Abstract

Deep excavation in a congested urban area is often required for the construction of underground transport systems, basements of high rise buildings, utility pipelines, etc. These excavations are often done vertically beneath the ground surface due to space constraints. The retaining walls are constructed and supported at different levels by horizontal beams (struts) spanning between the two opposite sides of an excavation to laterally support the near vertical excavated faces. The design of a cantilever wall or braced wall depends on number of factors, such as width of the excavation, embedment depth of the wall, excavation depth, wall thickness etc. Significant numbers of numerical and experimental studies have been performed to understand the behavior of a braced excavation under static condition. However, very limited studies have been conducted on the behavior of braced retaining walls under dynamic loading. In this research work, small scale model study in the laboratory and corresponding numerical analyses are performed to investigate the behavior of a cantilever and a braced retaining wall with single bracing or strut under dynamic loading condition in dry and saturated sands. It is found from the study that the maximum lateral displacement of an embedded cantilever wall occurs at the top of the wall and the maximum bending moment in the walls occurs below the bottom of the excavation in both dry and saturated soils. The maximum lateral displacement in the cantilever walls due to a dynamic loading is below 1% of the wall height in case of dry sand and 12.75% of the wall height in case of saturated sand. It is also found that, in case of braced excavation, the lateral displacement of the wall is significantly affected by a change in the peak amplitude of the base motions. The bending moment in the wall and the strut force are less affected. A change in the wall stiffness influences the deflection and the moment in the wall more than the strut force. The variation of the maximum bending moment in a braced wall for different excavation depths shows that the maximum bending moment occurs at the end of the shaking event, for a lower excavation depth. However, for a large excavation depth, the maximum bending moment occurs during the motion. From the study on the saturated sand, it is observed that the soil below the excavation level (as compared to the sides) is more susceptible to liquefaction. The pore water pressure ratio (r_u) increases with increasing peak amplitude of the base motions. The increase in the depth of excavation also enhances the triggering of liquefaction in the braced excavation. For a given depth of excavation, the lateral displacements and the bending moments in the braced walls increase with the amplitude of the base motions. However, when the soil liquefies due to an increase in the amplitude of the base motions, the braced walls undergo large deformations due to rotations.

Keywords: Dynamic loading; Shake table; Braced excavation; Liquefaction; FLAC2D.