SEMISUBMERSIBLE PLATFORMS: DESIGN AND FABRICATION: AN OVERVIEW

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ABSTRACT

Semisubmersible platforms (SSPs) are used to employ in some of the special offshore models such as oil and gas production platforms heavy lift derrick, offshore drilling rigs, and safety vessels. The SSPs have many benefits and approvable than other types of offshore platforms mainly because of the great yield, steadiness flexibility and compatibility to the sea state, Increasing both the safety conditions and production rate. The aim of this paper gives some information overview of the design, installation; consistency f SSPs also explain various categories of SSP and restriction of them.

Keywords: Offshore, semisubmersible platform, Design, fabrication, installation.

INTRODUCTION

Current research targets the SSPs (also called semisubmersible rigs) and their production facilities. There are five different categories of SSPs that was built from the early 1960s that vary according to the development of design and technology.

The first three SSPs are not more complex, lacking technology and without high-quality design, thus these structures have low production level. Approximately most of these SSPs have been transformed into drillships or floating production, storage, and offloading system.

Deck is the main component of SSPs may be one or more that situated on the system of immersed columns the hold the decks and give strong consistency to the structures. The columns operated as stabilized system structures. So that the center of flotation is located below the center of stability and is driven by the column restitute moment (Chakrabarti, 2005).

The first three Category SSPs were used in water under 400 m waterdepths. Beginning from the fourth production SSPs, working to water depths above 500 meters, where the new types of SSPs are working at deeper waters.

An SSP can be defined as a specialized watercraft (vessel) of its body form (70~85%) submerged in water (Sharma et al., 2010).

Employed in many of offshore utilizations such as offshore drilling rigs and heavy lift cranes SSPs are buoyant structures. The fundamental working of SSPs is drilling in deep waters. Generally, massive anchors due to their heavyweights maintain and hold the stability of SSP in the situation, the weight of one anchor is around ten-tons in the up directions. The immersed section of the rig together with these anchors, give more safety and stability to the platform in seawaters. Dynamic deployment is another factor that holds and sustains the SSPs in location. This type of platforms after drilling wells in the ocean floor are transported to another location easily (Sadeghi, 2007).

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The dynamic positioning system keeps the positioning of the rig. The SSPs can be utilized in waterdepth of 3000 meters (10,000 ft). (Leffler and Sterling, 2010).

The Blue Water Drilling Company created the first SSP in 1961. This company constructed and performed the four submersible boring structures and installed Rig No.1 in the Mexico Ocean for Shell Oil Company. There are currently six defined generations. The generations are based on building year, technology and capacities like variable deck load, capacity, and waterdepth (see Table 1) (Dobref, 2016).

Table 1. Generation of SSPs (Dobref, 2016)

Generation	Typical building period	Typical waterdepth (m)	Typical displacement(mT)
First	1962-1969	Less than 250	Less than 10000
second	1970-1981	300-450	16000-24000
third	1982-1986	800	25000-3000
fourth	1987-1998	1700	30000-53000
fifth	1999-2004	2000-3050	35000-53000
sixth	2005-20014	3050-3600	40000-60000

TYPES OF SSPs

Tourist SSP

Tourist SSP has one hull that can hold visitors to see various sea places. Its capacity change between 20 and 175 passengers. It's composed of passenger hull, outer hulls, hydraulic cylinders, pilot room, deck and isolated waterproof room for the motor. (Dobref, 2016).

Deep-sea research SSP

This type of platform can be used for watchful and investigation in ocean ambiance up to about 7400 ft waterdepth. It should be built in a consistent and strong form to be employed in harsh ocean water condition. Similar watercraft has a standard stern (back of neck) and bow (front of the boat) isolated and connected by a cylindrical tube-like structure. The accessories and apparatuses are designed and constructed in such way that even with the immersed of the ahead part of the ship, the craft easily and safely can work. (Leffler and Sterling, 2011).

Military SSP

This type of marine structure is employed for the military purpose. It has a limited upper-deck and all its combustion, motivation force device and attendants team house are located below water level. (Preston, 2001).

