

# A Review on Advancements in Jacket Platform

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**ABSTRACT:** Offshore Structures play a major role in the exploitation of oil and natural gases from marine environment and are also useful in other services such as navigation, met-ocean data collection, communication, monitoring, offshore wind power generation, etc. Depending upon the marine environmental conditions such as water depth, seabed nature, extreme conditions at sea and magnitude and type of the operational activities, different kinds of offshore platforms such as gravity, fixed, floating, semi-submersible, compliant, articulated structure, etc., are being adopted. As far as material of the construction is concerned, steel plays major role followed by concrete because strength to weight ratio of steel is more. Steel offshore jacket platform is a type of offshore structure, which is fixed to the sea bed and is provided with a deck at its top that acts as platform used for all the activities involved in the production and supply process. Researchers have been working on the stability and sustainability of offshore platforms to minimize the problems associated in the design process, fabrication, installation and the operations performed on the platforms. However, these problems are being addressed continuously. Various advancements have been made to overcome the hurdles of designing, fabrication, installation and operations using standard provisions namely ISO 19902 and API RP 2A. Thus, in the present paper an attempt has been done to review the available literature towards the various advancements made in jacket platform with respect to material, transportation and installation process.

**KEYWORDS:** Offshore structures, Offshore platforms, Jacket Platform, Oil and Gas industries.

## I. INTRODUCTION

Offshore structures are the structures that are constructed in deep or shallow water away from the shore or land. The growth of offshore structures came into existence due to man's exploration for hydrocarbons (oil and natural gas) in the offshore. However, today different form of offshore structures are used for various reasons such as navigational aid towers, bridges and causeways, shipping facilities, naval bases, power generation form wind and wave, observation of met-ocean parameters, etc. These structures have to sustain heavy dead and live loads and forces due to wind, current, wave, vessel berthing, etc., and should be designed in such a manner that they are durable and sustainable. Thus the material used for building such structures plays a vital role in terms of performance. The material used are steel, reinforced concrete or a combination of both as needed. The offshore structures are of different types like Jacket Platform, complaint towers, jack-up drilling rigs, drillships, floating production system, tension leg platforms, gravity based structure, spar platforms, etc., but oldest and the most commonly used platform is the jacket platform.

### A. OVERVIEW

In 1891, first oil wells were drilled from platforms on wooden piles by some local companies in the fresh waters of the Grand Lake St. Marys in Ohio. Later in 1896, the first submerged oil well in salt water was drilled in the extended portion Summerland field under Santa Barbara Channel in California. By 1921, the piers were made from steel and drilling was continued in the same manner. In 1932, a reclaimed island bound by series of steel pier was built half-a-mile from shore near to a small oil company, Indian Petroleum Corp., but due to huge storm the island was destroyed completely in 1940. It is said that this failure gave birth to the steel jacketed platform.

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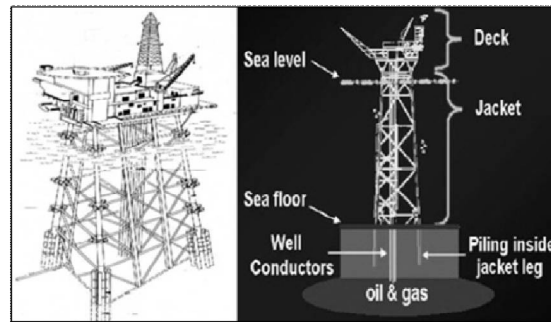


Fig. 1 Jacket Platform

A Jacket Platform is a very common welded tubular space frame with three or more near vertical tubular chord legs with a bracing system between the legs. These platforms are virtue of their immobility, designed for long term use. The platform exhibits a low natural period and deflection against environmental loads. The steel jacket platform fixed to the seabed by the foundation piles has conductors, risers, and other appurtenances. A jacket Platform foundation includes leg piles which are inserted through steel tubular legs and are connected to the legs either at the top, by welding or mechanical means, or along the length of the legs, by grouting. Additional piles, called skirt piles, can be inserted through and connected to sleeves at the base of the structure. Leg and skirt piles jointly anchor the structure through transfer both vertical and horizontal forces to the seabed. When the piles are connected to the legs, the forces are transferred to the piles at the connection and the jacket “hangs” from the piles. When the piles are connected by full length grouting, the jacket platform behaviour is similar to that of a tower, with the legs and piles acting together as composite components.

### B. ADVANCEMENTS OF VARIOUS FACTORS

Engineering began to be understood in the renaissance and have been developing ever since. Thus, advancement is needed to meet the needs of ever growing demands which keeps changing day by day. It is necessary to survive, develop and sustain their being in the world. It may be small or large but its implication is indeed essential to remove haphazard's of the flaws. Advancements bring an era of development in the respected field and gives better solutions for structural improvements. Advances are done in various factors when it comes to fixed steel offshore platform which are material, transportation and installation, but major advancement is made in installing the jacket platform.

