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Analysis of the Load Displacement Behaviour of Bored Pile using Different Soil Constitutive Models for Chittagong Soil

Sultan Al Shafian[1], Jin Zhenqi[2], Md. Shaheduzzaman[3], Fuad Bin Nazrul[4], Daud Nabi Hridoy[5], Musaddik Hossain[6]
[1,3,4,5,6] Islamic University of Technology
Boardbazar, Gazipur, Bangladesh
sultanalshafian@iut-dhaka.edu; shaheduzzaman@iut-dhaka.edu ; fuadbinnazrul@iut-dhaka.edu ; daudnabi@iut-dhaka.edu; musaddikhossain@iut-dhaka.edu
[2]CCCC
Karnaphuli Tunnel Project, Chattogram, Bangladesh
jinzhenqi0614@gmail.com;

Extended Abstract

Pile foundation is one of the most common and secure construction methods for high-rise buildings. A common technique for determining a pile's strength is the pile static load test. This static load test is a widespread practice to evaluate the bearing capacity for the piles, but the settlement behaviour could be affected due to the variation of the geological properties of the soil for example, presence of different layers of soil, compressibility of the soil, water level of the soil and many others.

Even though this test method is common among the engineers, there are some certain drawbacks of this test. Firstly, these load tests are expensive because of the arrangements. Secondly, these tests need reasonable amount of time to conduct before starting the actual construction works. In the case of failure, additional tests might be required which can impact the efficiency of the construction works to a great extent [1]. As the load-displacement behaviour of the pile is irregular for different types of soils [2], finite element analysis can be considered as an excellent tool to review and predict the results of the load tests [3],especially for middle-income countries like Bangladesh where rapid construction works are in progress. Also, these kinds of comparative studies have not been done before for marine areas of Bangladesh, like Chittagong where the soft soil condition is unpredictable. So, this kind of detailed analysis can provide a good reference for future construction.

So, the primary objective of this study is to examine the load-displacement results for three different types of bored piles using finite element analysis in Plaxis 2D and Plaxis 3D software. For this study, three distinctive bored piles with different bearing capacity have been chosen from the construction site of the Karnaphuli Tunnel Project. The diameters of the piles range from 500mm to 1000mm and the boring depth ranges from 25m to 40m. The applied loads on the piles were 1.5 to 2 times more than the actual design load for each pile. The geological conditions were almost similar for all the piles.

FEM analysis has been done using two different constitutive models, Mohr-Coulomb soil model and Hardening Soil Model. As the chosen location of Chittagong has multilayers of soft soil, so the applicability of the Hardening soil model is specially studied here. Certain soil parameters were calibrated based on the soil test feature of Plaxis[4]. A comparison has been made between the real-life load-displacement curve and the results obtained from finite element analysis.

Keywords: Pile Load Test, PLAXIS , Mohr-Coulomb Model, Hardening Soil Model, Load Displacement Behaviour, Soft Soil

References

[1] K. Muthukkumaran, S. Keerthi Raaj, and M. Vinoth Kumar, "Assessment of pile failures due to excessive settlement during pile load test," Japanese Geotechnical Society Special Publication, vol. 2, no. 73, pp. 2520–2524, 2016

[2] L. M. Zhang and S. M. Dasaka, "Uncertainties in Geologic Profiles versus Variability in Pile Founding Depth," Journal of Geotechnical and Geoenvironmental Engineering, vol. 136, no. 11, pp. 1475–1488, Nov. 2010

[3] R. Adel and R. R. Shakir, “Evaluation of Static Pile Load Test Results of Ultimate Bearing Capacity by Interpreting Methods,” IOP Conference Series: Earth and Environmental Science, vol. 961, no. 1, p. 012013, Jan. 2022
[4] M. Hatanaka and A. Uchida, “Empirical Correlation Between Penetration Resistance and Internal Friction Angle of Sandy Soils,” Soils and Foundations, vol. 36, no. 4, pp. 1–9, Dec. 1996