Heavy-lift SSP

Large watercraft can be rescued and salvation buoys using this type of platform it can be used for transporting of destroyed vessels and lifting of offshore steel structures, platforms and so on.

It composed of pilothouse machinery as well as small and length well deck. A heavy-lift SSP is mainly employed for carrying out of oil drilling rigs in the oil industry because such a vessel can move the platforms from their manufacturing place to a boring place (MVBM, 2009).

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Offshore drilling SSP

This sort of platform can be exerted for boring and drilling in a high depth of seawater. Pontoons are given extra floatation support. The vertical supports and pontoons which form the framework and body are of adequate suitable load dispersion to hold the platform stable and buoy. This draft has very small hydrodynamic movement, and now widespread use of this type of marine manufacturing as a steady rig for survey drilling for offshore petroleum products. It's possible hauled and pulled them into location by a tugboat and anchored.

Crane SSP

A crane SSP has high stability and therefore has the ability to lift and transport extremely loads. So it can be used to raise heavy structure such as equipment/vessel/boats and watercraft. A crane SSP composed of the bottom Skelton hull, vertical supports on each bottom and top Skelton hull. At present time, it has the ability to lift up to 25000 tons. The latest model has been capacity to set up water level at nearly to waterdepth of 9200 ft. (CSSDCVB, 2009).

Floating drydock SSP

This model of structure is applying to renovate, maintain and repair of watercraft. The construction and design of a buoyant drydock platform is not complex, it composed of either large workboat or bridge pontoon or drydocking watercraft. In addition, it contains a floating small compartment and a patulous crate shaped. The main privilege of this manufacturing is that it can be transported and can change its location to another for a long distance. This keeps initial construction costs lower by increasing competition among decrease or eliminates vessel stability problems when landing the vessel on the blocks. The dock can be easily moved for dredging the sinking berth when needed. (HMB, 2009).

Brief of building procedures

The offshore platform manufacturing can be supplied on the basis of turn-key, i.e. inclusive full accuracy design, finance possibility researches, fundaments, purchase, preparing erection and establishment of steel composite and device and apparatus, and authorize the production.

Fundamentally, an offshore platform-manufacturing project covering the stages mentioned below:

- Finance possibility researches,
- Field survey,
- Fundamental full accuracy design,
- Calculation for resistance and strengths of rig components,
- Regulating authorities,
- Obtainment and purchase,
- Generation of steel structures,
- Procurement,
- Loadout, hauling, and erection processes,
- Authorize production.

Commonly, construction of steel component for these types of equipment as a platform in the sea is performed at sitting appreciably far off from the working and erection location. Special and precision design with accuracy calculation for structural resistance stability are needed for Hauling of these big -sized components. Since offshore production processes need to immediate actions and appropriateness of engineering planning and arrangements, apparatuses/preparation of material, and processes steel building composition production, several of steps are usually carried out at the same time owing to the high accuracy programming and scheduling requirements. (Sharma et al., 2010).

ADVANTAGES AND DISADVANTAGES OF APPLYING SSP

Advantages

a) High mobility,

b) Good motion response,

c) Easily positioned over well template for well drilling,

d) Large number of flexible risers due to no weather venting system, keeping the platform fixed in place,

e) Stable in high sea conditions,

f) Not more expenses,

g) Fast tow speeds,

h) Large working areas from the broad platform deck size,

i) High working platform away from the wave actions.

Disadvantages

a) High operating and building cost

b) The stability depends on the limit capacities, where it will fail if the weight limit is breached

c) Expensive to tow beyond the distance limit

d) Well operations and moorage are difficult to handle during rough climate

e) Need a large drydock facility for maintenance and repairs.

SSP PLATFORM CONFIGURATION

SSPs platform composed of a hull that holds up the deck, several columns, and pontoons. The center of gravity is located above the buoyancy center, thus the columns arrangement specify the stability to the SSP. The weight of all constant parameter and changeable loads should be estimated which involving apparatus and system tooling and equipment for the functions.

During the initial design of an SSP, the shape and arrangement of the function, that carrying out it should be completely imagined and must be in hand which it greatly affected in configurational selection.

