Proceedings of the 8th International Conference On Civil Structural and Transportation Engineering (ICCSTE'23)
Canada – June 04-06, 2023
Paper No. 109
DOI: 10.11159/iccste23.109

Seismic Behavior of Rigid Inclusion Foundation System

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Extended Abstract

Over the past few decades, ground improvement has been successful in delivering effective and sustainable technological base solutions by increasing ground bearing capacity and reducing settlements [1]. A new development in the European market is the use of ground improvement principles as an alternative or in addition to deep piling approaches. One of these ground improvement methods is using rigid inclusions [2]. Rigid inclusion consists of slender, mechanically continuous, and typically vertical elements (piles). They are placed in a regular mesh pattern that must be revised for the applied loads and soil conditions. According to the rigid inclusion concept, inclusion caps are not structurally connected to the superstructure (raft). A well-compacted, granular load transfer platform (LTP) between the inclusions and the raft. The LTP plays a critical role in ensuring load transfer to the pile ends and uniform settlements. It is often used with a thickness generally between 40 and 80 cm [3]. These improvement techniques will have an influence on the foundation soil, and thus the structure, during an earthquake. With rigid inclusions, the advantages of piles and shallow foundations are economically combined [4].

One of the essential advantages of the Rigid inclusion system is the isolation of the substructure and the superstructure, so the shear loads are not directly transferred from the improved soil to the foundation slab. Therefore it is believed to be less sensitive to seismic loads, in contrast to the raft piled system where the piles take high shear forces [5]. This indicates the importance of understanding the seismic behavior of this system. The seismic behavior of traditional pile foundations is now well known, and many researchers have worked in this area. However, the rigid inclusion was less.

For that, this research presents a parametric study on the response of rigid inclusion foundations under earthquake loading using 2D finite elements modeling by Plaxis 2D. It presents the seismic behavior of the rigid inclusion system compared with the piled-raft placed on 60 m thick, soft soil layer - clay, which rests on the rigid bedrock. Different real-time history records have been in the analyses.

It has been found that the seismic performance of a rigid inclusion system is less sensitive to earthquake loads compared to the piled raft system, where the internal forces in the raft are the lowest in the rigid inclusion system and the reinforcement. The piled raft system piles are subjected to the highest shear force. In contrast, in the rigid inclusion system, the shear force in the piles is reduced because there is no direct connection between the raft and the piles. Since the bedding layer (LTP) acts as an isolation layer between the piles and raft. This study has also demonstrated that the displacement in the piled raft system is less than in the rigid inclusion system.

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