OTC 18016

Potential Benefits of Using Skirted Foundations for Jack-up Platforms

H.P. Jostad and K.H. Andersen, Norwegian Geotechnical Inst.

Abstract

The paper gives examples of the potential benefits of adding skirts to the spud cans of a jack-up platform installed both at a site with stiff clay and a site with dense sand. A jack-up rig with a longitudinal leg spacing of 56 m and a spud can diameter of 20 m is used in the example calculations. The environmental loads caused by waves, wind and currents are representative for a field with a water depth of 94 m in the North Sea. Models for fully coupled non-linear spring stiffnesses of the foundations with and without skirts are used in a simplified beam model of the jack-up structure. The spring models are valid up to and including the critical load levels where large permanent rotation and displacements of the individual foundations develop. Redistribution of local moments and reaction forces for the individual foundations and between the different foundations that will occur at high load levels are therefore accounted for. Based on the example calculations the global bearing capacity of the jack-up in stiff clay was increased by about 60% by equipping the spud cans with skirts. The corresponding effect for the dense sand site was by conservatively assuming drained conditions found to be 16%. The load factor where the critical moment in the leg is reached was increased by 16% for the stiff clay site and 23% for the dense sand site. The paper also includes some practical aspects that have to be considered when the spud cans are equipped with skirts. The paper is directed to those interested in studying the possibility to increase the global bearing capacity and foundation fixity of jack-up rigs by using skirted foundations.

Introduction

Jack-up rigs are widely used offshore as mobil drilling units for the exploration and production of hydrocarbons. For a jack-up rig to be feasible in large water depths, it may be necessary to take moment fixity of the footings into account in order to reduce the critical moment in the lower leg guide. The moment fixity may be increased by equipping the footings with skirts that penetrate into the soil, since the effective embedment of the foundation in stiff clay then may be increased significantly without increasing the preload. The embedment may be increased further by applying suction within the skirt compartment during installation. Increased embedment will also increase the bearing capacity of footings and thus also the global bearing capacity of the jack-up. For sand sites the effect of using skirts may be even larger since the preload in many cases only gives partial penetration of the spud cans. However, in order to penetrate skirts in sand it will generally be necessary to apply suction within the skirt compartments.

Example calculations

Jack-up data.

A three-legged jack-up rig of the Gorilla Class is used in the example calculations. The main dimensions of the rig are:

Longitudinal leg spacing	= 56 m
Transverse leg spacing	= 64 m
Available leg length below hull	= 132 m

The weight of the platform during operation is 204 MN, which gives an average leg load of 68 MN. The geometry of the spud can is shown in Fig. 1.

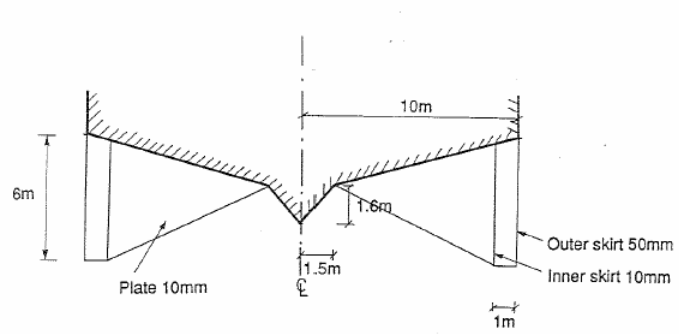

Figure 1 Spud can with 6 m long circular steel skirts.

The outer diameter is 20 m and the height of the base (from the bottom edge to the tip) is 3.9 m. The proposed skirt configuration is also shown in Fig. 1. The skirt system consists of a 50 mm thick circular outer skirt with a radius of 10 m, and a 10 mm thick circular inner skirt with a radius of 9 m. The two circular skirts are stiffened by 12 radial steel plates with thickness of 10 mm connected to the spud can tip. The height of the outer circular steel skirt is 6 m. The reason for this relatively complex skirt configuration is that the skirt system