The four main configurationally ingredients are:

- Deck
- Stability columns
- Pontoons
- Pontoons

Hull

Legs are the main structure that maintains the platform buoyancy on horizontal pontoons and vertical columns. Both pontoons and columns are connected and fastened together in a circular cross-section pattern, which increase the strength and stability of the structure. The lower pontoons and legs are void to allow seawater to provide ballast to submerge the structure and to hold large quantities of diesel oil, drilling mud and fresh drinking water (Lim, 2000), There are four kinds of hull arrangements which are shown below in Figure 1.

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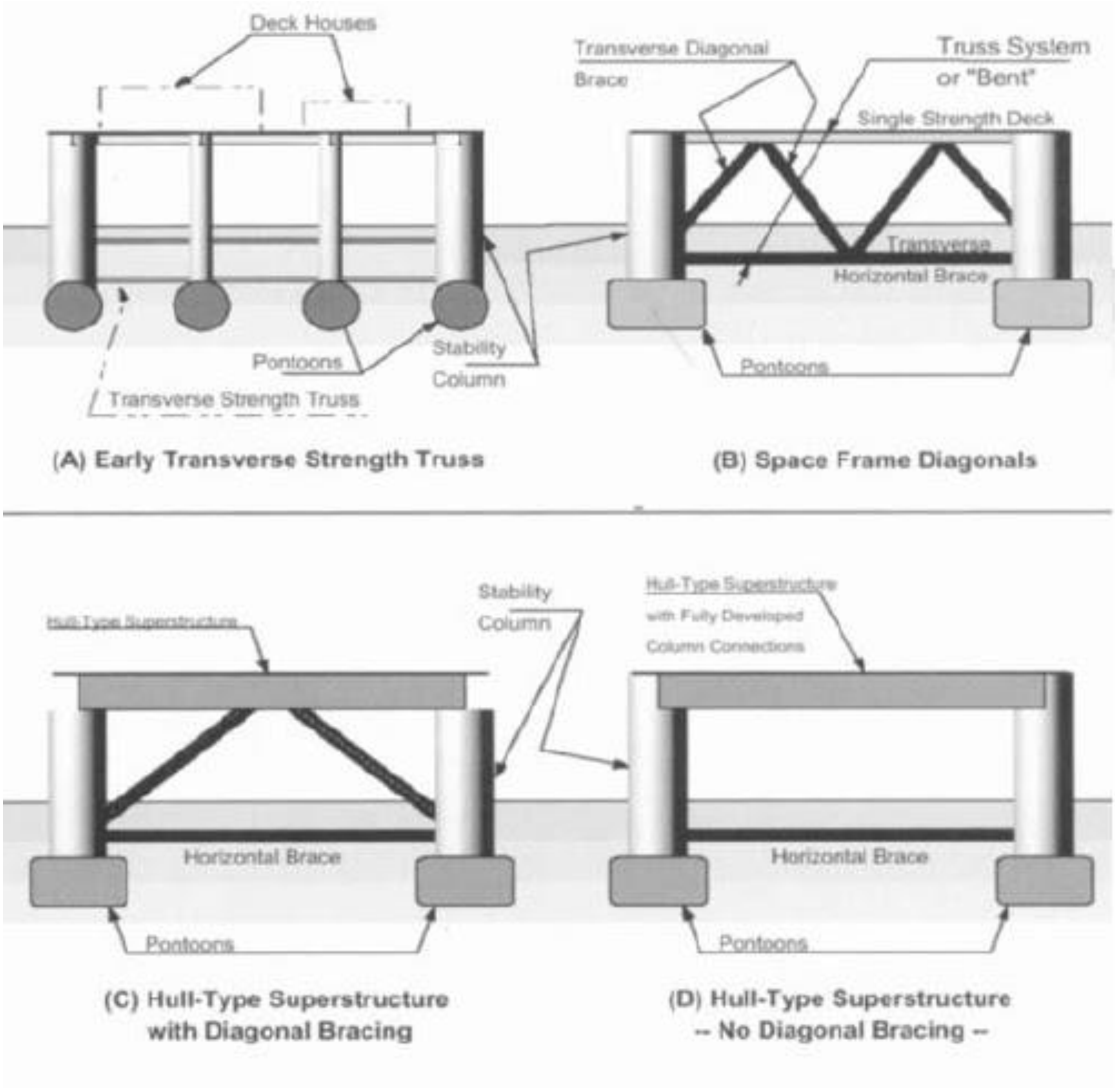

