A METHOD OF CONSTRUCTING A SEMI-SUBMERSIBLE RIG USING DRY DOCK MATING

FIELD OF THE INVENTION

This invention generally relates to construction of offshore structures and more particularly to a method of building a semi-submersible drilling rig, vessel or structure (referred to as "rig") in a shipyard.

BACKGROUND OF THE INVENTION

The market demand for the semi-submersible rigs has been increasing with the trend of exploring oil and gas reserves from deeper sea floors over 150 meters.

There are two conventional methods of constructing a semi-submersible rig. The first, the so-called "sequential block stacking" method, provides for the fabrication of a semi-submersible rig in a "from-bottom-to-top" sequence. According to this method, a lower hull of the rig, that is pontoons, columns and associated bracings are erected block-by-block first using shore cranes or floating cranes. The upper hull is then assembled in the same sequential manner building up on the lower hull. One main disadvantage of this method is that it requires extensive use of shore and floating cranes. Often times, the construction schedule depends on the availability of the floating cranes. Moreover, extensive amount of block joint welding leads to a long construction schedule. On the other hand, the outfitting, major equipment installation and commissioning have to be carried out onboard the rig after the completion of the entire rig erection. This will consequently result in a longer overall construction schedule and late commissioning of the equipment, especially the drilling package, which is located on the centre part of the upper hull.

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The second existing method of construction of a semi-submersible rig is to build the upper and lower hull simultaneously and subsequently join the two halves together. According to this method, upon completion, the upper hull is loaded-out onto a barge, and both the upper and the lower hulls are towed to an offshore location, where the sea depth can accommodate the lower hull. The lower hull is then sunk to a required depth with ballast and counterweight, with only the top parts of the columns emerging out of the water. Temporary mooring, power pack systems and complex logistics are required for this type of operation. The barge transports and positions the upper hull on top of the lower hull. The barge has to be secured in position against the lower hull before mating. Floating barge is then submerged gradually by ballasting until the upper hull bottom meets the lower hull columns. The welding at the connection joints between the upper and lower hulls is finally conducted. The major disadvantage of this method is associated with high risks operation in often harsh and uncontrollable offshore environment. Moreover, the operation may encounter a lot of uncertainties. In this connection the safety and quality of the operation will become a major concern.

Other methods of constructing offshore rigs are disclosed in a number of issued or published patent documents. For instance, U.S. patent No. 6,347,909 issued on February 19, 2002 discloses a method of constructing a rig, which provides for transporting a deck at sea and installing the deck on an offshore substructure. The deck is completely fabricated on a set of deep girders, which carry jacking units. The deck and deep girders, which have been secured together, are skidded onto two pontoons. The complete assembly is towed to the installation site, where the girders are jacked up and the pontoons simultaneously ballasted down until the assembly is supported on the pontoons. The deck is then lowered onto the substructure and the pontoons released

Another example of patented method is disclosed in U.S. patent No. 6.340,272 issued on January 22, 2002 discloses a method for constructing an offshore platform by mating a self-floating deck structure with a self-floating substructure. The self-floating deck structure may be a floating pier or barge, on which the desired equipment has been

mounted. Mating is achieved by partially submerging the substructure, positioning the pier or barge above it, and deballasting the substructure to create a vertical bearing force between the substructure and the pier or barge.

Still another patented method is shown in U.S. patent No. 5,924,822 issued on July 10, 1999 discloses an apparatus and method for the installation of a deck on an offshore substructure. Two independent pontoons each have two columns spaced apart from each other that extend upwardly from the pontoons. Each pontoon is provided with ballast tanks that are ballasted down during transit. The pontoons allow the deck to be placed directly above the offshore substructure. For a floating substructure, the pontoons are ballasted while the floating substructure is simultaneously de-ballasted to transfer the deck to the floating substructure.

U.S. patent No. 5,237,949 issued on August 24, 1993 discloses a method for building and assembling an offshore platform whose normal draft exceeds the depth of waterways between the building site and use location of the platform. The hull and deck of the platform are built separately in a shallow graving dock. The deck is then elevated, the graving dock partially flooded and the hull floated into position and mated to the deck.

Japanese application No. 56-154381 published on November 28, 1981 discloses a semi-submersible rig which consists of a pair of pontoons, an upper deck and columns. The end parts of connecting members on the columns and the end parts of the deck are fixed. Then the deck, the pontoons and the columns are ballasted to align the center parts of the connecting members and the center part of the deck, while adjusting the inclination of the columns.

While the patented methods may work under certain conditions, there exists a need for a simple, safe and a more cost-effective method of assembling a semi-submersible rig close to a shipyard, preferably at a shipyard.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a method of constructing a semi-submersible rig in a safe, secured and relatively lower cost than other methods.

It is another object of the present invention to provide a method of constructing a semi-submersible rig using land side and dry docks of a convention shipyard.

