10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

Numerical Evaluation of Wall Rigidity Effects on the Applied Dynamic Earth Pressure

Haddad[1], M. Iman Khodakarami[2] and Somayye Hemmati[3,*]

1, 2- Assistant professor, Faculty of Civil Engineering, Geotechnical Department, Semnan University, Semnan, Iran

3- MSc Student, Faculty of Civil Engineering, Geotechnical Department, Semnan University, Semnan, Iran

* s.hemmati@semnan.ac.ir

Abstract

In the design of quay walls the applied earth pressure has an important effect on the designed section. Furthermore the rigidity of the wall section affects the amount and mode of displacements. The effect of the wall rigidity is evaluated numerically considering three types of quay walls; Stepped-like Shape Concrete Block, Knapsack Concrete Block, and Sheetpile. Results show better capability of the Knapsack wall instead of Stepped-like Shape, because of the reduction in the applied earth pressure as a result of the hunchback shape of the wall. Also the Sheetpile wall can be introduced for soils with lower strength in low seismicity degree regions, because of flexibility of these walls and less dependent on the soil strength. Also in accordance with performance based design criteria, the evaluation of the wall displacement for two levels of earthquakes is necessary and it has been considered in the numerical modeling in this research.

Keywords: Earth Pressure, Gravity Wall, Sheetpile

1. INTRODUCTION

Rigid and flexible retaining walls are largely used in geotechnical engineering including quay walls construction. The earth pressure is affected by many factors, such as the relative geotechnical properties of the backfill and the seismic coefficient [1]. Comparing with these factors, the displacement modes of the retaining wall have more distinct effect on the earth pressure [2, 3]. A general analytical method to calculate the passive rigid retaining wall pressure was deduced considering all displacement modes [4]. The analytical results show that the resultant forces of the passive earth pressure are equal to those of Coulomb's theory, but the distribution of the passive pressure and the position of the resultant force depend on the passive displacement mode parameter, and the former is a parabolic function of the soil depth.

In this article the effect of the wall rigidity on the deformation amount and consequently the applied earth pressure is evaluated numerically considering three types of walls; stepped-like shape Concrete Block, Knapsack Concrete Block, and Sheetpile Walls. Studies have been done in two situations concluding static and pseudo static conditions. Different wall types and two soil deposits with different geotechnical properties were considered. Deformation diagrams and consequent applied earth pressure derived from the numerical analyses to predict the effect of deformation/movements of walls on the earth pressure and to compare it with the conventional earth pressure diagram by Coulomb theory.

2. PERFORMANCE-BASED DESIGN METHOD

Seismic performance-based design approach is a new design method, which is a "risk-performance balance" approach. It allows a certain degree of damage depending upon the specific operating functions. As a result, various combinations of risk and structural performance can be considered. This design approach has been widely accepted by different design codes [5, 6]. Key steps of the performance-based design are as follows:

(i) Definition of appropriate levels of design earthquakes (More than one design earthquake level should be considered.)

(ii) Definition of the corresponding acceptable levels of structural damage in engineering terms (displacements, stresses, etc.)

(iii) Evaluation of the seismic performance of the structure