

Caisson Foundations for Jacket Structures

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ABSTRACT

In order to simplify and make the installation of lightweight jackets more economical, a caisson foundation system has been developed. This paper describes the theoretical basis for the geotechnical and structural design of the caisson foundations as well as the system itself. A study investigating the technical and economical feasibility of such a foundation system for three different soil conditions is also presented.

NOMENCLATURE

| | |
|----------------|--|
| A_b | : base area of a single caisson |
| c_v | : coefficient of soil consolidation |
| FS_{ip} | : factor of safety against piping |
| FS_{uf} | : factor of safety against unloading failure |
| γ_s' | : submerged unit weight of soil |
| γ_w | : unit weight of water |
| K | : lateral earth pressure coefficient |
| L_d | : distance from mudline to skirt tip |
| N_c | : bearing capacity factor |
| p | : pore pressure distribution for no drainage |
| Q_t | : tip resistance without applied suction |
| Q_{ts} | : tip resistance due to applied suction ($q_{\delta u}$) |
| $q_{\delta u}$ | : allowable applied suction |
| r | : soil/steel roughness |
| $s_{u(av)}$ | : average undrained shear strength |
| T_p | : period of cyclic loading |
| u | : actual pore pressure distribution |
| α | : coefficient for reduction of tip resistance |
| σ_v' | : effective vertical stress |
| ϕ' | : drained friction angle |

INTRODUCTION

Traditional installation methods for lightweight jackets have shown to be time-consuming and expensive. Many design efforts have been undertaken to simplify the installation operations (Eriksen et al., 1990). Among those is a simpler foundation design.

Traditional jacket foundation systems consist of mudmats and piles. The mudmats provide unpiled stability until the structure is permanently anchored to the soil by piles. Pile installation costs are high due to a time-consuming operation and the expensive

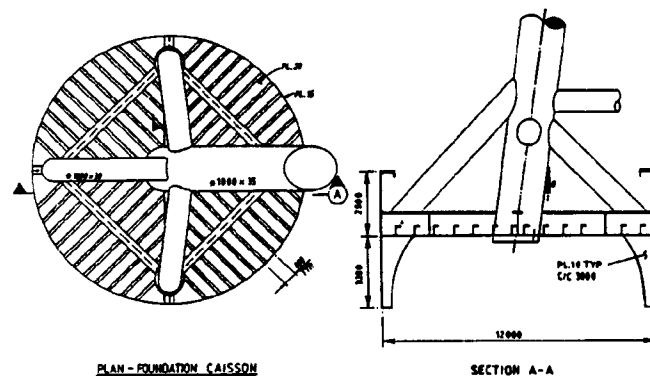


Fig. 1 Sketch of typical caisson foundation

pile-driving equipment.

By introducing large-diameter caisson foundations at the bottom of each jacket leg (Fig. 1), a simpler and significantly shorter installation period will be secured. The caisson foundation system consists of a base plate with skirts penetrating the soil. Skirt walls above the base plate may be required for ballast.

This paper describes the geotechnical and structural aspects of the caisson foundation system and presents technical results and cost estimates for three separate cases. The soil conditions applied for the three different cases may be described as follows:

- Site A: very dense sand
- Site B: dense sand
- Site C: stiff clay

The main case, Site A, is based on a North Sea riser platform conceptual study performed by Aker Engineering (AE) for Statoil. A jacket sketch is shown in Fig. 2. The scope of work for this study included a comparison of a traditional piled foundation system and a caisson foundation system. To investigate the effect of different soil conditions, caisson foundations for two other typical North Sea sites have been investigated. Parts of the work presented here have required geotechnical expertise provided by the Norwegian Geotechnical Institute (NGI).

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KEY WORDS: Jacket, caisson foundation, suction, skirt penetration, installation method.