Research on the Formation Mechanism of Suction Force during Uplift of Jack-up

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ABSTRACT

For the problem that the suction force forms at the bottom of spudcan during uplift operation for jack-up, based on correlative soil mechanics and permeation fluid mechanics computational theories and methods, the law and formation mechanism of the suction force at the bottom of spudcan was studied by numerical analysis on the suction force at the bottom of spudcan in the different soils. The result showed that the suction force at the bottom of spudcan of jack-up increased with decrease of permeability and the suction force got to the maximum when the separation between the spudcan and soil appeared. The suction force resulted from the negative pore water pressure which decreased first and then increased from center to outer edge and the distribution area of the minimum of negative pore pressure is concluded. The above study results demonstrated the essentiality of nozzle arrangement of jetting system and it provides a theoretical guidance for rational nozzle arrangement of jetting system.

KEY WORDS: Jack-up; uplift; suction force; mechanism

INTRODUCTION

Jack-up platform needs to be moved to the new job location after completion of the drilling operation. How to quickly and efficiently overcome uplift resistance is the important criterion to evaluate uplift operation working efficiency. Many accidents arising from uplift operation have taken place causing severe damages of the legs or even hulls of the units (Li Haiying, 1992). Suction force that can be eliminated by jetting is an important part of the uplift capacity. Vesic (1971) carried out an experiment on suction force of the round plate anchor, and the important factors for the formation of suction force were analyzed. Das and Shin (1978; 1980; 1994) showed that the suction force of plate anchor with different shape were measured and estimated under different load conditions. Purwana (2005) and Bienen (2009) carried out the extensive research that the suction force and jetting system were studied, and the feasibility for elimination of suction force was expounded. However, the research about formation mechanism of suction force in different soil is not thorough in most of the existing studies. Due to the different seabed soil properties of the location, the formation process and mechanism of suction force varies, which has direct influence on arrangement of jetting system. In this paper, based on the theories and methods of soil mechanics and saturated seepage, the law and formation mechanism of the suction force at the bottom of spudcan was studied by numerical analysis on the suction force at the bottom of spudcan in the different soils. The results provide a theoretical guidance for rational nozzle arrangement of jetting system.

NUMERICAL SIMULATION MODEL FOR SPUDCAN BOTTOM SUCTION FORCE OF JACK-UP PLATFORM

Physical model for numerical simulation experiment

The numerical simulation is conducted with ABAQUS, which is able to solve axisymmetric, plane-strain and three-dimension porous media seepage problems. The calculation and analysis for suction force of spudcan are carried out by an example of HYSY944 Jack-up platform. Due to only the analysis on the suction force, the soil above the spudcan isn’t established and the calculation process is simplified by using the axisymmetric model. The FEM is shown in Fig. 1, with diameter of 22.4 meters of spudcan, radius of 100 meters of soil and thickness of 50m of soil. The penetration depth is the actual depth. The element type is Pore/Stress and the soil is modeled with CAX8RP(an 8-node axisymmetric quadrilateral, biquadratic displacement, bilinear pore pressure, reduced integration).

Fig.1 Physical model for numerical simulation experiment