ABSTRACT OF THE DISCLOSURE

Tubular, battered, lateral support braces secured below the water-line to substantially vertically disposed tubular support columns for an offshore drilling platform may be made to receive foundation piles inserted and driven through the bore of said tubular support columns by affixing a pile deflecting shoe at the juncture between said battered braces and said tubular support columns and vertically driving the pile against said shoe to deflect the pile into the tubular brace and ultimately into the ocean floor.

In the past, it has been the practice of the drilling industry to support equipment for drilling in water-covered surface areas having a depth of from about fifty to several hundred feet from multiple legged tower structures secured to the marine floor with piles driven deeply into the earth. These structures have generally taken one of two forms, the distinction residing in whether the legs or main support columns are vertical or battered. In either case, the legs, which are hollow tubular casings, are straight along their length and receive anchoring piles through the bore thereof.

Each of the two tower structures described above has respective advantages and disadvantages for which reasons that vertical legged structures are generally used in shallow or protected waters where surface wave and current forces are minimal, thereby taking advantage of a simpler, less expensive construction and the need for vertical pile driving only.

Those structures having battered legs, however, are of considerably greater strength and cost. The design geometry is a near necessity in open seas of 300-foot depths and greater due to the high overturning forces imposed on the structure by wave and current, and in some environments by large floes of ice many feet in thickness, acting laterally against the upper end thereof. However, the design has heretofore also required that the piles to anchor the structure to the marine floor be driven at the same angle as the batter of the legs, more difficult operation than that of vertical pile driving.

This invention combines the desirable features of both aforementioned structural types by providing a main platform support structure having substantially vertical main support columns with the additional lateral support of battered bracing. Unlike the prior art, however, the battered bracing of the invention terminates short of the full length of the structure, preferably below the waterline level. Anchoring or foundation piles are driven through the central bore of the tubular main support columns and deflected into the central bore of respective battered tubular braces by a deflecting shoe positioned in the main support column bore near the juncture thereof with the respective battered brace.

It is, therefore, an object of this invention to provide a stationary offshore platform support structure having battered positioned foundation piles that are driven with a vertically acting pile driver.

Another object of this invention is to provide an offshore platform support structure having battered support legs which terminate their upper ends below the marine surface.

A further object of this invention is to provide vertical support casings as drill string guide and conductor pipes for an offshore drilling platform that are laterally reinforced by subsurface battered braces positioned below major wave action or ice floes.

These and other objects of the invention will be understood from the following description taken with reference to the following drawings wherein:

FIGURE 1 is a perspective view of a drilling platform support structure constructed according to the present invention;
FIGURE 2 is an orthographic elevation of the present invention;
FIGURE 3 is a sectional plan view of the base of the FIGURE 2 structure taken across cut lines III—III;
FIGURE 4 is a phantom line detail showing the juncture of the battered braces with the vertical columns;
FIGURE 5 is a sectional plan view of the FIGURE 4 detail taken across cut lines V—V;
FIGURE 6 is a detail of the juncture between the lower ends of two battered supports; and
FIGURE 7 is a sectional plan view of the base of a modified embodiment of the drilling platform support structure according to the invention.

With reference to FIGURES 1 and 2, a work platform 10 having a derrick 11 and protective housing 12 for personnel and equipment mounted thereon is supported above the surface 15 of a body of water 16 by a support structure designated generally as 20.

The primary or main support columns 21 are shown as four in number but may be of any desired number including a single support mast of very large diameter. For a structure as shown with four main columns and approximately 350 feet in height, the main columns 21 are preferably steel pipes or casings of about 72 inches in diameter.

Along the height of the main columns 21 are a number of horizontal and diagonal cross braces 22 and 23, respectively, which tie the columns 21 together as an integral structural unit.

Each main column 21 is laterally braced by a plurality of battered pile jackets, supports or braces 25. The particular illustrated structure includes three such battered braces 25 for each column 21. Each brace 25 is aligned with its respective column 21 so that the axis thereof intersects the axis of the column 21, thereby placing the brace and its respective column in a common vertical plane. Furthermore, the axes of the three braces 25 respectively to each column 21 preferably intersect the column axis at a common point or juncture 26 below the water surface 15. However, it is also possible to intersect the braces 25 with their respective support column 21 at different levels vertically spaced along the length of the support column.