Semi-submersible sectional arrangements

Figure1. SSP sectional arrangements (Chakrabarti, 2005**)**

Columns and Pontoons

Pontoons give steady and flotation from its ballasted and waterproofing properties. The pontoons are placed under the water surface and wave motion. Columns provide stability where the SSP is submerging, the buoyancy properties change from the pontoons to the columns, and the column linked pontoons and deck. There are various shapes for regulation and arrangements of column and pontoons that gives stability and determine the capacity of the deck. The size of the SSP depends upon the deck area. (Lim, 2000).

Anchors

The anchors are fixed and fastened to the batch of wires and cables that contain 6 to 12. A mooring device employed to make it safe to the lower of the seabed where the vessel is motionless. The anchors acting an important function in drilling as the anchors must be strong and stable the ocean currents to sustain and hold the position of the platform.

The anchor is fabricated from metal and resisting the platform motions. The anchor is released and controlled automatically using dynamic positioning such as the global positioning system (GPS) until it reaches the seabed. When they are not in use, the anchors are stored on the deck (Sharda, 2014).

Bracings

Arrangement and shape of bracings are very significant and should be considered as shown in Figure 2. These configurations involve a crosswise strengthening, bottom on the supports, to stand out the force owing to pressure and compression. The cross-inclined bracing combined with horizontal transverse resist and support the deck weight, supply the lateral resistance and stable versus sea quartering phenomena. The strengthening system is invented mainly in the 3rd generation type of drilling SSP and newer.

Perfect and good design, as well as good jointing and connected deck structure and arranged and closed of rows of the pontoon, can reduce the number of needed bracings.

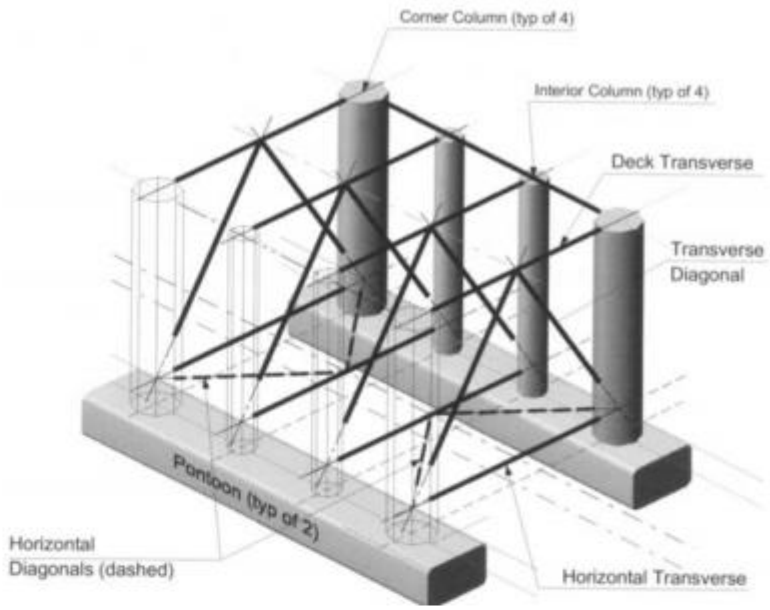

Figure 2. Typical 3rd generation SSP bracing system (Chakrabarti, 2005).

CRUCIAL DESIGN FOR SSPs

A suitable equivalent design is obtained through an approach integral. The unified approach, the design criteria (deck space, goods and substance hauling equipment and machines, movement, steady, operational properties, and buoyancy and safety (API, 2003) are optimized to obtain adequate and stable major particulars.

