

MOVABLE BRACE FRAME FOR SELF-INSTALLING PLATFORM

BACKGROUND

Technical Field

Embodiments of the invention relate generally to apparatus and methods for improving the in place performance of a self-installing platform.

Description of Related Art

Various methods of installing offshore platforms are available but have inherent problems.

One conventional method of installing fixed offshore platforms requires large floating cranes to lift and install a jacket structure onto the seabed, and subsequently lift and install a topside structure onto the installed jacket structure. This method is expensive due to limited availability and high operational and rental costs of the large floating cranes.

Alternative to using large floating cranes, self-installing platforms have been developed. These self-installing platforms may be completely assembled at the yard and include movable legs which can be moved up and down relative to the hull using a (temporary) jacking system. The legs are disposed in a raised position during tow and are lowered once the platform is at the offshore site.

One type of self-installing platform has a relatively light steel truss structure to support topside structures. The self-installing platforms may be transported by a barge which provides enhanced sea keeping characteristics during tow. The hull structure is supported by legs which are not interconnected, thereby resulting in a very flexible supporting structure. Accordingly, the platform can only be installed in relative shallow water and/or benign environments.

Another type of self-installing platform includes interconnected legs which provide a much stiffer supporting structure. Accordingly, the platform can be installed in deeper waters and/or harsher environments, unlike a platform without interconnected legs. However, it is not possible to tow the platform on a barge as the presence of a barge supporting the platform would prevent lowering of the interconnected legs. As such, the platform has to be specially designed to take the hydrostatic loads during tow and the small freeboard during tow renders the platform susceptible to green water. Further, when the legs are interconnected, the acceptable differential seabed penetration of the footings is within very narrow limits. If the differential penetration is too large, the bracings interconnecting the legs would experience large structural loads. Consequently, this type of self-installing platform can only be installed on a flat seabed.

Canadian Patent No. 1,117,301 (Evans, Darrell L.) discloses a self-contained jack up type drilling and production platform structure comprising a floatable barge-like hull with support legs which can be jacked up and down to lower and raise the hull with respect to the surface of the sea. A removable drilling module rests on top of the hull and extends over an opening therein between two of the support legs. Production equipment is arranged in the hull and communicates with the opening. Moveable conductor supports extend between the legs of the platform and serve to brace the drill string and production conduit conductors. However, the movable conductor supports are meant to support the drill string and production conduit conductors, and would not improve the performance of the support legs.

U.S. Patent No. 4,245,928 (Nei et al.) discloses a method for the construction of a structure sufficiently reinforced particularly against a lateral force by driving the desired number of pile members into the water and integrally connecting these pile members with the brace members. The connection of the pile members with the brace members is accomplished by providing a gap between the brace and pile members, and filling the gap with a filler joining material having a powerful bonding force, such as an expansive

mortar. The connecting work is devised to be performed safely and accurately on the surface of the water. However, various components of the structure have to be assembled at the offshore site which is a time-consuming and expensive process requiring floating cranes, and is therefore not a desirable alternative.

U.S. Patent No. 2,837,897 (Nedderman et al.) relates one of its objects as providing an automatic underwater bracing system which is initially collapsed but which is automatically erected between the supporting columns as they are being lowered to bottom. The bracing system is primarily used to tension the cables connected to the bracing system so that the tensioned cables provide stiffness to the support structure.

U.S. Patent No. 3,593,529 (Smulders) discloses a buoyant mobile drilling platform having a gap in its side in which is detachably disposed a permanent drilling platform. The two platforms are floated to the drilling site and temporarily emplaced. If a test drill shows the presence of gas or oil, then the permanent platform is permanently emplaced and the mobile platform is floated away.

Summary

Embodiments of the invention relate to pre-assembled self-installing platforms which are provided with rotational restraint. A pre-assembled self-installing platform may include a hull, a plurality of supporting legs which are movable relative to the hull, and at least one brace frame which is movably connected to at least two of the plurality of legs and is securable to the at least two of the plurality of legs.

The self-installing platform may be pre-assembled before being transported to an offshore site for installation. At the offshore site, the plurality of legs of the self-installing platform may be lowered into the seabed. The brace frame may then be positioned at a desired elevation along the at least two of the plurality of legs and secured thereto. This way, rotational restraint is

provided to significantly reduce leg stress and increase rigidity of the legs. With the increased rigidity, it has become possible to install platforms in relatively deep waters and harsh environments, and yet preventing large overall platform sway induced by adverse weather or sea conditions. As the brace frame is securable to the legs after the legs or footings are penetrated into or supported on the sea bed, differential penetration of legs or footings into the seabed is possible without risking large structural loads in the brace frame.