Below the juncture 26, each brace 25 drops angularly away from its respective column 21 to an appropriate position on the marine floor 17. The bottom ends of adjacent braces 25 for the same column 21 may subtend equal segments of an imaginary circle circumscribing the integral unit of the main support columns as shown in FIGURE 3. Additional bracing 27 typically forms the lateral bracing skirt formed by all the braces 25 together and to the vertical unit of the main columns 21.

Although adjacent battered braces 25 respective to adjacent main columns 21 are secured together as illustrated by FIGURES 1 through 3, the details of the juncture may be as shown by FIGURE 6. In other words, the axis of the battered brace 25a may be skewed with respect to the axis of battered brace 25 so that their respective
foundation piles 35a and 35 may be driven home in a manner to be subsequently described without mutual interference.

At the junction point 26 of the battered braces 25 with their respective main columns 21, the wall of the main column tubing is cut away to place the internal bore of the column in open communication with the internal bores of the battered braces 25 which also are hollow tubes. With reference to FIGURE 5, the main columns 21 may be also provided with longitudinal guide means such as tracks 31. The tracks 31 extend the length of the main column 21 from the top down to a landing abutment (not shown) just below the juncture 26. Radially, the tracks 31 are suitably spaced around the circular segment remote from the juncture opening with the battered braces 25.

Received by each of the tracks 31 are carrier lugs 32 which operatively cooperate to keep a pile guide or deflecting means such as a removable shoe 30 in non-rotative alignment with the main column bore and the bore of a selected one of the battered braces 25. The deflecting shoe 30 is secured to a carrier ring 33 by means of a thrust collar on the shoe 30 and held in angular position with respect to the carrier ring 33 by indexing pins 34. As an alternative method of indexing the deflecting shoe 30, the carrier ring 33 may be secured to or integrally constructed with the deflecting ring and additional guide tracks 31 provided in the bore of the main column so that the shoe may be aligned with a selected one of the battered braces by merely inserting the carrier lugs 32 in the appropriate set of guide tracks 31.

In practice, the aforesaid described structure, without the platform assembly 10, is fabricated on land in a drydock or boat building facility with the open ends of the constituent tubes capped to provide inherent flotation for the unit. When completed, the structure is conveyed to the site by tugs where the tubes are selectively floored, thereby sinking the structure bottom-first to the marine floor. At this point a pile guide or orienting means which may be in the form of a deflecting shoe 30 is dropped or lowered into place along the guide tracks 31 in a selected main column 21. The face of the shoe 30 has been angularly positioned with respect to the carrier ring 32 to align with the bore of a selected one of the battered braces 25. When in position, a pile 35 is inserted through the bore of the main column 21 until the lower end thereof comes to rest against the face of the shoe 30. A pile driver then engages the upper end of the pile 35 to drive the pile through column 21 and to bend and deflect the pile 35 into the battered brace bore and axially therealong into the earth forming the marine floor 17.

Since it may be desirable to ultimately use the main columns 21 as drill string guides or as a protective casing for plurality of conductor pipes clustered longitudinally within the main column bores, the upper end of the piling 35 may be driven past the juncture 26 and clear of the main column bore as shown in FIGURE 4 by a pile follower 36 which is subsequently withdrawn. As a possible alternative to the use of a removable deflecting shoe, the main support column 21 may be fabricated with a prepositioned deflecting shoe secured in place in the bore thereof. Such a prepositioned deflecting shoe would serve to deflect the first pile string into its respective battered brace bore. If more than one pile string is to be driven, such other braces would junction with the main column bore at a vertically higher position on said support column. The upper end of the final section of the first pile string, which is made up of a plurality of tubes, for example, secured as by welding end to end, a new section being added as the pile string is driven in an equivalent length, is provided with a deflecting shoe that is oriented so that when the first piling string is driven to the desired depth, the deflecting shoe on the upper end thereof is properly positioned to deflect a second pile string into the bore of the second battered brace.

Of course, the bore of the main support column 21 will be obstructed by the protruding ends of the respective pile strings as well as by the respective shoes in such an alternative exploitation of this invention. Nevertheless, if such an alternative should be found desirable under particular circumstances, and it should also be desired to use the main column bore to conduct drilling operations, it would be possible to ream or otherwise cut such obstructive structure from the bore by any of the known means for performing such tasks such as milling bits and casing cutting tools.

