

## Cross-shore Change of Beach Profile in Two Shapes of Beach Slope Breakdown

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### ABSTRACT

A numerical analysis is performed to predict actual change of beach profile due to cross-shore sediment transport during severe storm. In the existing cross-shore beach erosion studies, calculation of cross-shore sediment transport includes only continuous process of beach erosion but stability of beach slope which predicts time of beach breakdown during erosion is not considered. In this study, the process of cross-shore beach erosion and beach profile change are simulated by various shapes of sand covering over the beach after breakdown. The stability of beach slope using the critical equilibrium analysis is analyzed on every changing beach profile in every given time to predict the actual change of cross-shore beach profile. The measured cross-shore beach profile, storm surge level and wave height in Florida in U.S.A. are used for the numerical analysis and various values of soil modulus based on the existing studies are applied in the stability analysis of beach slope.

**KEY WORDS:** Cross-shore beach erosion; equilibrium beach profile; stability of beach slope; safety factor of slope

### INTRODUCTION

Recently, Korea coastlines and beach profiles have been variously changed due to indiscreet coastal development, construction of coastal structures and unexpected super typhoons. Change of coastline and beach profile results in change of wave height, wave breaking, wave driven-current and so on, and it causes some coastal problems, such as coastal erosion and accretion, coastal structure damage and so on. Since continuous retreat of coastline and loss of beach sand due to coastal erosion causes geotechnical problems and eventually affects stability of coastal structures and houses adjacent to coastline, it is crucial to predict erosion process and stability of beach slope to protect coastal structures.

Sediment transport, generally, is divided into longshore sediment transport and cross-shore sediment transport. Longshore sediment transport is driven primarily by an alongshore wave-induced current produced by waves approaching at an angle to the shore. Cross-shore

sediment transport is considerably generated during storm. Dean(1977) introduced the equilibrium beach profile theory in his study of beach erosion. Kriebel and Dean(1985) developed a time-dependent beach and dune erosion model(EDUNE) using the equilibrium beach profile theory, and applied the model to beach erosion in Florida during Hurricane Eloise(1977).

In this study, the process of beach profile change in a given time is analyzed to predict the actual change of beach profile during storm using EDUNE model and SLOPILE(Ver. 3.0), which is able to determine the stability and the time of breakdown of beach slope. The measured cross-shore beach profile, storm surge level and wave height in Florida are used to calculate the time-dependent process of beach erosion and various values of soil modulus based on the existing studies are used for the stability analysis of beach slope.

### BASIC CONCEPT AND EQUATIONS

#### Cross-shore beach erosion

As shown in Figure 1, beach profile before storm responds to a stable equilibrium form relative to a given water level and wave height. However, as water level and wave height increase during storm, wave breaking occurs closer to the shore, leading to an increase in wave energy dissipation per unit volume across the beach profile. Since the wave energy dissipation per unit volume,  $D$ , in the surf zone is greater than the equilibrium wave energy dissipation per unit volume,  $D_{eq}$ , the beach profile evolves to a new form until energy dissipation is reduced to the equilibrium value.

Dean(1977) derived Equation (1) for equilibrium beach profile forms,

$$h(x) = Ax^{\frac{2}{3}} \quad (1)$$

where,  $h$  is the water depth at a distance  $x$  seaward of the still water shoreline and  $A$  is a scaling parameter. A scaling parameter is expressed as Equation (2),