OFFSHORE TOWER PLATFORMS: AN OVERVIEW OF DESIGN, ANALYSIS, CONSTRUCTION AND INSTALLATION

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ABSTRACT

Offshore platforms are very significant structures which have great impacts on the current economic development worldwide. These structures are developed for an assortment of capacities and in an alternate scope of water depths, and natural conditions. Offshore structures for oil and gas advancement investigation exist in various classes relying on their ecological and structural arrangement conditions. These structures might be fixed, moveable, complaint and floating structures. Production and loading operation includes more permanent structures. The paper covers predominantly the design, installation and construction of offshore tower platforms; basically emphases on the complaint tower platforms. The offshore compliant tower is utilized by way of exploration, manufacturing, lubricant stockpiling, otherwise lubricant arrival capacity in the oil industry. Compliant structures remain adaptable platforms to such an extent that little relocations and deformations are permitted unlike in the case of fixed structures. Such structures are harder to demonstrate. In any case, the requirement for more profound sea exploration with less cost of manufacture has made compliant towers more well-known as of late.

Keywords: Design, Construction, Installation, Offshore, Tower Platform

INTRODUCTION

A standout amongst the most vital design contemplations is extreme load made by tropical storm wind and waves which require in planning an enduring structure that can withstand the contradicting states of high winds and waves, earthquakes, tidal wave and ice impact. The arrangement of the compliant towers makes them more proficient to oppose waves and currents. One pivotal characteristic of the compliant towers is that they rely upon high strain in the pole or ligaments for constancy. Fixed structures, then again, rely upon structural rigidity meant for stability (Sadeghi, 1989), (Will, 1999).

In modeling the perpendicular members of the offshore towers, inflexible body movement and bending are the essential segments of the general conduct. This model is frequently utilized with composite liquid compelling models, keeping in mind the end goal to catch the nonlinear cooperation between the liquid and structure.

Based on the verifiable recognition the compliant tower idea has basically advanced through a development of three setups.

The primary raise in the mid-1980s through the establishment of Exxon's Lena stage, a guyed tower up to 1,018 ft water depth. What's more, upheld with 20 weighted guy ropes to accomplish compliance and steadiness.

A moment age of arrangements consistent, compliant towers, was presented amid toward the end of 1980's, which depended on the heaps for its elasticity and steadiness.

The most up to date age of compliant structure design is characterized using the 1998 establishment of:

a. Amerada Hess' Baldpate compliant structure which stands up to 1,650-ft water depths,
b. Texaco's Petronius tower, up to 1,754-ft water depths (Will, 1999).

DIFFERENT TYPES OF OFFSHORE STRUCTURES

Contingent upon the natural, structural arrangement and water depth conditions of the offshore structures for oil and gas improvement has been subdivided into subsequent groupings as given below.

Fixed Platforms

There are numerous conceivable designs of fixed platforms. The principle favorable position of these kinds of platforms is their solidness. As they are appended to the ocean floor, there is constrained development because of the impacts of wind, current and wave forces. Be that as it may, these platforms can't be utilized as a part of exceedingly deep water. This is additionally divided into two groups: i) Steel template Structures, ii) Concrete Gravity Structures.

The steel template type structure comprises of an elevated upright segment ended with tubular steel members sustained by piles driven into the bottom of the ocean and a deck put to finish everything, giving space to staff quarters, a boring device, and manufacture services. The fixed platform is monetarily possible for fitting in water depths up to 500m (Nouban et al., 2016), (Kapadiya, 2014), (Sadeghi, 2001), (Nallayarasu, 1981).

Concrete gravity platforms are for the most part utilized as a part of the region wherever attainability of pile installation is inaccessible. These platforms are exceptionally regular in regions with solid ocean floor topographical conditions also with rock protrusion otherwise sandy development. These structures are essentially concrete casings gathered in circular clusters with column segments anticipating to above water to help the deck and services. Concrete gravity platforms can be built in water depths as far as 350m (Nouban et al., 2016), (Kapadiya, 2014), (Nallayarasu, 1981).

