An Overview of In-service Deep-Water Compliant Tower Platforms Worldwide

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ABSTRACT

Compliant tower platform is a fixed rig structure normally used for the offshore production of oil or gas. The platform consists of narrow, flexible (compliant) towers and a piled foundation supporting a conventional deck for drilling and production operations. Compliant towers are typically used in water depths ranging from 1,000 to 2,000 feet, which exceeds the economic limit of the fixed platform. In this paper, Compliant tower platform working principle was fully discussed, in contrast to a conventional skirted fixed platform, a compliant tower does not have battered legs. The overall configuration is usually slender, tubular steel, and the spatial frame is relatively constant with the cross-section size in the direction of the whole structure height. Compared with the traditional fixed platform, the structure is designed to resist the environmental force and inertia force. In addition, the platform structure is the least sensitive to deck weight load among all platforms, and the design stress level, steel tonnage and manufacturing cost are significantly lower than deep-water jacket platforms in water depth of more than 1,000 feet. Since the application of the first deep water compliant tower platform in the Gulf of Mexico in 1983, after more than 20 years of development, there are five compliant tower platforms in the world, three in the Gulf of Mexico and two in Angola, West Africa. Compliant tower platform is not a simple evolution and substitution, but a revolutionary technological development. Through the comparative analysis of the existing deep-water compliant tower platforms, the specific technical characteristics and application difficulties of the compliant tower are obtained.

KEY WORDS: Compliant tower platform; Flexible; Flex-legs; Nonlinear

INTRODUCTION

Compliant Piled Tower (CPT) platform has a more slender profile that requires less steel to construct. Due to its small base dimension, regular section geometry much more even distributed weight on skid beam, fabrication of CPT is relative easier. Unlike conventional platforms that are designed to resist forces, the compliant tower is designed to flex with the forces of waves, wind and current. The flex-legs are attached to the lower section of the tower with brace members and shear plates and connected to foundation pile with grout connections. The tower is secured to the seafloor with foundation piles. With flex-legs, resonance is reduced and wave forces are de-amplified. Compared with floating systems, such as tension-leg platforms and SPARs, the production risers are conventional and are subjected to less structural demands and flexing. However, because of cost, it becomes uneconomical to build compliant towers in depths greater than 1,000 meters.

Unlike conventional offshore fixed jackets, CPT is designed to have natural period much beyond the wave period to avoid significant wave dynamic response. This however, similar to floats, second order motion will be introduced and its induced structural response will need to be accounted for. Non-linearities, such as relative wave particle velocity, flex-leg friction on flex-leg guides, primary member P-Delta effect, as well as hysterical soil behavior, etc., shall be included in the CPT in-place analysis. Thus more sophisticated analysis methodologies and tools compared to conventional jacket design that can perform time domain non-linear random wave analysis is necessary. Other special design issues relate to the foundation piles, docking, verticality, interim construction, wearing, etc., shall be considered in the design as well. In general, CPT is a mature concept with mature design methodology and tool and similar fabrication and installation procedures and equipment compare to conventional jacket platform. CPT concept has distinct advantages over other platform concepts for the water depth ranging from 1,000 ft to 2,000 ft, topside weight is relative heavy, large number of well slots, traditional fabrication and installation method and resources.

TECHNICAL CHARACTERISTICS OF COMPLIANT TOWER PLATFORM

Compliant tower platform development is in water depth of 300 meters to 600 meters; in this water depth range beyond the economic limit of fixed platform, the overall configuration is usually slender, tubular steel, space frame and the cross-section size in the direction of the overall structure height is relatively constant. Compared with the traditional fixed platform, the structure is designed to resist the environmental force and inertia force. In addition, the platform structure is the least sensitive to deck weight load in all deep platforms, and the design stress level, steel tonnage and manufacturing cost are significantly lower.