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An ANN Based Sensitivity Analysis of Factors Affecting Stability of Gravity Hunched Back Quay Walls

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Abstract

This paper presents Artificial Neural Network (ANN) prediction models that relate the safety factors of a quay wall against sliding, overturning and bearing capacity failure to the soil geotechnical properties, the geometry of the gravity hunched back quay walls and the loading conditions. In this study, a database of around 80000 hypothetical data sets was created using a conceptual model of a gravity hunched back quay wall with different geometries, loading conditions and geotechnical properties of the soil backfill and the wall foundation. To create this database a MATLAB aided program was written based on one of the most common manuals, OCDI (2002). Comparison between the results of the developed models and cases in the data bank indicates that the predictions are within a confidence interval of 95%. To evaluate the effect of each factor on these values of factor of safety, sensitivity analysis were performed and discussed. According to the performed sensitivity analysis, shear strength parameters of the soil behind and beneath the walls are the most important variables in predicting the safety factors.

Keywords: Quay Wall; Hunched Back; Safety Factor; Sliding; Overturning; Bearing Capacity; Artificial Neural Network.

1. Introduction

Gravity quay walls are one of the most common port and harbor structures because of their applicability (e.g., ship-loading, supporting facilities on their backfill, optimizing access to land, and navigable waters), durability, ease of construction, and the possibility of deep construction and reaching deep seabed elevations. However, because of the considerable weight of the wall's sections, some issues exist regarding the stability of their foundations. During previous earthquakes, gravity quay walls have suffered significant damage as a result of their seaward movement and this has led to subsequent damage to the structures built on their backfill [1].

According to Figure 1, compared to a vertical-back wall, a landward-leaning wall has a smaller failure wedge and therefore a smaller lateral thrust to retain. But, a larger failure wedge and lateral thrust develop behind a seaward (for quay walls) leaning wall. However, in comparison to the more common vertical-back walls, a large landward-leaning gravity wall would be considerably more expensive as it would require a significant amounts of material (e.g., concrete and steel reinforcement) to construct, may have soil bearing capacity problems attributable to its heavier weight, and because of its larger mass, greater inertial forces are applied on it during earthquakes [2].

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