Brief Description of the Drawings

Embodiments of the invention are disclosed hereinafter with reference to the drawings, in which:

Figure 1A illustrates a self-installing platform with a movable brace frame during transportation according to one embodiment of the invention;

Figure 1B illustrates a self-installing platform of Figure 1A after installation;

Figure 2 is a close-up view of a leg and brace frame connection of a self-installing platform with grouting;

Figure 3A illustrates a self-installing platform having a movable brace frame movably coupled to the legs using a rack and pinion system;

Figure 3B illustrates a leg and brace frame connection of Figure 3A in an unsecured arrangement;

Figure 3C illustrates a leg and brace frame connection of Figure 3A in a secured arrangement;

Figure 4A illustrates a self-installing platform with two movable brace frames during transportation according to one embodiment of the invention;

Figure 4B illustrates a self-installing platform of Figure 4A after installation;

Figure 5 is a top view of a movable brace frame according to one embodiment of the invention;

Figure 6 illustrates a self-installing platform having a movable brace frame formed of a truss structure according to one embodiment of the invention; and

Figures 7A to 7D illustrate a sequence for installing a self-installing platform according to one embodiment of the invention.

Detailed Description

In the following description, numerous specific details are set forth in order to provide a thorough understanding of various illustrative embodiments of the invention. It will be understood, however, to one skilled in the art, that embodiments of the invention may be practiced without some or all of these specific details. In other instances, well known process operations have not been described in detail in order not to unnecessarily obscure pertinent aspects of embodiments being described. In the drawings, like reference numerals refer to same or similar functionalities or features throughout the several views.

According to embodiments of the invention, in which a platform includes a hull and supporting legs, at least one brace frame is provided which is movable along at least two legs of a platform and securable to the legs at any elevation. Upon securing the brace frame to the legs that provide a support structure to the platform, the brace frame provides rotational restraint to the legs, thus resulting in significantly reduced stress in the legs and a more rigid supporting structure. This would allow installation of platforms in relatively deep waters and harsh environments, and yet preventing large overall platform sway.

Reference is made to Figures 1A and 1B which illustrate a self-installing platform 10, according to one embodiment of the invention, during transportation (or tow) and after installation respectively. The hull 12 is illustrated as a truss structure for supporting topside modules (not shown)

thereon. It is to be appreciated that the hull 12 may be formed of other suitable structures including, but not limited to, a barge type buoyant hull.

The supporting legs 14 of the self-installing platform 10 are movable relative to the hull 12 and adjustable between at least a raised (or stowed) position and a lowered (or installed) position depending on the operational status of the self-installing platform 10. Particularly, the legs 14 may be disposed for independent vertical movement relative to the hull 12, such as by using a jacking system provided on the hull. In Figures 1A and 1B, through holes are provided in the hull 12 for receiving the legs 14 and allowing the legs 14 to be lowered or raised. During transportation (Figure 1A), the legs 14 are stowed in a raised position in which the legs 14 may be partially supported by the hull 12. The hull 12 may, in turn, be supported on a barge 40. Additionally, the legs 14 may be secured to the barge 40 or hull 12 during transportation to fixedly arrange the legs 14 in the raised position. During installation (Figure 1B), the legs 14 are lowered relative to the hull 12 into an installed position in which the legs 14 support the hull 12. Additionally, the legs 14 may be secured to the hull 12 to fixedly arrange the legs 14 in the installed position.

In Figures 1A and 1B, the self-installing platform 10 includes four legs 14 of tubular type. In certain other embodiments of the invention, a self-installing platform 10 may have other number of legs 14, ranging from three and above. Also, the legs 14 may take other forms including, but not limited to, rectangular hollow section, square truss and triangular truss.

At bottom ends of the legs 14, footings 16 may be provided to provide sufficient bearing when the legs 14 are anchored to the seabed 55. Examples of suitable footings include, but are not limited to, suction cans, spud cans, and piled footings. At top ends of the legs 14, leg heads, having a cross-section larger than the legs 14 and the through holes receiving the legs 14, may be provided. Further, after the legs 14 are lowered into an installed position, the legs 14 may be secured to the hull 12, such as by bolts.

Rotational restraint of the legs 14 may be provided to increase stiffness and rigidity of the support structure of the self-installing platform 10 in the installed position. Particularly, at least one brace frame 20 may be provided to connect at least two legs 14 at one or more elevations. The at least one brace frame 20 is movable along the legs 14 to be positioned at one or more desired elevations. Once the brace frame 20 is secured to the legs 14, rotational restraint is provided to the legs 14 to significantly reduce leg stresses and increase rigidity of the supporting structure of the self-installing platform 10. With this increased rigidity, it has now become possible to install platforms in relatively deep waters and harsh environments, and yet preventing large overall platform sway induced by adverse weather or sea conditions. Accordingly, the rotational restraint provided to the legs 14 or supporting structure of a self-installing platform improves the in place performance of the self-installing platform.