These and other objects of the present invention are achieved through a provision of a method, which allows the upper hull and the lower hull to be constructed in a shipyard simultaneously and thereby shorten the overall construction schedule. The upper hull is completely erected at land side on a skidding truss and supporting towers, while the lower hull is constructed in a dry dock adjacent to the skidding truss. A supporting truss is installed in the dry dock to support a plurality of skidding beams extending from upper hull construction site at land side to the mating position above the lower hull in the dry dock.

Once the upper hull and the lower hull are constructed, the upper hull is loaded out to the mating position by skidding on the skidding beams using a hydraulic jacking system. The mating operation is subsequently carried out by floating up the lower hull in the dry dock until it meets and supports the upper hull. The welding of the upper and lower hulls' joint is finally performed. In doing so, the complete mating operation is conducted in a controllable condition, which ensures the safety as well as the quality of the operation.

BRIEF DESCRIPTION OF THE DRAWINGS

For a further understanding of the nature and objects of the present invention reference should be made to the following description, taken in conjunction with the attached drawings in which like parts are given like reference numerals, and wherein:

FIG. 1 and FIG. 2 are profile and plan view, respectively, of the load-out and mating operation arrangement.

FIG. 3 is a sectional view of the upper hull supported by the skidding truss and the construction tower.

FIG. 4 illustrates a step of installing the supporting truss in the dry dock.

FIG. 5 illustrates positioning of wedge-shaped members in the method of the present invention.

FIG. 6 is a sectional view illustrating the upper hull at its mating location above the lower hull in the dry dock.

FIG. 7 illustrates a step in the process when the upper hull is fully supported by the lower hull and clear of the skidding truss after a mating operation.

FIG. 8 shows the dismantling of the skidding beams before the rig floats out.

FIG. 9 illustrates the completion of the mating operation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in more detail, Figures 1 and 2 show the general arrangement of the shipyard area including the dry dock, where the semi-submersible rig of the present invention is constructed and mated. As can be seen in Figures 1 and 2, the semi-submersible rig comprises an upper hull 1 and a lower hull 2. During construction, the upper hull is supported by a skidding truss 3 located on land adjacent to a dry dock 4. The truss 3 is designed to also skid the completed upper hull on skidding beam 6 using skidding shoes 8 during the load-out operation. An auxiliary supporting structure 5, or supporting truss 5 is erected in the dry dock 4.

The skidding beams, or connecting members 6 extend between the supporting truss 5 and the bottom portion of the skidding truss 3. The connecting members 6 are removed from the support truss after the mating operation is completed, as will be explained in more detail hereinafter.

Cylinders of the hydraulic jacking system 7 are mounted on the first skidding shoe 8, and anchor blocks 9 are affixed at the distant ends of the skidding beams 6. Strand wires 14 connect the anchor blocks 9 with the jacking system 7. Two barges 10 are positioned behind the support truss 5 on the dock floor. The barges 10 have their tanks fully ballasted. The barges 10 are connected to the distant ends of the beams 6 by tie bars 11. The barges 10 act as a counterweight to resist the uplifting motion of the skidding beams 6.

Before the construction of the upper hull 1, temporary support towers 16 are erected around the skid truss 3 for supporting the upper hull 1 (Figure 3). A working platform 19 is constructed underneath the upper hull 1. Vertical staircases 17 and horizontal walkways 18 provide access from ground to the upper hull 1 through the working platform 19. These members are provided as a safety and production friendly feature.

FIG. 4 illustrates the installation of the supporting truss 5 in the dry dock. As can be seen in the drawing, the support truss 5 has an upper portion 5A and a lower portion 5B. The lower portion 5B has connecting elements 5C with outwardly convex surfaces. The upper portion 5A has connecting elements 5D with inwardly concave surfaces having a complimentary radius to the radius of the convex portion 5C. The lower portion 5B is installed on the dry dock floor, which is followed by the installation of the upper portion 5A using barges 10. The upper portion 5A of the truss 5 is simply lowered to rest on the lower portion 5B, matingly engaging the convex surface 5C with the concave surface 5D. No welding is necessary, which results in quick installation and dismantling of the support truss 5 and short dry dock occupation time.

FIG. 5 illustrates a feature of the present invention relating to positioning of friction enhancing means between adjoining members of the construction process. A plurality of wedge-shaped members, for instance wooden wedges 13 are used to minimize the welding requirement. In Detail '1' of Figure 5, two wedges 13 are seen fitted between the bottom of the upper hull 1 and the top of the skidding truss 3. Similarly, as shown in View 'A' and Detail '2' of Figure 5, the supporting truss 5 and skidding beam 6 are rested on wedges 13 fitted between the dock floor and supporting truss, respectively. The high compressive-strength wood transfers the vertical load and the friction between the interfaces constrains the lateral movements between the adjoining members.

