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. The aim of this research is to assess the change of magnitude and distribution of earth pressure from at rest to an active case. It is necessary to mobilize the active earth pressure on the retaining wall in the variety of possible wall movements. In this study, an experimental method was used to determine the magnitude and distribution of earth pressures caused by a strip surcharge load on the retaining wall backfill using small scale laboratory model. The rigid retaining wall was allowed to rotate about its base in the soil box model. This paper mainly focuses on the active case and various tests were conducted by applying surcharge load at different positions from the edge of retaining wall, to assess the effect of surcharge pressure on the active pressures.

Experimental setup

Figure (1). shows the details of the experimental box, retaining wall and their installation. The retaining wall was built of stainless steel plate, which is 55 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. Two longer sides consisted of 20 mm acrylic sheet, and it was glued rigidly to side edges, while two shorter sides of the test box consisted of 10 mm steel plates perfectly welded to the test frame. The bottom of the box is closed with 20 mm steel plate and welded to all sides of the steel frame. Furthermore, a motor was attached to the steel plate [retaining wall] that allows for lateral movement of the wall in the passive and active directions. In addition, a displacement transducer was mounted on the top of the test box in order to measure the wall rotation. The bottom of the retaining wall is fixed 15 cm from the non – backfilled side of the test box. In order to apply surcharge load, an air cylinder pressure was mounted on the top of the box as shown in Figure 1.

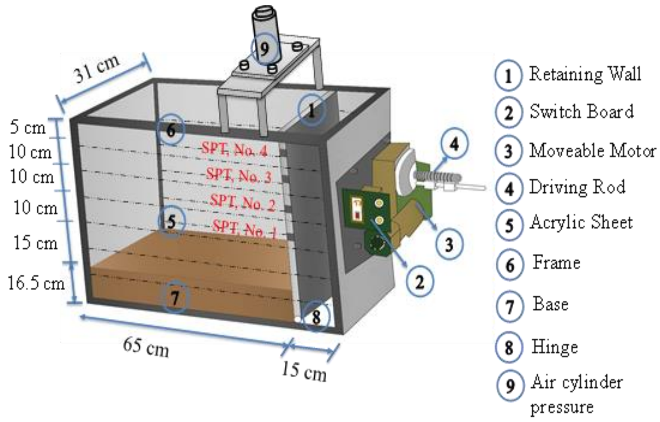

Figure 1. Schematic diagram of experimental setup.

Testing materials and methodology

The physical properties of soil was used in this study are as follows; specific gravity $G_s = 2.62$, maximum dry density $\gamma_{d\,max} = 1.661 \mathrm{g}/cm^3$, minimum dry density $\gamma_{d\,min} = 1.2$ g/ cm^3 , maximum void ratio $e_{max} = 1.211$, minimum void ratio $e_{min} = 0.65$, and internal friction angle $\varphi = 38^{\circ}$. The grain size distribution curve is shown in Figure 2. The soil was poured in into 10 cm layers, and each layer was prepared and compacted to its maximum dry density (1.661g/cm^3). Layeres were prepared using identical placement technique in order to assure uniform and consistent densities through the whole soil profile. Three active earth pressure cases were adopted, where the surcharge load position was varied [8, 16 and 24 cm] from the retaining wall. 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.

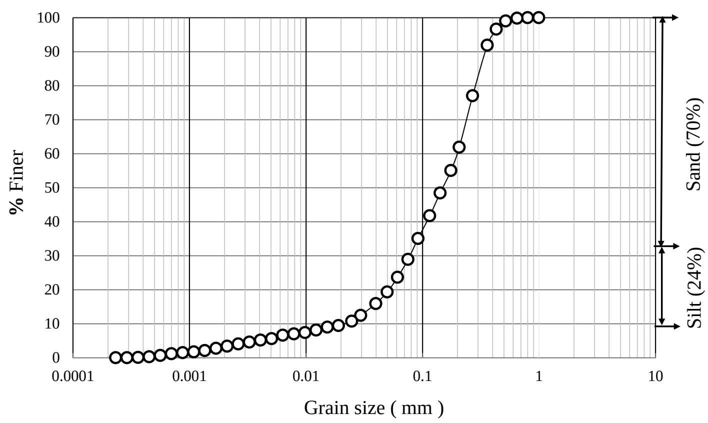

Figure 2. Grain size distribution.

Keywords: Earth pressure, rigid retaining walls and surchrage load.