The main types of fixed platforms are listed below.

i. Template (jacket) platforms,
ii. Tower platforms,
iii. Tension Leg Platforms,
iv. Gravity Platforms,
v. Sea Star Platform,
vi. Spar Platform (Muyiwa and Sadeghi, 2007), (Sadeghi, 2008).

Moveable Structures

i. Jack-up Platforms,
ii. Submersible platforms,
iii. Semi-submersible (Nouban et al., 2016), (Muyiwa and Sadeghi, 2007), (Sadeghi, 2008).

Floating Production System

Floating production frameworks are substantial boats outfitted with handling facilities and moored in an area for a long stretch. The fundamental kinds of floating production frameworks are:

i. Floating Production, Storage and Offloading System (FPSO),

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ii. Floating Storage and Offloading system (FSO),
iii. Floating Storage Units (FSU) (Nallayarasu, 1981).

Compliant Structures

Guyed Tower

A guyed tower is an expansion of the compliant tower by means of guy wires attached to the ocean floor by methods for anchors or piles. This guy lines control the influence movement and the parallel relocation of the platform topsides. Guyed towers are basically introduced for both adventure boring and production drilling. For the most part, these sorts of towers are sent to medium water depths, differing from 200 meters to 600 meters. The fundamental segments of a guyed tower are thin truss steel structure upheld by a spud-can foundation and detained vertical by different rope or sequence guy lines which are detained set up by cluster masses and secure piles; bunch masses can ascend off the ocean bottom in outrageous conditions (Nouban et al., 2016), (Jia, 2017), (Nallayarasu, 1981).

Merits:

i. Low cost (less than steel jacket),
ii. Good strength, guy lines and cluster weights give additional restoring force,
iii. Likely recycle.

Demerits:

i. High running costs,
ii. Small fields only,
iii. Cost increments exponentially with depth,
iv. Difficult anchorage.

Articulated Tower

The articulated tower is considered as amplification of tension leg platform. The tension ropes are supplanted by one particular floating casing which requires enough flexibility and essential reinstating moment against horizontal loads. The fundamental piece of the configuration is the all-inclusive joint which attaches the casing to the foundation framework. The foundation framework ordinarily comprises of a gravity-based concrete block or at times with driving piles. The articulated tower idea is appropriate for transitional water depths reaching from 150m to 500m, and small field design (Nouban et al., 2016), (Haritos, 2007), (Jia, 2017), (Nallayarasu, 1981).

Unrefined petroleum ascends the tower and shifted to a fastened tanker for handling and storing and after that shuttle tanker gets processed oil and transport its shore or otherwise, pipelines are utilized rather than carry tankers.

Merits

i. Low cost,
ii. Large restoring moments due to the high center of buoyancy,
iii. Risers are protected by a tower,
iv. Attracts less force due to complacency,
v. Natural period greater than wave period,
vi. Result in lower dynamic amplification factor than that of fixed offshore structures,
vii. Light structures; simple to fabricate, easy for towing, installation and decommissioning,
viii. No base moment due to hinged joint, foundation design is simple,
ix. Buoy system may be used in deep water

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Demerits

i. Relatively shallow waters only,
ii. Undergoes greater oscillations at greater water depth which is undesirable,
iii. Cannot operate in bad weather,
iv. Limited to small field,
v. Fatigue universal joint - single point failure,
vi. Riser not protected by buoys.

Compliant Tower

Compliant Tower is more or less like fixed platforms. It comprises of a slender, elastic tower along with a piled foundation that can sustain an ordinary deck for boring and production processes. The adaptability of compliant towers endures huge horizontal forces by managing critical horizontal deflections and is typically utilized as a part of water depths between 300 m and 600 m (Haritos, 2007), (Nallayarasu, 1981).

