**Ain Shams University**
Faculty of Engineering

# EVALUATION OF EARTHQUAKE EFFECT ON WATERFRONT RETAINING STRUCTURES USING NUMERICAL MODELING

By

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A THESIS

SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS
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# STATEMENT

This dissertation is submitted to Ain Shams University for the degree of **PhD** in Civil Engineering.

The work included in this thesis was carried out by the author in the Department of Structural Engineering, Ain Shams University from June 2006 to December 2009.

No part of this thesis has been submitted for a degree or for a qualification at any other University or Institution.

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**Evaluation of Earthquake Effect on Waterfront Retaining Structures Using Numerical Modeling.**

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## ABSTRACT

Recent earthquakes have indicated that damages of waterfront retaining structures are are primarily due to soil liquefaction and the associated ground failures. The current standared of practice for the design and remediation of waterfront retaining structures typically utilizes traditional limit equilibruim methods. However, performance based design method is more appropriate for designing waterfront retaining structures. Changing from a limit equilibrium method of design to a performance based design method, there is a need for a better understanding for the seismic performance of waterfront retaining structures.

The objective of this research is directed towards numerically investigating the seismic behavior of waterfront retaining structures/ soil system , in relation to variables such as wall dimensions, liquefaction resistances of subsoil below and behind wall, the thickness of soil deposit below the wall as well as the levels of seismic shaking at the base layer. The investigation has also examined the effectiveness of ground

improvement techniques in controlling permanent seismically-induced deformations to provide guidelines for remediation optimization. This research will be useful for future seismic design of gravity quay walls. Based on the results, design considerations have been provided.

**Keywords:** liquefaction; waterfront retaining structures; ground improvement techniques; remediation optimization.

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