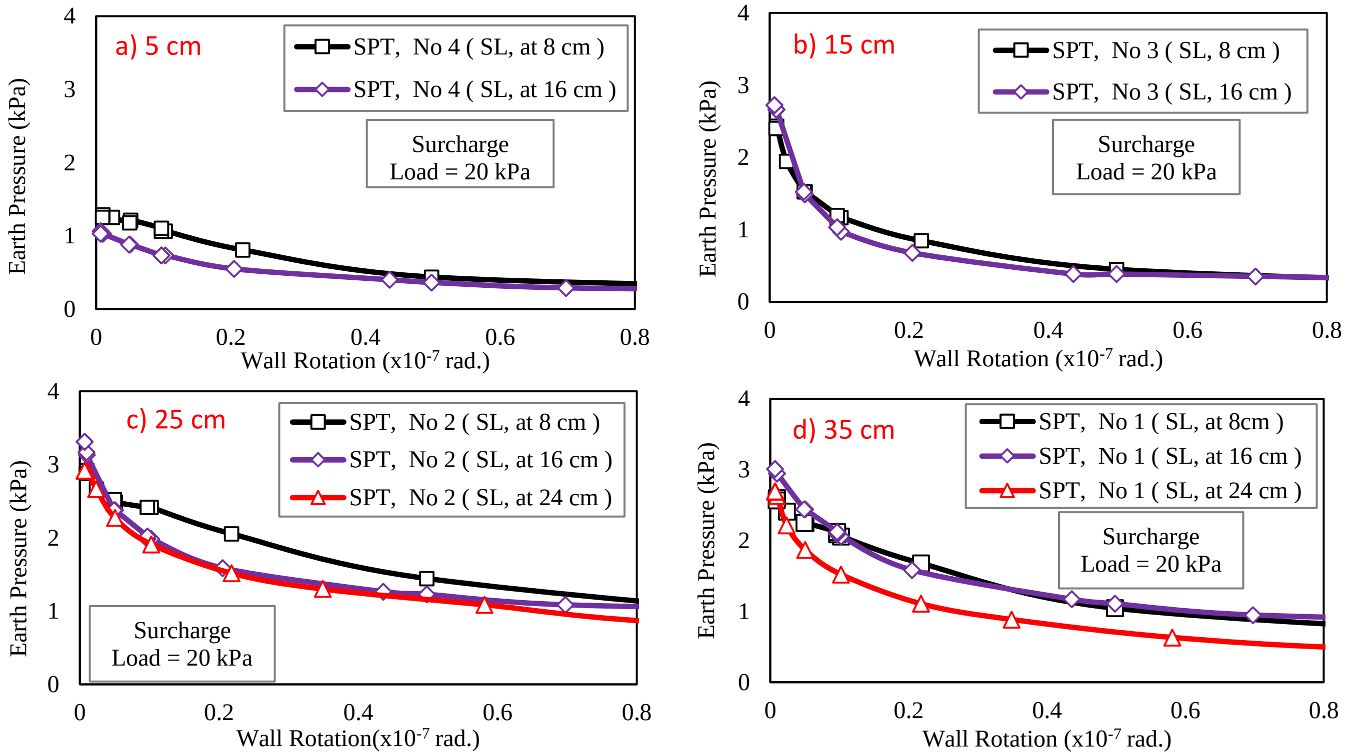

Figure 3. Earth pressure.

Result and discussion

Figures 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 H/6, H/3 and at H/2 (8, 16 and 24 cm), where H is wall's height. Comparing the three cases, it can be seen that the earth pressure decreases by increasing the distance of surcharge load from the edge of the retaining wall. For case 3, transducers installed at [5 and 15 cm] reading were excluded due to technical error.

Figure 4 shows the active earth pressure distributions for the three surcharge cases, where it can be observed that increasing the position [distance from the wall edge] of the applied surcharge load has the effect of slightly decreasing the active earth pressure distribution. It must be noted that the bottom part of the soil mass is influenced more significantly by the surcharge position compared to the top part.

Conclusions

The present research evaluated experimentally the magnitude and distribution of earth pressures on model retaining wall, under changing location of surcharge load. The conclusions drawn from this study are summarized as follows.

1) Distribution of the earth pressure is nonlinear when the surcharge load applies on the backfill.
2) 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 slightly decreasing the active earth pressure distribution especially for the deep soil layers.

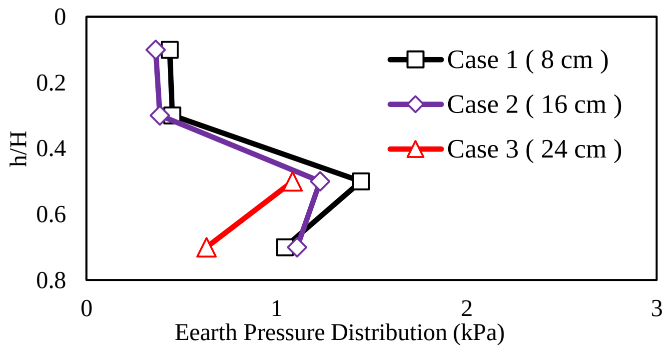

Figure 3. Earth pressures distribution.

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