The design accomplishes this by depending on a narrower tower of steel and concrete. However, fixed platform designs are inflexible, compliant towers are proposed to influence and move with the strains of wind and ocean storms. In this regard, they're much similar to current high rises that are working to influence by the wind (J. Jia, 2007).

The compliant towers are three-dimensional (3D) steel truss structures, which are thinner, less composite structure than the conservative deepwater fixed platform and have a seabed impression significantly not as much as a comparable steel-jacket structure. All things considered, it presents less fabrication constriction and more chances for economic (Seon, 2002).

As an example, the Baldpate Compliant Tower is one of the tallest freestanding structures in the world.

Construction Stages:

i. Design,
ii. Procurement,
iii. Construction,
iv. Load-Out,
v. Transportation,
vi. Installation,
vii. Commissioning,
viii. Operation (Sadeghi, 2004), (Muyiwa and Sadeghi, 2007), (Nouban, 2016).

ANALYSES AND DESIGN

The dynamic reaction of a compliant tower is vital, and dynamic analysis outlines some portion of the design procedure for this structure. An additional design and construction consideration is based on pile foundation design. Critical strain, pressure coupling forces are exerted in the piles as the structure deflects. Finding the piles close to the core of the tower, restricting the most extreme tower deflections, and choosing piles of adequate length to retain the imposed loads can confine the subsequent stresses in the piles. Compliant towers can be built utilizing strategies that have advanced for steel-jacket structures. A two-piece construction and installation can be embraced, for instance, as was utilized for the Petronius platform installation.

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CONSTRUCTION

Constructing multifaceted nature of submissive towers is insignificant. The basic outline of these structures is made with a rectangular arrangement and monotonous frame utilized all through the whole span of the tower segment. The compliant towers have less cost for mechanical framework segments required for long-haul execution. Or maybe, the entire auxiliary frameworks are made out of field demonstrated; the equipment and segments of the structure have been fabricated various circumstances in manufacture sites skilled with the construction of offshore structures which make it have less unit cost and of course an added advantage economically.

In a nutshell, the construction stages mainly include:

i. Design,
ii. Procurement,
iii. Manufacturing of steel assemblies,
iv. Load-Out ,
v. Conveyance,
vi. Fixing and,
vii. Commissioning (Nouban et al., 2016), (Sadeghi, 2008).

INSTALLATION

The installation systems aimed at the swimsuit compliant tower are demonstrated and might be taken care of via reasonable launch pushes existing in the Gulf of Mexico. Subsequently, the installation of flattening pile foundation on top of which the deck is to be positioned and the positioning of the deck is directed by two docking piles, the base itself is propelled and installed.

The base of every tower, pegs contained a cutting pin to facilitate into the delivery conduits of the arrangement deck. Formerly situated, and furthermore ballasted and networks grouted. Presently, the base was brought near the site, and then mounted by the gantry push in a solitary lift.

Hence, the fundamental base bundle, as well as the quarters, was raised up and position on the deck. Subsequent connection of streamlines and offices, opening oil manufacturing was documented within two months. Utilizing Baldpate and Petronius as illustrations, the regular way that the compliant tower can be launched, need no unique hardware, in addition to its engaging quality (Will, 1999).

Merits

These compliant structures proffer a considerable lot of similar merits that any base established structure delivering in shallow water depths. Moreover, the compliant tower advance permits certain advantages when contrasted with suspended systems. This includes:

i. Boring and production process: The topside compliant tower structure empowers boring and production to be completed at the same time not necessarily required for orderly mobile drilling tools that might be troublesome with more costly to hire (Will, 1999).
ii. Manufacturing riser and gantry sustenance: Similarly, submissive towers are capable provide and work by means of a focal manufacturing capacity, sustaining stage penetrated wells otherwise cable subsea tiebacks. Additionally, wells might be predrilled then incidentally uninhibited and connected back after fixing the tower. The

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exterior achievements enhance convenience for managing, upkeep and potential good adjusting (Will, 1999).

iii. Export riser support: These accommodating towers contain leeway as it can viably sustain vast steel diameter distributed risers, as well as steel catenary risers (SCR), J-tubes, otherwise pre-introduced risers (Will, 1999).