Once the upper hull 1 and the lower hull 2 have been constructed, the upper hull 1 is jacked and skidded along the skidding beams 6 on to a position above the lower hull 2 and in a general alignment with the columns of the lower hull 2. FIG. 6 illustrates the position of the upper hull 1 and the lower hull 2 after the former reaches the mating position. A sufficient clearance of approximately 500mm between upper hull bottom and the top of lower hull column is allowed.

The next step in the process involves floating up of the lower hull. At this stage in the process, the dry dock is flooded. The desired floating condition of the lower hull 2 is achieved by ballasting the respective water tanks or transferring the ballast water among those tanks, while the alignment of the upper and lower hulls is adjusted by floatation method. The column tops of the lower hull 2 eventually touch the bottom of the upper hull 1. Welding of temporary guide pieces at the upper and lower hulls joints are carried out at this stage.

The lower hull 2 is continuously floated until it supports the weight of the upper hull 1 and the gap between the upper hull 1 and the lower hull 2 is closed. The upper hull 1 is then completely cleared from the skidding truss 3. Sufficient welding at upper and lower hulls joints permanently attaches the lower hull 2 to the upper hull 1.

Following the mating step, the semi-submersible rig is cleared from the auxiliary support structure 5. The skidding truss 3 is retrieved from the mating position back to land side using the jacking system 7 mounted on the skidding truss 3. The skidding beams 6 above the dry dock 4 are cut, pulled out and offloaded to the barges 10 using jacking system 7, 9 mounted on the connecting beams 6. The connecting beams 6 are then removed from the dry dock 4 on one or more transporters, or low bay trailers 12.

FIG. 8 shows the floating out of the completed rig with the hulls 1 and 2 from the supporting truss 5 at the mating location in the dry dock 4.

FIG. 9 illustrates in plan view clearing of the rig from the supporting truss 5 in the dry dock 4.

The method of the present invention provides with several advantages over the existing conventional rig construction methods. The overall construction period is shortened by fabricating the upper and lower hulls simultaneously. The high risk and uncertainty of mating in an offshore harsh environment is avoided and, hence, high safety

and quality are ensured. As a result, good alignment of upper and lower hull structures and early commissioning of the equipment becomes possible.

The instant method provides for adequate structural support to the upper hull taking care of changing loading patterns during the entire installation of the upper hull. A safe working platform underneath the upper hull is erected, which enhances the safety and production friendly features of the instant invention. The towers provide vertical and horizontal safe access from ground to working platform underneath the upper hull. Additionally, unobstructed skidding of the upper hull to a mating position of provided. .

The supporting truss elements are easy to install, easy to align and easy to remove. There is no need for additional piling of the dry dock floor. Potential problems caused by differential ground settlements during the skidding process are eliminated and interferences between cross bracings of the lower hull and supporting truss are minimized or altogether eliminated. .

Additional advantages of the method of the present invention relate to elimination of expensive ground anchoring points to withstand the high pulling forces during the skidding process; to the use of a method of retrieval of the skidding beams, supporting trusses and preservation of the skidding surfaces. The wood wedges allow better adjustment of the structure level and constraint lateral movement by interfacial frictional force.

While the invention has been described with reference to a specific embodiment, the description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiment, as well as other embodiments of the invention, will be apparent to persons skilled in the art upon reference to this description. It is therefore contemplated that the appended claims will cover any such modifications or embodiments as fall within the true scope of the invention.

CLAIMS

What is claimed is:

1. A method of constructing a semi-submersible rig, comprising the steps of:
   providing an upper hull and a skidding truss means for supporting the upper hull on land;
   providing a lower hull in a dry dock adjacent to the skidding truss means;
   providing a means, mounted on said skidding truss means, for moving the upper hull to a position above the lower hull;
   transferring the upper hull to a position above the lower hull;
   ballasting the lower hull to align the lower hull with the upper hull;
   mating the upper hull to the lower hull, thereby assembling the semi-submersible rig; and
   clearing the semi-submersible rig from the skidding truss means.

2. The method of Claim 1, further comprising a step of providing an auxiliary truss support structure for temporarily supporting the upper hull when the upper hull is positioned above the lower hull and wherein said step of clearing the semi-submersible rig from the skid truss means further comprises a step of clearing the semi-submersible rig from the auxiliary truss support structure.

3. The method of Claim 1, wherein said step of providing the skidding truss means comprises steps of erecting a skidding truss and a plurality of tower superstructures for retaining the upper hull at an elevated position on land before construction of the upper hull on said skidding truss and tower superstructures and for providing horizontal and vertical access to the upper hull.

4. The method of Claim 3, further comprising a step of providing a means for restraining lateral movement of the upper hull in relation to the skidding truss without application of welding between the upper hull and the skidding truss.