FIGURE 7 illustrates a modification of the circular base arrangement depicted by FIGURE 3 and represents a base design which facilitates handling of a pre-assembled platform support structure that is to be transported to the erection site on the deck of a barge or other vessel. Notably, the lateral bracing skirt formed by all the battered braces 25 is terminated in the plane of one side of the main support structure. Hence, the plane passing through both main support columns 21a and 21b defines the circumferential extent of the lateral support skirt. The effect of such a configuration is to allow the structure to be fabricated and then placed in the plane of construction jigs and fixtures. Also, the flat side of the completed structure serves as a stable position therefor when lashed to the deck of the carrier vessel. Furthermore, due to the flat side of the structure, launching thereof over the side of the carrier vessel is facilitated.

We claim as our invention:
1. A method of anchoring an upright tubular support column of a platform support structure to the floor of a body of water comprising the steps of:
   a. positioning a tubular bracing member between a point intermediate of the top and bottom ends of said tubular support column that is normally below the surface of said body of water and a point on said floor that is laterally offset outwardly from the bottom end of said support column such that said support column axis and said bracing member axis lie substantially in the same plane;
   b. securing said bracing member to said support column at said intermediate point;
   c. placing the bore of said tubular support column in open communication with the bore of said tubular bracing member;
   d. inserting a pile member through said support column bore from the top end thereof;
   e. bending said pile member at the juncture of said support column and bracing member bores into said bracing member bore; and
   f. driving said pile member through said bracing member bore into said floor with pile driving means in said support column bore.
2. A method as described in claim 1 wherein said bending step includes the step of inserting in said support column a pile deflecting and bending means at a point adjacent said juncture.
3. A method as described in claim 2 including the step of subsequently reorienting said pile deflecting and bending means within said support column so as to align with the bore of another bracing member secured to said support column.
4. A structure for supporting a work platform from the floor of a body of water above the surface thereof, said structure comprising:
   a. a plurality of generally upright tubular support columns having one end adjacent said floor and the other end extending above said surface;
   b. cross-bracing means interconnecting said columns at points along the length thereof;
   c. substantially upright tubular bracing means having an upper end secured to a respective support column at
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5 a point below said water surface and a lower end adjacent said floor and laterally spaced from the axis of said respective support column and outwardly from said structure, the axis of said upright bracing means substantially intersecting the axis of said respective support column and the bore of said upright bracing means tube being in open communication with the bore of said respective support column tube; and
piling means extending coaxially through said upright bracing means bore into said floor.

5. Apparatus as described by claim 4 wherein the upper ends of said piling means are driven clear of said support column bore.

6. Apparatus as described by claim 4 additionally comprising piling guide means within said support column bore whereby said piling means may be driven coaxially through said support column bore against said piling guide means and deflected thereby into said upright bracing tube bore.

7. Apparatus as described by claim 4 wherein said upright bracing means comprises a plurality of bracing tubes secured to each support column, the axes of said bracing tubes intersecting the axis of said respective support column at a substantially common point, the bore of each said bracing tube being in open communication with said support column bore, said piling guide means including indexing means whereby said piling guide means may be aligned selectively with each of said bracing tubes to direct a respective piling therethrough.

8. Apparatus as described by claim 7 wherein the lower end of one of said bracing tubes respective to a first support column is positioned on said floor adjacent the lower end of a bracing tube respective to a support column adjacent said first support column.

9. Apparatus as described by claim 8 wherein the lower ends of said bracing tubes are positioned on said floor at equally spaced segments forming a circle around an axis centrally located with respect to said plurality of support columns.

10. A structure for supporting a work platform from the floor of a body of water above the surface thereof, said structure comprising:

a plurality of generally upright tubular support columns having one end adjacent said floor and the other end extending above said surface;
cross-bracing means interconnecting said columns at points along the length thereof; and
substantially upright tubular bracing means having an upper end secured to a respective support column at a point below said water surface and a lower end adjacent said floor laterally spaced from the axis of said respective support column and outwardly from said structure, the axis of said upright bracing means substantially intersecting the axis of said respective support column and the bore of said upright bracing means tube being in open communication with the bore of said respective support column tube.

References Cited

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