In one embodiment of the invention, a brace frame 20 may include sleeves 22, as shown in Figure 2, fitted around each of two or more legs 14 of the self-installing platform 10. Adjacent sleeves 22 are connected by brace members 24 to form a brace frame 20. The brace frame 20 is movably coupled to the legs 14 to allow positioning at any desired elevation along the legs 14. For this purpose, cables 36 (or cable system) in cooperation with winches or strand jacks (not shown) may be provided on the hull 12 and coupled to the brace frame 20 for lowering and raising the brace frame 20. After the brace frame 20 is positioned at a desired elevation, the brace frame 20 may be secured to the legs 14 to provide a rigid connection in a horizontal plane. In one example, the brace frame 20 may be secured to the legs 14 by grouting with a suitable filler joining or grout material 32 (see Figure 2) or by a mechanical connection including, but not limited to, clamps. Further, guides (not shown) may be disposed within the sleeves 22 to prevent the sleeves 22 from scratching the legs 14 during lowering or raising of the brace frame 20.

It is to be appreciated that other devices for lowering and raising the brace frame 20 may be employed. In one embodiment of the invention as

illustrated by Figures 3A to 3C, a rack and pinion system is provided for positioning the brace frame 20 along the legs 14. Particularly, rack railways 26 are mounted along the legs 14 while pinions 28 are mounted to the brace frame 20. The pinions 28 are disposed in movable engagement with the rack railways 26. To raise or lower the brace frame 20, the pinions 28 may be actuated by a power source in either rotational direction as required. Figure 3B illustrates the brace frame 20 in an unsecured or unlocked arrangement in which clamps 34 are disengaged with the rack railways 26. After the brace frame 20 is positioned at a desired elevation, the brace frame 20 may be rigidly secured to the legs 14. For this purpose, clamps 34 with compatible teeth configuration as the rack railway 26 are moved into locking engagement with the rack railways 26. Figure 3C illustrates the brace frame 20 in a secured or locked arrangement in which clamps 34 are arranged in locking engagement with the rack railways 26. This way, the brace frame 20 is prevented from undesirable movements and is rigidly secured to the legs 14.

While a single brace frame 20 is provided in Figures 1A and 1B, it is to be appreciated that two or more brace frames 20 may be secured to the legs 14 at different elevations for providing increased rigidity. Figures 4A and 4B illustrate a self-installing platform 10 with two brace frames 20 in a tow position and an installed position respectively.

In addition, while Figures 1A and 1B illustrate a brace frame 20 having brace members 24 forming a square configuration, other configurations may be envisaged. For example, Figure 5 illustrates a brace frame 20 having brace members 24 forming a square and a cross configuration.

Further, while Figures 1A and 1B illustrate brace members 24 in tubular form, the brace members 24 may take other forms including, but not limited to, rectangular hollow section, square truss and triangular truss. Figure 6 illustrates a brace frame 20 formed of a truss structure.

A method for installing a platform at an offshore site, without use of a floating crane, is described with reference to Figures 7A to 7D. A self-installing platform 10 may be pre-assembled at a yard. The self-installing platform 10 may comprise a hull 12, legs 14 for supporting the hull 12 and at least one brace frame 20 movably coupled to at least two of the legs 14. Other components may be pre-assembled if required. The pre-assembled self-installing platform 10 may be transported to an offshore site by a barge 40 which may be towed by another vessel (see Figure 7A for a side view of a barge 40 supporting a pre-assembled self-installing platform 10). Particularly, the hull 12 is supported on the barge 40 with legs 14 of the self-installing platform 10 arranged in a raised position and alongside the barge 40. The brace frame 20 may be interposed between the hull 12 and the barge 40. The legs 14 of the self-installing platform 10 may be secured to the barge 40 during transportation. Footings 16 of the legs 14 may be disposed below the barge 40 or under the water surface 50 and pulled against the barge 40.

After reaching the desired offshore site, the legs 14 may be individually or simultaneously lowered until the footings 16 of the legs 14 come into supporting contact with a seabed 55 or are penetrated into the seabed 55 (see Figure 7B). Suitable equipment including, but not limited to, strand jacks may be used for lowering and raising the legs 14 and other components. In certain embodiments, the footings 16 may be interconnected by a temporary frame (not shown) such that the positions of the footings 16 are fixed in a horizontal plane and would not displace relative to one another during lowering onto the seabed. This would prevent the footings 16 from penetrating the seabed with a relative offset which would cause difficulties subsequently when lowering the brace frame 20. After the footings 16 have penetrated the seabed, the temporary frame may be removed.