### C. MATERIAL

Selecting a material plays a vital role because of the harsh environmental conditions faced by platform and very less experiments or advancements have been done while choosing a material for construction of platform. Factors considered for material selection are operating loads and environment, extreme and upset conditions, special operating practices, operating temperatures, service life, maintenance flexibility, etc. In 18<sup>th</sup> century, the wooden piles were used to construct the platform in the water column but, due to its poor longevity (due to decay) issue, structural steel was adopted by 19<sup>th</sup> century. Later, when concrete came into picture, the platform were made of concrete. But, Structural steel is preferred due to its strength to the weight ratio, which is less in the case of concrete due to which the concrete structure becomes massive and is uneconomical. Later, by 20<sup>th</sup> century the platforms were made by combination of both steel and concrete, which made the structure more durable and sustainable. Structural steel gets corroded when it comes in contact with harsh marine conditions. Hence, provisions were made by coating the steel, which prevents it from rusting. But, toxic coating polluted the water bodies and also the life of the structure was not much protected. So, cathodic protection is used in combination of coating to preventing it from corroding. Now-a-days various materials are used for construction of platforms such as carbon steels, corrosion-resistant alloys, ceramics, elastomers, plastics and composites.

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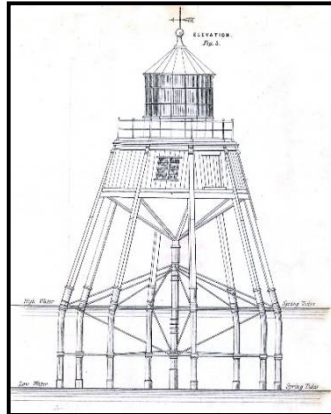


Fig. 2 Wooden platform

### D. TRANSPORTATION

Transportation from dock is a critical activity. There are two methods of transportation viz wet or dry. In wet transportation, the structure floats on its own hull and is towed by one, or more tugs to the offshore site. In dry transportation, the structure is loaded onto a flat top cargo barge or on a built submersible ship (i.e. Heavy lift vessel (HLV)). It is critical in the case of the jacket, since the behaviour of the unit usually influences the verification of barge strength, the design of sea fastenings, and indeed the design of the jacket itself. Also, there are practical aspects of tug selection, tow route, etc. to be considered. The size and power requirements of the towing vessels and the design of the towing arrangement must be calculated or determined from past experience.

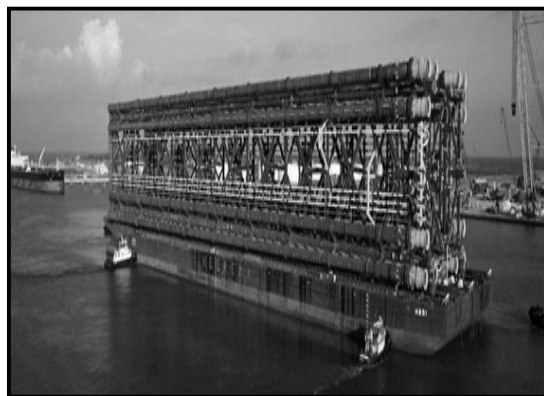


Fig. 3 Transportation

However, this criterion depends on the location. Experience has shown that the first phase of transportation is the most treacherous. There are several reasons for this. In the harbour area a big tug can normally exercise very little control even with a shortened towline. With a short towline between two considerable masses, the large tug and the much larger barge/jacket, the risk of snapping is high. Thus, it is standard practice to lengthen the towline once out of the port. Also, because of the nature of many ports, close control is essential in order to avoid the possibility of running aground. Normally, therefore, the harbour tugs take the barge out under the guidance of a pilot who knows the port. When the barge is out of the port the problems are not totally solved since it must be assumed that the worst can happen, i.e. the towline may break. Improvements can be made choosing a narrower barge or by increasing the draft. Incorrect

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"balancing" of these aspects can have very serious cost/risk implications in overall project terms. Thus, for a large jacket, the barge selection process is normally performed at a very early stage of the design process.

### E. INSTALLATION

Usually structures are built on site but in the case of offshore structure, maximum structures are built offsite and then transported to the site. This engineering is termed as "Installation engineering". The structure is subjected to loads that are different in magnitude and direction from the offsite loads. The installation phase also affects the choice of fabrication yard, cost and schedule of the overall project. Different structure requires different installation methods. The jacket Platform installation depends on the weight, physical dimensions of the jacket and also capacity of installation equipment. The most common methods of jacket installation are Lift and Lower in water, Lift and Upend and launching.

#### I.E.1 LIFT AND LOWER IN WATER

The methods are used for small jackets in very shallow water by transporting on barges. Once the jacket and its size piles are transported to the site, the jacket is lifted and lowered to the seabed and the foundation piles are installed using pile hammer of adequate size. But this type of installation is suitable for only 50m tall jacket.