5. The method of Claim 4, wherein said restraining means comprises a plurality of wedge-shaped members having at least exterior surfaces formed from friction-increasing material, said wedge-shaped members being fitted between a bottom surface of the upper hull and a contact surface of the skidding truss.

6. The method of Claim 2, wherein said step of providing the auxiliary truss support structure comprises a step of erecting a supporting truss in the dry dock and providing connecting beams extending between the auxiliary truss support structure and the upper hull skidding truss means.

7. The method of Claim 6, further comprising a step of providing a means for restraining lateral movement of the auxiliary truss support structure in relation to the dry dock without application of welding and/or anchoring between the auxiliary truss support structure and the dry dock.

8. The method of Claim 7, wherein said restraining means comprises a plurality of wedge-shaped members having at least exterior surfaces formed from friction-increasing material, said wedge-shaped members being fitted between a bottom surface of the auxiliary truss support structure and the floor of the dry dock.

9. The method of Claim 6, further comprising a step of providing a means for restraining lateral movement of the connecting beams and the auxiliary truss support structure without application of welding between the auxiliary truss support structure and the connecting beams.

10. The method of Claim 9, wherein said restraining means comprises a plurality of wedge-shaped members having at least exterior surfaces formed from friction-increasing material, said wedge-shaped members being fitted between a bottom surface of the connecting beams and contact surfaces of the auxiliary truss support structure.

11. The method of Claim 6, wherein said means for transferring the upper hull comprises a jacking system mounted on skidding truss means and the connecting beams.

12. The method of Claim 6, wherein said connecting beams have proximate ends, and wherein the said proximate ends are secured to the skidding truss means.

13. The method of Claim 12, further comprising a step of detachably securing distant ends of the connecting beams to a counterweight positioned behind the auxiliary truss support structure.

14. The method of Claim 1, further comprising a step of installing the auxiliary truss support structure on a floor of the dry dock.

15. The method of Claim 14, wherein said auxiliary truss support structure comprises a lower portion having outwardly convex connecting members and an upper portion having corresponding inwardly concave connecting members, and wherein said step of installing the auxiliary truss support structure on the dry dock floor comprises a step of matingly engaging the upper portion and the lower portion of the auxiliary truss support structure.

16. The method of Claim 2, wherein said step of clearing the semi-submersible rig from the auxiliary truss support structure comprises a step of retrieving the skidding truss means and the connecting beams.

17. The method of Claim 16, further comprising a step of pulling the skidding truss means using a jacking system mounted on the skidding truss means.

18. The method of Claim 16, further comprising a step of pulling and offloading the connecting beams using a jacking system mounted on the connecting beams to a plurality of transporters.

19. A method of constructing a semi-submersible rig in a shipyard, comprising the steps of:

providing a skidding truss and a plurality of supporting towers on land;

constructing an upper hull of the semi-submersible rig on the skidding truss and the supporting towers;

providing a supporting truss in a dry dock adjacent to the skidding truss;

constructing a lower hull of the semi-submersible rig in the dry dock contemporaneously with the construction of the upper hull;

securing a jacking system below the skidding truss;

providing a plurality of skidding beams secured between the supporting truss and a lower portion of the skidding truss;

jacking the upper hull and transferring constructed upper hull along the skidding beams to a position above constructed lower hull;

floating the lower hull in the dry dock;

ballasting the lower hull to align the lower hull with the upper hull;

mating the upper hull to the lower hull, thereby assembling the semi-submersible rig in the dry dock; and

clearing the semi-submersible rig from the skidding truss and the supporting truss

20. The method of Claim 19, wherein the skidding beams have distant ends, and wherein the distant ends are detachably connected to a counterweight for resisting uplifting of the skidding beams during the upper hull transfer.

21. The method of Claim 20, further comprising a step of installing the supporting truss on a floor of the dry dock.

22. The method of Claim 21, wherein said supporting truss comprises a lower portion having outwardly convex connecting members and an upper portion having corresponding inwardly concave connecting members, and wherein said step of

installing the supporting truss on the dry dock floor comprises a step of matingly engaging the upper portion and the lower portion of the supporting truss.

23. The method of Claim 20, further comprising a step of mounting friction-enhancing wedge-shaped members between at least the upper hull and the skidding truss, said wedge-shaped members restraining lateral movement of the upper hull without application of welding between the upper hull and the skidding truss.

24. The method of Claim 19, wherein said step of clearing the semi-submersible rig from the skidding truss and the supporting truss comprises a step of retrieving the skidding truss and the skidding beams.

25. The method of Claim 24, further comprising a step of pulling the skidding truss using a jacking system mounted on the skidding truss.

26. The method of Claim 24, further comprising a step of pulling and offloading the skidding beams using a jacking system mounted on the skidding beams to a plurality of barges.