After the footings 16 are suitably supported on or penetrated into the seabed, the hull 12 and brace frame 20 may be raised relative to the legs 14 to provide sufficient clearance from the barge 40 (see Figure 7C) so that the barge 40 may be floated away from the self-installing platform 10. The brace

frame 20 may then be lowered to a desired position, such as by lowering cables 36 coupled to the brace frame 20 (see Figure 7D) or by a rack and pinion system. After the brace frame 20 is positioned at the desired position, the brace frame 20 may be rigidly secured to the legs 14, such as by a grout material 32 or by clamps 34.

Using a barge for transporting the self-installing platform provides stability and enhanced sea keeping characteristics during tow, and also minimises risk of green water, i.e. relatively compact mass of water flowing onto platform, which would cause damage to the platform and any topside modules thereon. However, in certain other embodiments of the invention, the pre-assembled self-installing platform may be floated to an offshore site without assistance of a barge. In this connection, the hull of the self-installing platform may be formed of a buoyant structure.

Other variations to the above-described method may also be envisaged. For example, the brace frame may be supported below the barge during transportation. The footings may be disposed alongside the barge during transportation. Depending on the topology of the seabed, the footings may have equal penetration where the seabed is relatively even or have differential penetration if the seabed is undulating. An advantage of the brace frame, according to embodiments of the invention, is that a secured connection between a leg and a brace frame is made after the platform is installed on-site. This necessarily means that differential penetration would not introduce structural loads in the brace frame. This is in contrast with certain other types of self-installing platforms with interconnected legs, where differential penetration of support legs will result in considerable structural loads in the interconnecting bracings.

A method for uninstalling the platform may be performed as follows. The secured connection between the brace frame and legs may be removed. The movable brace frame may be raised to a suitable height so that a barge may be moved under the hull of the platform and the brace frame (see for

example Figure 7C). The hull and the movable brace may be supported on the barge while the legs may be lifted into a raised position. The legs may be secured to the barge which then transports the platform to a destination, e.g. another offshore site, or yard.

Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the invention. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the disclosed embodiments of the invention. The embodiments and features described above should be considered exemplary, with the invention being defined by the appended claims.

Claims

1. A pre-assembled self-installing platform comprising:
 - a hull;
 - a plurality of legs movable relative to the hull, the plurality of legs having a plurality of bottom ends unconnected to one another, the plurality of bottom ends being provided with a plurality of footings; and
 - at least one brace frame movably connected to at least two of the plurality of legs, wherein the at least one brace frame is securable to the at least two of the plurality of legs for providing rotational restraint thereto, and wherein after installation of the self-installing platform, the at least one brace frame is secured to the at least two of the plurality of legs at an elevation that is free from contact with the plurality of footings and a seabed.
2. The pre-assembled self-installing platform of claim 1, wherein the at least one brace frame further includes:
 - a plurality of sleeves fitted around the at least two of the plurality of legs; and
 - at least one brace member connecting the plurality of sleeves.
3. The pre-assembled self-installing platform of claim 1, wherein the at least one brace frame includes a truss structure.
4. The pre-assembled self-installing platform of claim 1, wherein the at least one brace frame is securable to the at least two of the plurality of legs by one of a filler joining material and a clamp.
5. The pre-assembled self-installing platform of claim 1, further comprising: a plurality of guides interposed between the plurality of sleeves and the at least two of the plurality of legs for preventing scratching on the at least two of the plurality of legs.

6. The pre-assembled self-installing platform of claim 1, further comprising:

a rack and pinion system for movably connecting the at least one brace frame with the at least two of the plurality of legs; and

a plurality of clamps for securing the brace frame to the at least two of the plurality of legs at a desired elevation.

7. A method for installing a platform, comprising:

transporting a pre-assembled self-installing platform to an offshore site, the pre-assembled self-installing platform comprising:

a hull;

a plurality of legs movable relative to the hull, the plurality of legs having a plurality of bottom ends unconnected to one another, the plurality of bottom ends being provided with a plurality of footings; and

at least one brace frame movably connected to at least two of the plurality of legs, wherein the at least one brace frame is securable to the at least two of the plurality of legs for providing rotational restraint thereto;

lowering the plurality of legs into a seabed;

positioning the at least one brace member at a desired elevation along the at least two of the plurality of legs; and

securing the at least one brace member to the at least two of the plurality of legs at an elevation that is free from contact with the plurality of footings and a seabed.

8. The method of claim 7, wherein transporting a pre-assembled self-installing platform further includes transporting by a barge supporting the pre-assembled self-installing platform.

9. The method of claim 7, wherein transporting a pre-assembled self-installing platform further includes floating the pre-assembled self-installing platform.

10. The method of claim 7, wherein positioning the at least one brace member further includes lowering the at least one brace member using one of a cable system and a rack and pinion system.

11. The method of claim 7, wherein securing the at least one brace member to the at least two of the plurality of legs further includes securing using one of a filler joining material and a clamp.