The Crucial design topic that influences the stability and proficiency of an SSP is stability and strength, the geometrical shape of aircraft (vessel), capability (changeable drilling load and complete changeable load), movements and fabrication.

THE BEST SHAPE ARRANGEMENT CRITERIA

Loads of deck

The favorable load deck is variable and its alteration at doing action ship draft influences the design of reserve planning. SSP should have the capacity to store more consumables while it is commonly away from the shore.

Capability of load

The speed of the fully loaded system relies on the load valence at transmission vessel. The minor pontoons may stay immersed in water while it has the lesser-speed transmission. The larger pontoons may stay relatively immersed but due to the heavy weight of steel, expense, and extra force necessary of the dynamic hold situate structures, they are not favorable. Moreover, the changeable load valence at performing and running vessel inversely proportional with pontoon volume. The larger pontoons due to having more expense, undesirable movement properties, and large power need to hold a dynamic stability apparatus. The larger pontoons are not economic. Therefore, the best favorable size of the pontoons has a significant role (Sharma et al., 2010).

Environment

Sea stream, wind velocity, and wave heights are the major factors that should be taking into account in designing the offshore platforms. In the rough and aggressive marine ambiance condition, to prevent wave impact on the lower part of the running deck, the height of the backing columns must be raised. The data about wind velocity, contemporary speed for the running and continuation design condition, duration, wave altitude are required. Generally, every 10 years and 100-year storm condition data (wave height, wind speed, sea current) should be chosen to stable and safe design of platform (Sharma et al., 2010)

Dynamic problems are produced due to the waves, and contemporary forces in structural examination and determination. And, the response forces in the ‘horizontal’ and ‘vertical’ orientation are generated by dynamic water-structural interplay. Generally, the physical ambiance criteria for the Gulf of Mexico are converged wind velocities of 170 km/hr, wave altitude up to 21 meters which associated to the profoundness of water in and velocities of wind of 170 kilometer per hour, for the, combine with stream flow of till 4 m in low water depth. In addition, for the Persian Gulf, the velocities of wind until 130 kilometers/hour and wind wave altitude up to 12.2 meters, accompany with circulation flow stream until 3 m are deliberated in analysis and design of platforms. The wave height about 19 m for a duration of 100 years can be used for design in the Southern Caspian Sea and for the North Sea is more than 32 m according to the site condition. The platform should withstand the forces that produced due to nature and ambient state and cargo, conveyance and erection loads in addition to other loads produced by onboard equipment (Sadeghi, 2007).

Structural analysis

The pontoons, deck and multiplex columns, are the major components of SSPs. the center of gravity is placed over the center of floatation and it means that the consistency and steadiness are specified by restitute moment of the column. deck live load, environmental load, and wind load should be considered for analyses of SSP. Several generic to floater concepts are important and should be considered and take as a principle in the design of SSPs such as Damaged Stability, Loads and CG’s (cycle of firmly ameliorating evaluation), Full tank size and Hydrostatics.

There are two basic levels to the structural design of SSPs first is Local Strength and the second is global Strength besides of these, the buckling strength, fatigue, and tolerance need to be study and checked (Chakrabarti, 2005).

Design for situation (local) loading generally depends on experimental, categorization law, codes and gravity flotation pressure and force, however, stress-based inspection are applied for several ingredients. “Basic scantlings” Is commonly used for Steel scale. The experimental formula specified in the standard dimensions and specification fundamental has been long definite and are the results of substantial service tests and study. The tantamount hydrostatic head commonly involves applies force and pressure on the pontoons and the supports are universally articulate a tantamount hydrostatic head. Filed planning layout of the project in the upper structures firstly depends upon amount, distributed deck pressure. The important factors that considered by universal strength are rotation analysis, stress based, amount of gravity floatation and the interaction with environmental loading, besides the influence of wind load, stream flow should be Conceded.

FABRICATION

The high quality and suggestion material and suitable for construction structure listed all steel structure plate and shape are listed in API-2A. All material used in designed and steel plate shape and dimensions should be accepted by (AISC) (ASTM) grade A36.

