BEACH NOURISHMENT IN THE PRESENCE OF A SEAWALL: ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS

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INTRODUCTION

Beach nourishment projects are usually constructed to counter past erosion. In some cases earlier erosion control efforts have utilized armoring such as seawalls and in these cases there may be little sand remaining in the nearshore. Due in part to the costs of beach nourishment, it is essential to be able to predict their performance. For projects constructed on a long unobstructed shoreline of compatible sand, the centroid of the planform anomaly can be shown to be relatively unchanged under the action of normal or oblique incident waves. Also, under the action of constant wave energy, the rate of increase of the planform variance is constant. The behavior of a beach nourishment project fronting a seawall was investigated and was found to differ markedly from one constructed on a beach with compatible sand.

RESULTS

It can be shown theoretically that for the case of oblique waves and no ambient sand transport, the placed sand, in effect, "cannibalizes" itself on the updrift side and deposits on the downdrift side, resulting in a migration of the planform centroid. Under the most idealized conditions in which the transport is nearly uniform over the effective length, l_e, of the project, the speed of the centroid, U_c, is determined as

$$U_c = \frac{Q_o l_e}{V} \qquad (1)$$

in which Q_o is the transport and V is the total volume placed. Because of the planform spreading and the associated increase in the effective length, l_e, with time, the speed, U_c, also increases. Additionally, it can be shown that the planform variance increases at the same rate as it would for the case of nourishment along a sandy beach. These results are based on the assumption that the transport is nearly uniform along the length of the active project. As will be discussed later, because of the reduced transport along those portions of the project for which the transport does not extend over the full water depth, the experimental results differed considerably from the theory.

Experiments were conducted in the basin of the Coastal and Oceanographic Engineering Laboratory of the University of Florida. Conditions included both sandy and seawalled shorelines, normal and oblique wave incidence and two sands of 0.2 and 0.5 mm median diameter. Regular waves of 3.5 cm height and 1.0 sec. period were generated. The planforms were documented at 0, 0.25, 0.75, and 1.75 hours. Replicate tests were conducted for all cases and generally agreed well. Figure 1 presents one set

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of planform evolution data for the 0.2 mm sand size and 30° obliquity. The data were analyzed and compared with the analytical framework as described in the following paragraphs.

As expected, the centroid was found to migrate for the case of oblique waves and nourishment on a seawalled shoreline. For normal incident waves and oblique waves on a sandy shoreline, the centroid remained stationary. For oblique waves and a seawalled shoreline, the centroid migration speed increased slightly initially and then remained nearly constant. The rate of increase of the planform variance was in good agreement with theory. Based on the measured planform evolution, the alongshore sediment transport distribution was calculated from the conservation equation and served as a basis of comparison for a numerical model developed to represent the nourishment response. Based on comparisons between the measured and calculated transport, it was possible to determine the sediment transport coefficients and to develop models for transport over submerged profiles. The transport coefficients with a seawall present were found to be greater for the case of oblique than normal incident waves. This is attributed to the influence of the transport reductions for the submerged profiles because the transport coefficients were determined to be relatively insensitive to wave direction for nourishment on a sandy beach.

The near best transport relationship for submerged profiles was determined to be

$$Q_A = Q\left(\frac{h_* - h_w}{h_* + B}\right)^n \qquad (2)$$

where Q_A is the transport actually applied and Q is the transport calculated as if the profile extended over the full depth, h_* and h_w are the limiting depth of sand transport and the depth of the sand at the wall, respectively, B is the berm height and n is an empirical exponent. The paper will present the full results from the study.

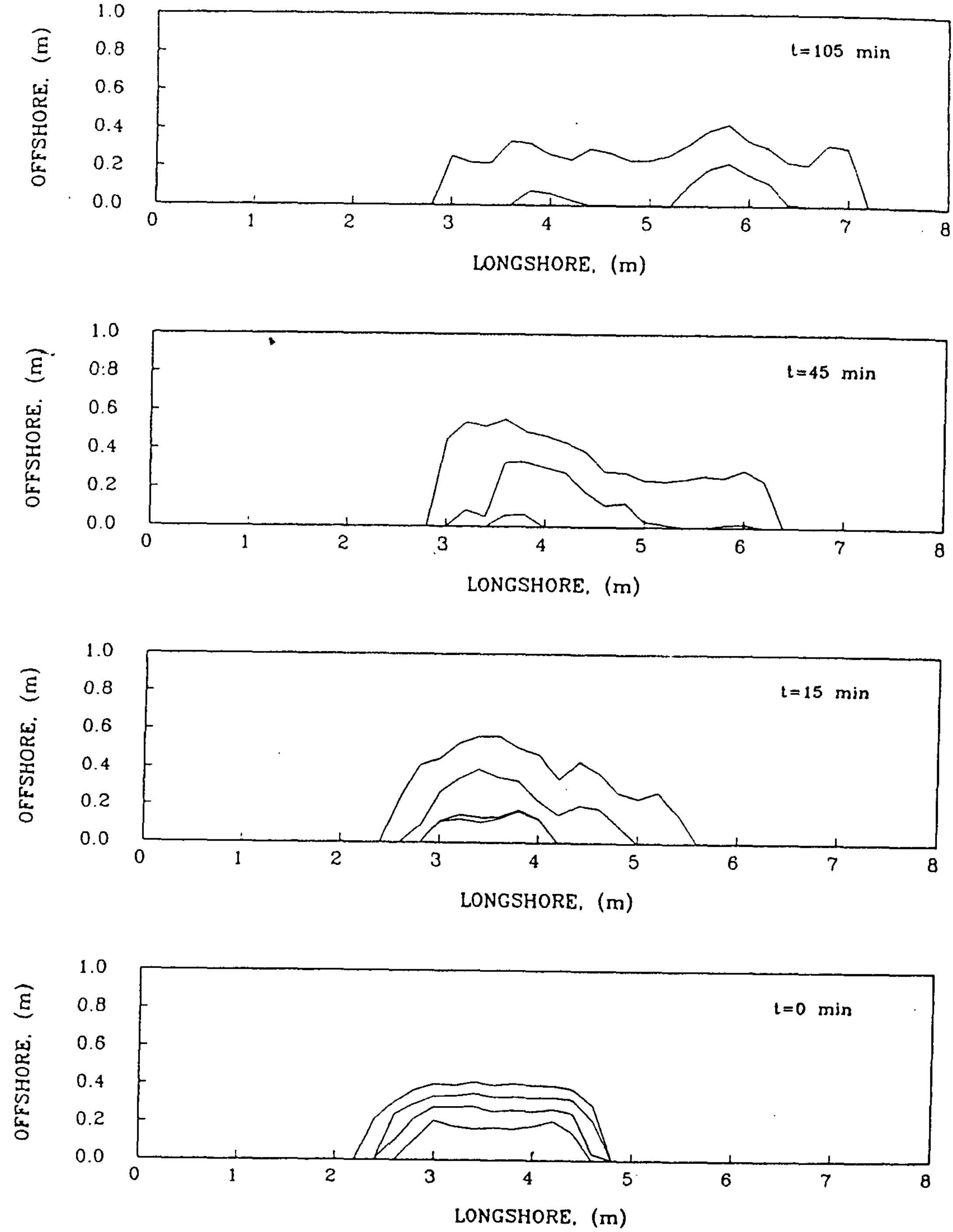

Fig. 1 Planform Evolution For a Seawalled Shoreline. Contours shown include +8, 4, 0 and -4m relative to still water level.