Proceedings of the Eighth (1998) International Offshore and Polar Engineering Conference
Montréal, Canada, May 24-29, 1998
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ISBN 1-880653-34-6 (Set); ISBN 1-880653-38-9 (Vol. IV)

Dynamic Behavior of Gravity Type Quay Wall-Backfill System During Earthquake with Regard to the Liquefaction of Backfill

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ABSTRACT

The dynamic behavior of the gravity type quay walls during the earthquake was investigated experimentally and analytically, and the effect of the liquefaction of the backfill ground on the dynamic earth pressure and the damage to the quay wall was made clear. Series of model shaking table tests under gravitational and centrifugal forces were conducted, focusing on the occurrence of the liquefaction in the backfill ground. The fluctuating earth pressure on the caisson is quite different in magnitude and phase angle difference with inertial force, whether liquefaction of backfill occurs or not.

The careful examination of fluctuating earth pressure in the process of liquefaction showed that the interaction between caisson and backfill controls the fluctuating earth pressure; the fluctuating earth pressure changes as a function of natural frequency of backfill with respect to that of the caisson, which reduced due to the softening of backfill induced by the liquefaction. This feature is demonstrated by the simplified mass-spring-dashpot model proposed by the authors. Also the dynamic behavior of gravity type quay wall is simulated by using non-linear Finite Element Method (FLIP).

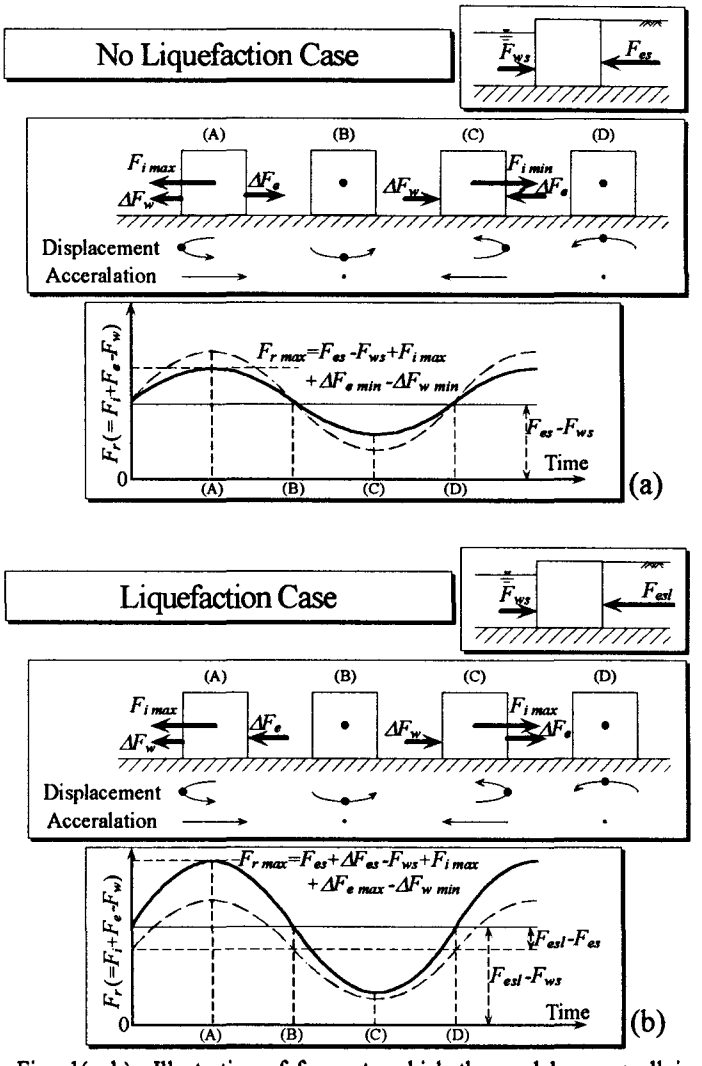
KEY WORDS: Gravity Type Quay Wall, Earthquake, Liquefaction, Shaking Table Test, Mass-Spring Model, Finite Element Method, Centrifugal Test

INTRODUCTION

Significant damages were caused by liquefaction in the reclaimed lands of port and harbor facilities during the recent earthquakes in Japan. The functions of quay walls were frequently lost severely when the gravity type quay wall caissons were displaced toward sea and/or subsided due to the thrust from the liquefied backfill ground.

Table 1. Physical properties of siliceous sand used

Grain density ρ_s	Mean diameter D_{50}	Uniformity coefficient, U_c	Maximum density, $\rho_{d\,max}$	Minimum density, $\rho_{d\,min}$
2.717 g/cm^3	0.18 mm	1.82	1.61 g/cm^3	1.255 g/cm^3



Figs. 1(a, b). Illustration of forces to which the model quay wall is subjected; (a) dynamic component in the no-liquefaction case, (b) dynamic component in the liquefaction case.