detached and removed leaving the anchor embedded in the seabed.

WO 2004/011327 discloses a method and device for deployment of a sheet anchor. The sheet anchor is mounted at a lower end of a pile which is lowered to the seabed and driven into the seabed by a vibratory hammer, or the like. After deployment of the anchor in the seabed the pile is removed from the sheet anchor.

Dynamically installed anchors, often referred to as torpedo piles, are an economical means of installing anchors in deep water. Dynamically installed anchors are released from a predetermined height above the seabed and rely on their self weight and the kinetic energy gained during freefall to self-bury in the seabed sediments. As no mechanical intervention is required during installation, installation costs are relatively independent of water depth. However these anchors can be extremely large and heavy with overall lengths of up to 22 metres and masses of over 100 tonnes. Hence fabrication and transportation costs can be very high. Furthermore, compared with other anchor types such as plate anchors, they are relatively inefficient at resisting vertical loads and tend to be susceptible to "setup" effects where the anchor capacity can only be realised after a significant period of time after installation has elapsed.

The present invention is directed towards overcoming these problems.

Summary of the Invention

According to a first aspect of the present invention, there is provided an anchor assembly including a plate anchor element having at least one tether attachment, wherein the plate anchor element is releasably mounted on an implanting follower to facilitate dynamically embedding the plate anchor element in a mooring bed below a body of water, wherein the implanting follower has a shaft with a leading tip at one end and the plate anchor element has a sleeve which is slidably engagable with the shaft, and a stop on the shaft limits sliding movement of the sleeve on the shaft away from the leading tip of the shaft, wherein the shaft of the implanting follower passes through the sleeve with the leading tip spaced apart from the sleeve, wherein the plate anchor element has a number of radial flukes mounted on the sleeve which form flights thereby giving the anchor assembly a dart-shape.

According to a second aspect of the present invention, there is provided a method for dynamically embedding a plate anchor element in a mooring bed below a body of water using an anchor assembly, wherein the anchor assembly includes a plate anchor element and an implanting follower, wherein the plate anchor element has a tether attachment, wherein the plate anchor element is releasably mounted on the plate anchor element on the implanting follower to facilitate dynamically embedding the plate anchor element in the mooring bed below the body of water, wherein the implanting follower has a shaft with a leading tip at one end and the plate anchor element has a sleeve which is slidably engagable with the shaft, and a stop on the shaft for limiting sliding movement of the sleeve on the shaft away from the leading tip of the shaft, wherein the shaft of the implanting follower passes through the sleeve with the leading tip spaced apart from the sleeve, wherein the plate anchor element has a number of radial flukes mounted on the sleeve which form flights, wherein the method comprises: mounting the plate anchor element on the implanting follower, suspending the implanting follower above the mooring bed, releasing the implanting follower such that the implanting follower freefalls downwardly penetrating the mooring bed, and disengaging and lifting the implanting follower away from the plate anchor element leaving the plate anchor element embedded in the mooring bed below the body of water.

ThereAccording to the invention there is also disclosedprovided an anchor assembly including an anchor element having tether attachment means and mounting means for releasably mounting the anchor element on an associated dynamic implanting follower to facilitate dynamically embedding the anchor element in a mooring bed below a body of water in use. Advantageously the invention provides aA relatively simple and economical system for burying an anchor in the bed of the body of water by freefall may be provided. Conveniently also after deployment the implanting follower may beis retrieved for re-use.

In one embodiment of the invention the anchor element is releasably engagable with the implanting follower at a position behind a leading tip of the implanting

follower. The leading tip of the implanting follower will be the lower end of the implanting follower in use. Thus, advantageously the leading tip of the implanting follower projects below the anchor element when deploying the anchor element which may beis protected from damage when the freefalling implanting follower impacts with the mooring bed. The force of the impact is taken by the leading tip of the implanting follower. Essentially, the leading tip of the implanting follower forces its way through the mooring bed pulling the anchor element behind it.

In another embodiment the anchor element is engagable with a trailing end of the implanting follower.

In a further embodiment the anchor element is substantially symmetrical about a longitudinal axis of the implanting follower when mounted thereon. This may provides a stable and streamlined assembly for freefall through the water and into the mooring bed.

In another embodiment the anchor element is slidably engagable with the implanting follower. Thus conveniently the follower can be readily and easily retrieved from the anchor element after the anchor element has been buried in the mooring bed below the body of water.

