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ANALYSIS OF THREE-DIMENSIONAL SEDIMENT GRAVITY FLOWS

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In recent years, offshore pipeline engineering has increasingly dealt with continental slopes and deep waters. This means new problems have to be faced, that were previously disregarded. Among these, the hazard of sediment gravity flows has received attention due to the richness in the physics involved and environmental consequences. The importance of pore water pressure in debris flows was point out by Iverson (1997). We consider that the changes in pore water pressure may exert significant effects on the process of subaqueous liquefied sediment flow. However, current flow models are mostly deth-averaged ones and cannot describe fully the process of pore fluid migration that should occur in the flowing sediments.

The purpose of this study was to extend a fluid-dynamics-based method so as to predict the flow dynamics of liquefied granular soil in coastal oceans. Specifically, it aims at describing the mobility and internal flow structure of the liquefied soil with consideration solidification.

A three-dimensional analysis code along this line has been developed in the present study by extending a two-dimensional analysis code developed by Sassa et al. (2003). The analysis procedure is based on the integrated system of three-dimensional Navier-Stokes equations for a fully liquefied soil domain and consolidation equation for a solidifying domain soil. The Navier-Stokes equations together with the equation of continuity may be solved using a finite difference method. Specifically, a simplified MAC method (Amsden and Harlow, 1970) in terms of staggered rectilinear grid is applied, and the Poisson equations regarding the excess pore pressures are solved using the Gauss-Jordan method. For the purpose of identifying the moving interface between the ambient fluid and the liquefied soil, we adopted the volume-of-fluid (VOF) technique (Hirt and Nicholas, 1981). The VOF technique also permitted us to track moving interface between the liquefied soil and the internally formed zone of solidified soil can be predicted, based on the equation of consolidation.

We examined the validity of the proposed analysis procedure against a dam-break problem in which a column of water in air collapses under its own weight. The predicted time histories of water front location and the water column height is shown in Figure 1. The experimental results of Martin and Moyce (1952) and the calculated results in terms of the two-dimensional code are also plotted in this figure. It is seen that the predicted performance compares favourables with the observed flow behavior, validating the proposed analysis procedure

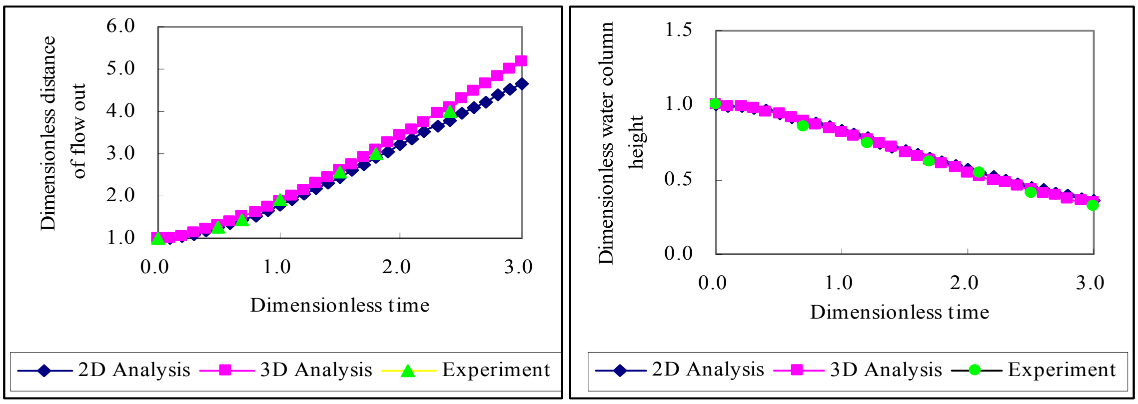

Figure 1 Predicted and measured time histories of water front location and water column height