

Changes in Coastal Groundwater Flow Field Due to Coastal Drain System (Coastal Drain による海岸地下水の流況変化)

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1. Introduction

The characteristics of flow of the water through the porous medium are of great importance in the fields of Engineering and groundwater geology. Dewatering systems have been attempted as one of the ‘Soft Shore Protection’ methods against beach erosion. The dewatering techniques are trying to manipulate the water table under the beach surface to control the erosion.

The best location for the dewatering pipes to be placed has been one of the frequently asked but not frequently answered questions. The location of the dewatering plays an important part to control the water table and stabilize the sandy beach. So, from the practical point of view, the selection of the location has crucial importance especially at sites where tidal range is not small.

Another aspect of the dewatering techniques to be answered is the way to dewater, i.e., gravity drain or forced drain with suction.

The aim of this study is to provide the information about the effective dewatering location and the dewatering way by clarifying the changes of the water table and the flow field under the beach surface including the infiltration velocity on it under the operation of a dewatering system.

2. Theoretical Background

Let us consider a two dimensional problems. Where x is the positive landward distance, y is the vertical distance and the beach face forms the angle β with the horizontal. L is the distance between the drainpipe and beach face. H is the vertical distance between the drainpipe and still water level. Groundwater collects with the pipe and eventually drains by gravity to a sump, thereby artificially lowering the groundwater table in the immediate vicinity of the beach foreshore. The filtered water is pumped from the sump either offshore or to near the beach. The permeability component, k , appearing in the following equation is called hydraulic conductivity. The hydraulic head is denoted by h . In our research work, a numerical model is developed on the change of the groundwater flow field under dewatering taking the tide into consideration by considering the Darcy’s law. The steady-state continuity equation for 2D is shown as follows

$$\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} = \frac{\partial}{\partial x} \left(k \frac{\partial h}{\partial x} \right) + \frac{\partial}{\partial y} \left(k \frac{\partial h}{\partial y} \right) = 0 \quad \text{where, } v_x = -k \frac{\partial h}{\partial x}, \quad v_y = -k \frac{\partial h}{\partial y}$$

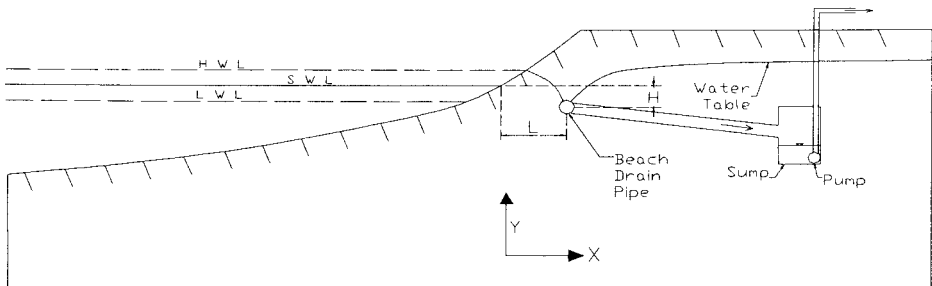


Figure 1. Sketch of Typical Beach Drain System

The Finite Element technique is used to develop this mathematical model. Where the 204 triangular elements and 131 nodes are considered in the domain, shown in Figure 2. The tidal water level is considered at the onshore and the boundary condition at the onshore is used as a moving boundary with respect to time. The coupling & decoupling of the exit point profile is applied by considering the characteristics of the sand. We have considered the coefficient of permeability k is 0.0032 m/s and the porosity n is 0.30.

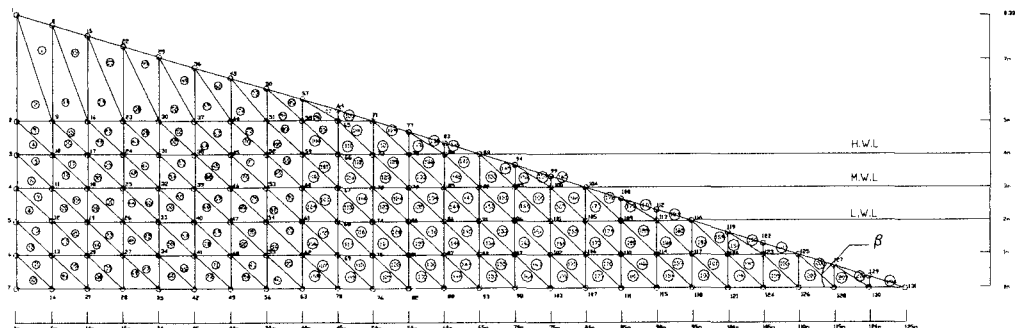


Figure 2. Definition sketch for the triangular elements and nodes

3. Result and Discussions:

The calculations are done with and without the drainpipe. The drainpipe is placed at the different locations. Here, the tidal range is considered as 2m and a drainpipe is placed at a distance 55m in x direction and 2.5m in y direction. A number of calculations are done by changing the x & y parameter. It is observed that the water table goes down while drainpipe is placed but the water table characteristic

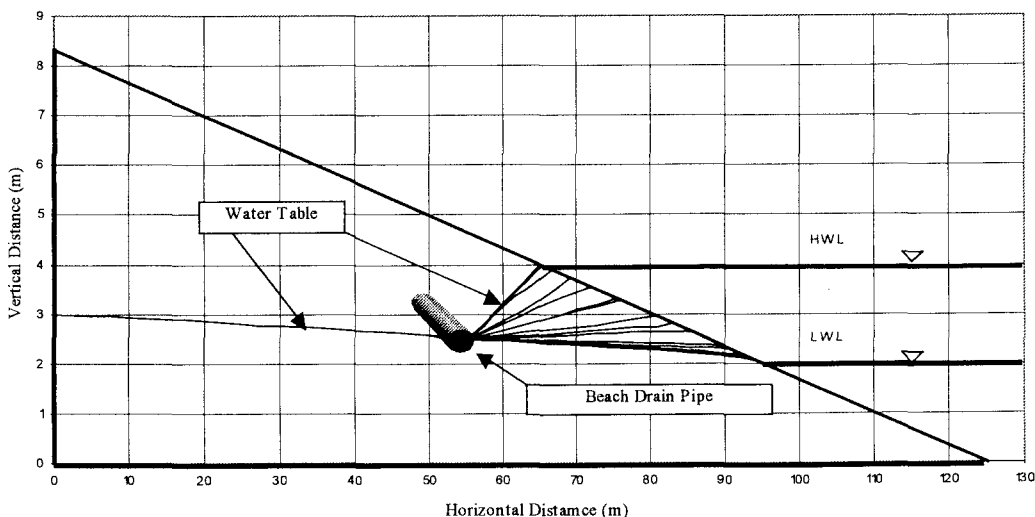


Figure 3. Calculated water table profiles with drainpipe

depends on the location of the drainpipe. The velocities of the seepage also depend upon the location of the drainpipe, which may be one of the factors to retard beach face. Detailed results will be shown at the time of presentation.