#### I.E.2 LIFT AND UPEND

As the size increases, it is difficult to build and upending the jacket platform. So, the installation is done through two methods in this case. In first method, the jacket is lowered into the water with the help of crane so that it floats. Slings can be removed and new slings are attached at the top of the jacket and the jacket can be up-ended. This may require closures to legs and some additional buoyancy. In second method, the jacket is upended directly with special pulleys so that there is a necessary rotation between slings and jacket. Once the jacket is floating on the sea the cranes fix the position of the platform and the platform is set for piling. As the equipment required is heavy and the sea conditions are to be taken into account, this method is not used much.

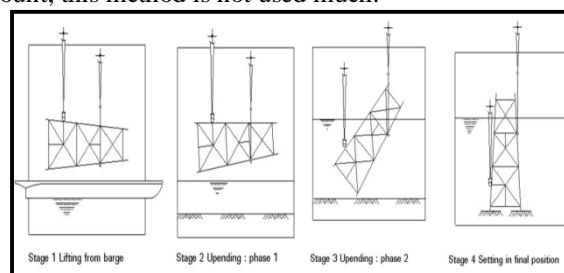


Fig. 4 Lift and upend

#### I.E.3 LAUNCHING

Jacket structures are heavy to be lifted and piled into the sea so alternative method was made to install the structure in the seabed. In this, the jacket is towed to the site and is pulled down along the barge by winches. As the jacket moves towards the end of the barge, the barge starts to tilt and a point is reached where the jacket starts self-sliding. The rocker arms support the jacket weight as it rotates over the barge end. Once the jacket is self-floating and is brought under control by tugs and installation vessels, then with the help of crane vessels, the jacket is made stable in the seabed and piling is done. After the installation is done, the jacket is either piled by precast piles or cast in-situ piles. Precast are difficult to be hammered to the conditions on site. Hence, cast in-situ piles are used in maximum conditions for piling the jacket platform.

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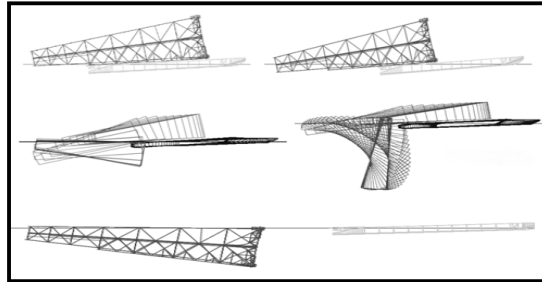


Fig. 5 Launching

## II. RELATED WORK

Various literatures are available on fixed steel jacket platform and there advancements made in material, transportation and installation which are presented in following section.

**Nasseri. T. et. al. (2014)**[14], studied the optimization of steel jacket platform for wind and wave loads under axial and flexural stresses, buckling of members, displacement of structure, etc.

**Mohan. P. et.al. (2013)** [11], studied the typical platform of Mumbai High using STRUCAD\*3D software for modeling and PILE 19.4 OASYS software to find out the ultimate load carrying capacity of pile. The structure is subjected to various loads like wind, wave and current.

**Mohamad Ali. A. A. et. al. (2012)** [2], studied free and forced vibration analysis of submerged or floating structure using ANSYS 12 and ABAQUS 6.9 for modeling and MAPLE 13 software for programming and apply the boundary conditions in Laplace Equation.

**Harish. N. et. al. (2010)** [5], studied responses of structures with respect to individual and combined wave and wind forces. P-M (Pierson-Moskowitz) spectrum is used to calculate wave height and wave period for different wind speed. The dynamic behavior of platform to different loads is difficult to calculate the exact dynamic responses.

**Sadeghi. K.(2007)**[6], proposed that the offshore structures are of different types, hence right selection of equipments, platforms, method of drilling, planning, designing, fabrication, transportation and installation should be done. The paper reviews about the fundamentals behind all types of offshore structures and their principles. It states that each platform is chosen mainly due to water depth considerations and due to the deck equipment necessary to perform its service. It says that the jacket platform can be used upto 300m.

**Nourpanah. N. et. al. (2008)** [8], proposed development of the numerical model which describes the launching of offshore jackets from barge. The force is more important for horizontal slender members near the mud-line. Taking water entry forces in account modifies the jacket trajectory only in little extent.

**Jo. C. H, Kim. S. K, Lee. S. H (2002)** [4], proposed that as the jacket weight and dimensions become large, a launching technique is applied to install the jacket. The launching analysis needs to consider quite a number of parameters including environmental conditions, launch barge specification, ballast, trim angle, local member integrity, etc.

## III. CONCLUSION

The jacket Platform is the most common type of platform and been used for many decades. Hence, advancements are made in each and every manner possible to make the structure durable and sustainable. The best material for construction of jacket Platform is steel due to its high strength to weight ratio. Transportation is suitable as per the height and weight of the platform. Launching method is the best method for installing jacket Platform but when the height of the platform is small lift and lower method can be used for installation of the platform.

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