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Effects of Soil Modulus and Flexural Rigidity on Structural Analysis of Water Intake Basins

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Abstract

A water intake basin is a buried box that functions as a water reservoir near shorelines. Number of these structures has been increased in the recent years and for a safe design, it is necessary to know their behaviour under applied loads. In addition to common dead, live and seismic loads, the bottom of such a basin is usually located below sea water level and endures uplift pressure as well as reaction of supporting soils. Uncertainty of these special loads complicates the structural response of this buried basin to the applied loads. Therefore, the unreliability in the soil parameter and in the rigidity of the basin structure is studied in this research by calculating the generated internal bending moments. Different loads and load combinations have been taken into account and finite element analysis is carried out for modelling nonlinear behaviour of different types of supporting soils. It is concluded that the geometry and flexural stiffness of the basin affects the analysis more than the soil parameters because the contribution of the soil modulus in the total stiffness of the system is negligible than the structural rigidity of the basin structure. In addition, inner walls and geometry of the basin should be modelled in detail to obtain acceptable results.

Keywords: Soil Modulus; Water Intake; Rigidity; Bending Moment.

1. Introduction

In recent years, water consumptions have been increased due to development of industrial activities as well as extension of urban areas. Although demand of potable water has been expanded, the source of water is limited and its consumption should be done with special attentions. Desalination plants near seas are cost effective and reliable methods for establishing the required source of water [1]. In these systems, the sea water comes to a water intake basin through marine pipes and then the water is pumped from the basin to the required destination. Destination can be a plant or a crowded area with industrial or urban activities. Seawater intakes can be classified to submerged and buried intakes [2]. In a submerged intake, water comes to a basin through offshore pipes and in a buried intake system, water passes through screens and drilled wells. The capacity of the latter case is limited; however, a submerged system is applicable in different conditions and it is a common practice for providing required waters for industries. A chamber structure is usually used at offshore and water comes to inland basin through pipes. A desalination system has different parts including a water intake and an effluent outfall. There are some criteria and studies for the intake and outfall conditions [3, 4] and different shapes of the offshore chamber is investigated [5], but studies for the structural behavior of the intake basins is limited. This basin is actually a buried structure because its bottom level is under the sea level and the water comes to the basin by gravity. The basin acts as a box with interior walls and soil pressure as well as water pressures exert on the exterior walls. In addition, the bottom slab should resist against uplift force and soil reaction. Analysis of this structure is complicated because it is a combined system of solid, water and soil. The thickness of the bottom slab is usually uniform and the soil beneath the intake basin support the basin with reaction forces. In addition to the bearing capacity of the base soil, differential and total settlements also control the design [6]. Although the thickness of the bottom slab affects differential settlement and bending moments, its effect on the total

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