In a particularly preferred embodiment the implanting follower has a shaft with the leading tip at one end and the anchor element has a complementary sleeve which is slidably engagable with the shaft, a stop on the shaft for limiting sliding movement of the sleeve on the shaft away from the leading tip of the shaft.

In another embodiment the stop comprises a flanged head at the trailing end of the shaft. The trailing end of the shaft will be the upper end of the shaft in use. This may provides a simple and robust construction.

In a preferred embodiment the anchor element is releasably attached to the implanting follower by a shear pin. Thus, the anchor element is securely retained on the shaft until it is deployed in the bed of the body of water and then either during or after deployment, the shear pin ruptures or is ruptured to allow removal

and retrieval of the implanting follower for re-use.

In one embodiment of the invention the shear pin is engagable with complementary mounting holes in the anchor element and in the implanting follower.

In another embodiment the mounting holes are located such that when the anchor element and the implanting follower are interconnected by the shear pin, the anchor element is supported on the implanting follower spaced-apart from the stop. Thus, conveniently as the anchor assembly is penetrating into the bed of the body of water, the anchor element can move upwardly along the shaft to engage against the stop at the same time rupturing the shear pin to allow subsequent removal of the implanting follower.

In a further embodiment the head has means for attachment of a lifting cable to the implanting follower.

In a further embodiment the plate anchor element has a number of radial flukes mounted on the sleeve.

Conveniently at least a lower portion of each fluke is curved or tapered. This may advantageously facilitates penetration of the bed of the body of water during deployment of the anchor element.

In another embodiment each fluke has a semi-circular shape.

In another embodiment four radial flukes are mounted on the sleeve in a cruciform configuration. Other arrangements such as two, three or more flukes are possible

In another embodiment at least one fluke has the tether attachment means. Conveniently each fluke has a tether attachment means.

In another embodiment the tether attachment means is a through hole adjacent an outer edge of the fluke at a central portion of the fluke. Thus, a tethering chain can be easily and quickly attached to the anchor element by a shackle or the like.

In another embodiment the leading tip of the shaft is shaped to facilitate penetration of the shaft into the mooring bed below the body of water.

There is also disclosed~~In another aspect the invention provides~~ a method for dynamically embedding an anchor element in a mooring bed below a body of water including;

mounting the anchor element on an associated dynamic implanting follower,

suspending the implanting follower a preset distance above the mooring bed,

releasing the implanting follower such that it freefalls downwardly penetrating the mooring bed, and

disengaging and lifting the implanting follower away from the anchor element leaving the anchor element embedded in the mooring bed below the body of water.

Brief Description of the Drawings

The invention will be more clearly understood by the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which;

Fig. 1 is an elevational view of an anchor assembly according to the invention;

Fig. 2 is a sectional view taken along the lines II-II of Fig. 1;

Fig. 3 is a detail elevational view of an implanting follower forming portion of the anchor assembly;

Fig. 4 is a detail elevational view showing a plate anchor element forming

Claims

1. An anchor assembly including a plate anchor element, having tether attachment means and mounting means for releasably mounting the anchor element on an associated dynamic implanting follower to facilitate dynamically embedding the anchor element in a mooring bed below a body of water in use, wherein the implant follower has a shaft with a leading tip at one end and the anchor element has a complementary sleeve which is slidably engagable with the shaft, and a stop on the shaft for limiting sliding movement of the sleeve on the shaft away from the leading tip of the shaft, wherein the shaft of the implant follower passes through the sleeve with its leading tip spaced apart from the sleeve, wherein the anchor element has a number of radial flukes mounted on the sleeve which form the flights of the dart shaped anchor assembly.

2. The anchor assembly as claimed in claim 1, wherein the anchor element is releasably engagable with the implanting follower at a position behind the leading tip of the implanting follower.

3. The anchor assembly as claimed in claim 2, wherein the anchor element is engagable with the trailing end of the implanting follower.

4. The anchor assembly as claimed in any one of the preceding claims, wherein the anchor element is substantially symmetrical about a longitudinal axis of the implanting follower when mounted thereon.

5. The anchor assembly as claimed in any one of the preceding claims, wherein the stop comprises a flanged head at the trailing end of the shaft.

6. The anchor assembly as claimed in any one of the preceding claims, wherein the anchor element is releasably attached to the implanting follower by a shear pin.

