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Study on Capacities of Symmetry Multibucket Foundation for Soft Clays Strata Under Cyclic Loads

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Abstract

The influence of bucket spacing has been studied for either static capacities or cyclic capacities of symmetry multi-bucket foundation on soft clays strata. The changing law for adjustment parameter of vertical (horizontal) static capacities and cyclic capacities for different bucket spacing has been analyzed. The vertical (horizontal) static capacities of two-bucket and four-bucket foundation have been calculated though three-dimensional finite element analysis, and a method has been suggested to determine vertical (horizontal) static capacities for symmetry multi-bucket on soft clays strata.

Further, vertical (horizontal) cyclic capacities of two-bucket foundation for different bucket spacing have been determined considering cyclic strength at 1000 times of cycles as yielding strength. Several conclusions can be obtained though analyzing the relationship between adjustment parameter of vertical (horizontal) cyclic capacities and bucket spacing as well as static loads. Vertical (horizontal) cyclic capacities are related to static loads for certain bucket spacing. Vertical (horizontal) cyclic capacities are on the peak when static is 0.23 or 0.60 times of vertical static capacities. Adjustment parameter of vertical (horizontal) cyclic capacities is the function of bucket spacing not related to static loads, and it can be substituted with corresponding adjustment parameter of static capacities when the bucket spacing exceeds 1.0 times of bucket diameter. Then, a practical method, verified through cyclic capacities calculation results of four-bucket, has been suggested for determining vertical (horizontal) cyclic capacities of symmetry multi-bucket foundation on soft clays strata.

Introduction

As a newly and moving platform, bucket foundation has been widely used in the construction of offshore oil and gas

platforms since early 1990s. Because of its simplicity, reliability and cost savings, bucket foundation is specially applied to marginal offshore oil field. Studies have been done on uplift capacity and stability in subsiding for bucket foundation (Sherif EI-Gharbawy, 1999; M.F.Randolph and A.R.House, 2002). However, cyclic mechanical character of bucket foundation under static loads combined cyclic loads has not been well understood and applied, which will relate to designing and using bucket foundation in long-term ocean environment.

Up to now, several approaches to evaluating capacities under static loads combined cyclic loads are as followed. One method is to set up the constitutive relations of clays with cyclic loading and then calculate cyclic capacities by elastoplastic numerical method (Prevost, 1981; Marr, W. A., 1981; Wang Jianhua and Yao Minglun 1996(in chinese)). This method can follow cyclic stress path and reflect cyclic failure course in intuitive manner. But the workload of calculation will be extremely large and calculating results will be not easy to be collected because of calculating error are accumulated, especially in three-dimensional calculating. Andersen (1988, 1993) ever developed the method evaluating cyclic capacities on Drammen Clay. The soil element stress state along the potential failure surface and cyclic strength relationship at failure have been determined through a lot of cyclic triaxial and cyclic simple shear tests using quasi-static method. Cyclic capacities are further evaluated according to limiting equilibrium theory. The disadvantage lies in simplifying the three dimensional into plane problem and conducting a large number of cyclic triaxial and cyclic simple shear tests on the same soil sample. The action of cyclic loading on foundation soils is thought the reduction of its static strength and the cyclic capacities are estimated from the reduction strength of foundation soils using the static capacities formula (David, 1982). Because the strength of soils with cyclic loads depends on not only its cyclic stress but also its static stress, cyclic strength of each soil element is different in a foundation. Obviously, it is not appropriate that cyclic capacities are evaluated on uniform reduction strength of foundation soil using static capacities formula.

According to the soil element cyclic degradation strength is different with different element static stress, the cyclic capacities of foundations are determined by finite element calculation (WANG Jianhua and LIU Yuanfeng, 1998).The