Numerical Evaluation of Foundation of Digester Tank of Sewage Treatment Plant

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Abstract

In the present study the foundation of digester tank, main part of sewage treatment plant, is reanalyzed analytically and numerically to check the adequacy of such foundation to support superstructure loading. The foundation of digester tank consists of raft foundation and bored piles. The diameter of raft is 33 m and thickness of 1 m, while the piles are bored type of diameter 0.6 m and length 15 m. After testing eleven working piles, it is found that three piles cannot support a load of 1.5 times the working load (1305 kN) safely or in other words the factor of safety of these failed piles is less than 1.5. The results of filed pile tests are reanalyzed using two well-known methods, Davisson's method and Brinch-Hansen method to check the ultimate carrying capacity of tested piles. Also, this paper includes analysis of previous soil investigation report and conducting additional soil investigation by drilling three boreholes to secure the soil parameters used in the analytical and numerical analysis of digester tank foundation. SAFE 12 software is used to analysis the foundation of structure as piled-raft instead of pile group to interest from the interaction between soil and raft foundation. The results of analysis showed that the piles failed in the tests can support its share of the superstructure load by a factor of safety 1.8 and the piles success in the field tests can support its share of the superstructure load by a factor of safety not less than 2.86. Also, the settlement under structure will be less than 100 mm, where using piled-raft analysis reduces the settlement to be within allowable limits.

Keywords: Pile; Raft; Foundation; Soil; Tank.

1. Introduction

The digester tank is considered important structures in comparison with other structures that are consist the sewage treatment plant. The digester tank is reinforced concrete tank and consists of three main parts. The upper part is of a conical shape with outer radius of 12.5 m and height of 6.5 m, the middle part has a cylindrical shape with outer radius of 12.5 m at its upper part (7.3 m height) and 12.8 m at its lower part (6.45 m height) and the lower part of the digester is of an inverted conical shape with outer radius of 12.8 m. The total height of the tank will be 29.25 m. The tank is supported by eight triangular radial walls that fixing the inverted conical base to the tank raft. The foundation of tank is a reinforced concrete raft of 16.5 m radius and 1 m thickness resting at a depth of about 2.5 m below the ground level. This raft is supported by 193 piles distributed in a radial direction. The bored piles of 600 mm diameter and 15 m length were casted in situ using reinforced concrete. The digester is currently under construction and 193 piles were constructed and the raft has been casted as well. The structural designer has defined the working load of each pile as 870 kN [1].