directions. The bottom of the retaining wall is fixed 15 cm from the non – backfilled side of the test box to achieve rotation about base wall motion. In order to apply surcharge load, an air cylinder pressure was mounted on the top of the steel plate as strip load, which is 30 cm length, and 8 cm width, as shown in Figure 1.

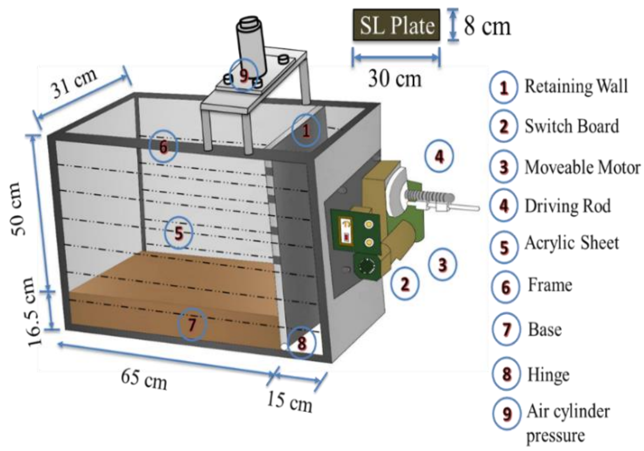

Figure 1. Schematic diagram of experimental setup.

Testing materials and methodology

The physical properties of soil used in this study are as follows; specific gravity $G_s = 2.646$, maximum dry density $\gamma_{d\,max} = 1.633\text{g}/cm^3$, minimum dry density $\gamma_{d\,min} = 1.3$ g/cm^3, maximum void ratio $e_{max} = 1.041$, minimum void ratio $e_{min} = 0.625$, and internal friction angle $\varphi = 38^{\circ}$. The soil was poured into 8.5 cm layers, and each layer was compacted to its maximum dry density (1.633g/cm^3). Layeres were prepared using identical placement technique in order to assure uniform and consistent densities through the whole soil profile. Three active cases were adopted, where the surcharge load position was varied [8, 16 and 24 cm] from the retaining wall as shown in figure 2. During the tests, the earth pressure was continuously measured using lateral pressure cells installed at [5, 15, 25 and 35 cm] from the soil surface.

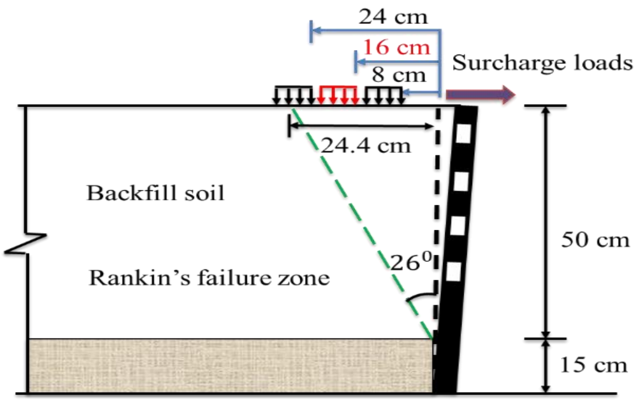

Figure 2. Surcharge load locations

Results and discussion

Figure 3 (a), (b), (c) and (d) show the earth pressure values measured by the 4 soil pressure transducers and their respective analysis in response to the location of the surcharge load from the edge of retaining wall under three cases; the location of surcharge load equals to 8 cm, 16 cm, and 24 cm. Comparing the three cases, it can be observed that the earth pressure decreases by increasing the distance of surcharge load from the edge of the retaining wall. It must be noted that in case 3 the applied surcharge load was located farther from the wall almost covered the boundary Rankin's active zone.