API 5L, grade X52gives specifications for high strength usage. Manufacturing includes tow into two types: 1st truss kinds and the 2nd hull kinds construction.

A Hull group construction is likely to ship production with a flat plate and right angle

tightener a roughly and girders (framing) practicable to the plate. The SSP hulls are constructed in this way. The design of the SSP should be more precision and constructed for long service life. Characteristics for welding and fit up are designed to produce high fatigue life and should be tested very carefully. The fabrication yard should supply with the necessary machines and instruments for a particular purpose and has a large area for both construction and transportation of platform (Sadeghi K. (2007).

TRANSPORTATION

It consists of positioning and leveling the platform on the site and installation the different ingredients in the form a resistant and steady manufacturing in conformity with the planning drawings and characteristics (Nagel and McLennan, 2010). Hauling starts up at the fabrication yard. Means moving and carrying the platform to the outside of the fabrication yard, actually. Moving this type of structure is usually a more complex and hard problem.

All SSPs plate form are commonly constructed in onshore (fabrication yard) for economical purpose and after fabrication completion, loaded out and transported to offshore. Offshore structures heavier may be reached or may weigh 10,000 tons or more. So it must be pushed, commonly by sliding, into the water or onto a big and overweight lift craft that can haul it to its target. The fundamental technical restriction for moving structures involves quay load capability, water depth and hazard of waves. Before hauling of the platform sea fastening analysis is carried out (Nagel and McLennan, 2010).

While loading, the equilibrium and balance of the watercraft necessary adjusted and corrected to be continually corrected to protect the draft and tidy, appropriate with the loading action. Commonly both structure and the vessel need to accurate stress for the load out and transport stage. For a long distance sea transport, sea fastenings should have sufficient resistance against a strong hurricane. The farce and loads that affecting the structure during hauling t may be the critical loads for the design and must be studied in the primary design stage (Chakrabarti, 2005).

INSTALLATION

Mainly, SSPs are utilized for primary well drilling and then transported for floating generation depository and unloading to extend output.

• Some SSPs are staying overall the manufacture duration.

• SSPs are transmitted to the field and then the last situation by employing Dynamic controlled anchor device, which holds its situation correctly (Chakrabarti, 2005).

SOME DATE ABOUT SSPS ERECTED IN THE SEA CASPIAN (AMIR KABIR SSP)

Weight: about 30,000 tons

Max. Max. Water depth: 1,000 m (Max. water depth in Southern Caspian Sea 1027 m

and Max. water depth in Northern Caspian Sea about 150 m).

Price: About 350 million USD for platform plus 60 million USD for three tugboats. (Sadeghi, 2007).

SUMMARY OF SAMPLE DESIGN

Major design: HYN MD 1850 DP-UR:

- Pontoon dimensions: 8 m x 11.5 m,
- Deck dimensions and distance: 54.75 m x 42.65 m and 12.25 m x 42.65 m (in 2 levels),
- Major hull dimensions: 70.5 m x 70.5 m x 51.75 m,
- Dimensions of vertical supports of major hull: 14 m x 14 m,
- Mooring: 12 leg mooring system (with 0.115 m radius polyester chord),
- Total payload (deck/facilities/risers):14,500 tons,
- Wells production number: 4 (sub-sea),
- Generation risers: 0.20 m x 6~8 m steel consecutive risers,
- Production of water: 1,5000,000 tons per year,
- Oil extraction: 2.25~3,000,000 tones/year,
- Depth of water: 1,850 m,
- Gas extraction: 2 million m^3/day.

MORE DATA AND INFORMATION

For extra information on design and data on the ecological information together with important equations information required for the design of offshore structures, the guidelines and information given in references [13] to[19] and [21] to [30] may be utilized.

CONCLUSION

The paper has ensured a wide of some of the key aspect in the analysis, design, construction, and installation of semisubmersible platforms. Moreover, the paper has emphasized introducing platform components, platform installation, naval architecture, structural design and structural analysis. Finally, the reference list of the paper gives to interested readers many paper lists about semisubmersible platforms and offshore structure so they can investigate the topic more detailed.

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