COMPARISON OF COMPLIANT TOWER EITH OTHER TOWER PLATFORMS

i. The fixed platforms were classified into the gravity base, the template (jacket) type and the truss tower compose. Regularly the template and tower structure are equally utilized for steel space frames, structures in common, despite the fact that there is an imperative distinction in the form of foundation. As for the template type, the piles for the foundation are driven via the legs and linked to the legs through a join at the best. To the truss tower platform, the foundation piles are attached to pile sleeves at the bottom of the platform, set as an example by grouting. As a rule, the help structure is initially put on the ocean floor after then the pile driving occurs (Wijgaarden, 2013).

ii. The primary contrast involving the compliant tower and the fixed structure is the pile dispersion: for a fixed structure, this implies the dynamic and static forces are altogether conveyed to the ocean bottom. While the compliant tower, then again, the lateral dynamic burdens are stabilized as a result of the inertia forces. This diminishes the internal forces in the tower and the supportive effects. The perpendicular dynamic loads are transmitted to the ocean bottom similar to a fixed tower, in light of the fact that the structure is vertically compelled from considerable movement, in spite of the fact that these forces are less normal increased in value. The static loads are shifted to the seabed similarly concerning the fixed structure (Sadeghi, 2007b), (Wijgaarden, 2013).

iii. The best kinds of plate frames where implied, for shallow or medium water depths. While, the current sort of compliant offshore structures are basically intended for boring, particularly in Deep Ocean. They are associated with the ocean stream, by enabling them to move openly under the activity of current waves, and wind; which is the horizontal force, leaving the structure. Clearly, the technique by which, these compliant structures are joined to the ocean stream, must be unique in relation to that of the fixed kind structures. As we recall, if there should arise an occurrence of fixed type structures, they are found in the ocean depths, either by piles or by gravity based basic framework or by spud cans. (Sadeghi, 1989), (Will, 1999).

iv. These structures, subsequently, obviously depend on a reestablishing flexibility constrain, to keep up the constancy, after any horizontal movement happens to the structure. In this way, the restoration of compliant structures, are basically and fundamentally, from the flexibility, force, which are acting upon the structures. These structures keep away from reverberation by working at a frequency well underneath that of the sea wave's frequency. This is thought to be, one of the best outline advantages, of the compliant kind of offshore structures.

WAVE ANALYSIS AND FURTHER INFORMATION

For extra data on the ecological information together with important equations and the information required for outline and examination of such structures, the guidelines, information and suggestions given by (Kaiser et al., 2013), (DNV Technical Report, 1996), (Jerman, 2015), (API, 2010), (Sadeghi, 1989, 2001, 2004, 2007a, 2007b, 2008 and 2013), (US Army Coastal Engineering Research Center, 1980), (US Army Corps of Engineers, 2002), Muyiwa and Sadeghi, 2007), (Sadeghi and Aleali, 2008) (Nouban and Sadeghi, 2013

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and 2014), (US Army Corps of Engineers, 2011), (Nouban, 2016), (Nouban et al., 2016) and (Nouban et al., 2017) may be utilized. (Nouban et al., 2017)

CONCLUSION

The enhanced competencies in ground advancement have remained delivered through a blend of outline progresses, enhanced arrangements along with lessened well tallies. Alternatives currently exist for incorporating boring and manufacturing among the outline of recent age compliant tower setups that are less heavy, less demanding toward manufacture and more reasonably priced to mount.

Compliant structure arrangements being more productive gives a method for enhancing ground improvement expenses by means of these efficiencies converting into bringing down assets uses required for the advancement of minor deep water locations.

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