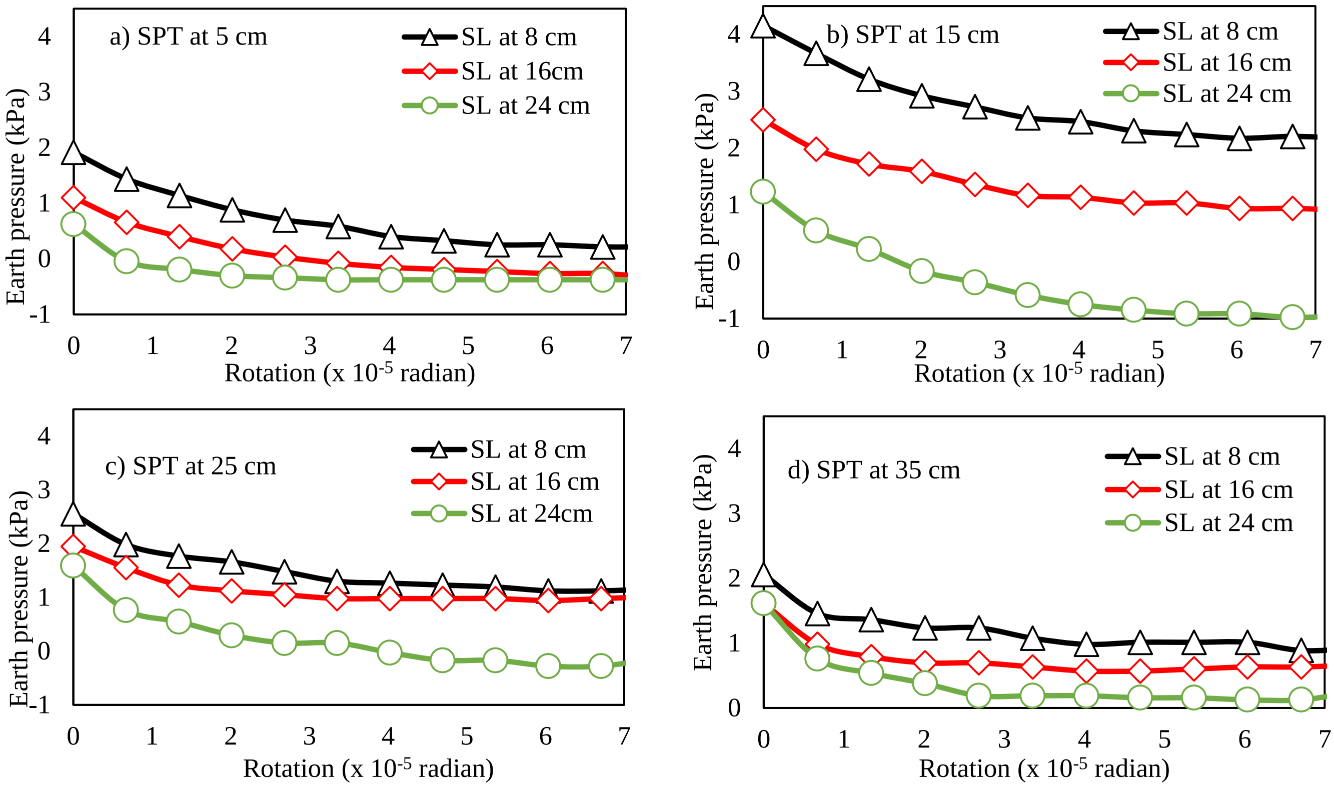

Figure 3. Earth pressure variation.

Figure (4) shows the earth pressure distribution, where it can be seen, the cases were located in within Rankin's active zone [case 1 and 2], increasing the position of the applied surcharge load has the effect of significantly decreasing the distribution on the top layers' soil mass. But case 3 where located on the boundary of the Rankin's active zone, the soil deformed on the top layers' and it does not have effect on the retaining wall.

Conclusions

The conclusions drawn from this study are summarized as follows.

Increasing the position [distance from the wall edge] of the surcharge load has the effect of decreasing earth pressure. On the other hand, it has the influence of significantly decreasing the active earth pressure distribution especially for the top soil layers in within Rankin's active failure zone.

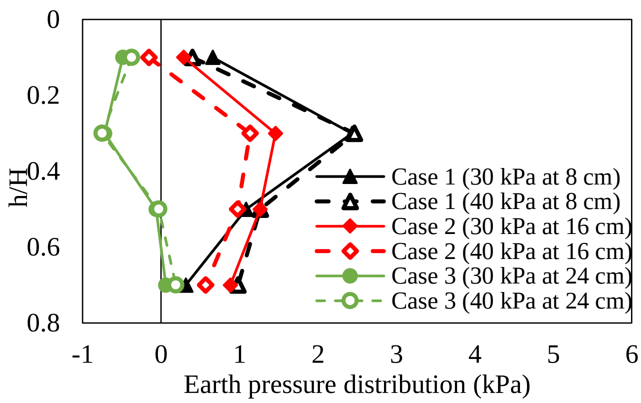

Figure 4. Earth pressures distribution.

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