7. The anchor assembly as claimed in claim 6, wherein the shear pin is engagable with complementary mounting holes in the anchor element and in the implanting follower.

8. The anchor assembly as claimed in claim 7, wherein the mounting holes are located such that when the anchor element and the implanting follower are interconnected by the shear pin, the anchor element is supported on the implanting follower spaced-apart from the stop.

9. The anchor assembly as claimed in any of the claims 5 to 8, wherein the head has means for attachment of a lifting cable to the implanting follower.

10. The anchor element as claimed in any one of the preceding claims, wherein at least a lower portion of each fluke is curved or tapered.

11. The anchor assembly as claimed in claim 10, wherein each fluke has semi-circular shape.

12. The anchor assembly as claimed in any one of the preceding claims, wherein four radial flukes are mounted on the sleeve in a cruciform configuration.

13. The anchor assembly as claimed in any one of the preceding claims, wherein at least one fluke has the tether attachment means.

14. The anchor assembly as claimed in any one of the preceding claims, wherein each fluke has a tether attachment means.

15. The anchor assembly as claimed in claim 13 or claim 14, wherein the tether attachment means is a through hole adjacent an outer edge of the fluke at a central portion of the fluke.

16. The anchor assembly as claimed in any one of the preceding claims, wherein the leading tip of the shaft is shaped to facilitate penetration of the shaft into the mooring bed below the body of the water.

17. A method for dynamically embedding a plate anchor element in a mooring bed below a body of water by means of an anchor assembly, wherein the anchor assembly includes the plate anchor element and an associated dynamic implant follower, wherein the anchor element has tether attachment means and mounting means for releasably mounting the anchor element on the associated dynamic implanting follower to facilitate dynamically embedding the anchor element in the mooring bed below the body of water in use, wherein the implant follower has a shaft with a leading tip at one end and the anchor element has a complementary sleeve which is slidably engagable with the shaft, and a stop on the shaft for limiting sliding movement of the sleeve on the shaft away from the leading tip of the shaft, wherein the shaft of the implant follower passes through the sleeve with its leading tip spaced apart from the sleeve, wherein the anchor element has a number of radial flukes mounted on the sleeve which form the flights of the dart shaped anchor assembly, wherein the method comprises:

mounting the anchor element on the associated dynamic implanting follower,

suspending the implanting follower a present distance above the mooring bed,

releasing the implanting follower such that it freefalls downwardly penetrating the mooring bed, and

disengaging and lifting the implanting follower away from the plate anchor element leaving the anchor element embedded in the mooring bed below the body of water.

Claims

1. An anchor assembly including a plate anchor element having at least one tether attachment, wherein the plate anchor element is releasably mounted on an implanting follower to facilitate dynamically embedding the plate anchor element in a mooring bed below a body of water, wherein the implanting follower has a shaft with a leading tip at one end and the plate anchor element has a sleeve which is slidably engagable with the shaft, and a stop on the shaft limits sliding movement of the sleeve on the shaft away from the leading tip of the shaft, wherein the shaft of the implanting follower passes through the sleeve with the leading tip spaced apart from the sleeve, wherein the plate anchor element has a number of radial flukes mounted on the sleeve which form flights thereby giving the anchor assembly a dart-shape.

2. The anchor assembly as claimed in claim 1, wherein the plate anchor element is releasably engagable with the implanting follower at a position behind the leading tip of the implanting follower.

3. The anchor assembly as claimed in claim 1, wherein the plate anchor element is releasably attached to the implanting follower by a shear pin.

4. The anchor assembly as claimed in claim 3 wherein the shear pin is engagable with complementary mounting holes in the plate anchor element and in the implanting follower.

5. The anchor assembly as claimed in claim 4 wherein the mounting holes are located such that when the plate anchor element and the implanting follower are interconnected by the shear pin, the plate anchor element is supported on the implanting follower spaced-apart from the stop.

6. The anchor assembly as claimed in claim 2, wherein the stop has an upstanding web and a through-hole for attachment of a lifting cable to the implanting follower.

7. The anchor assembly as claimed in claim 1, wherein at least a lower portion of each radial fluke is curved or tapered.

8. The anchor assembly as claimed in claim 7, wherein each radial fluke has semi-circular shape.

9. The anchor assembly as claimed in claim 1, wherein at least one radial fluke has a tether attachment.

10. The anchor assembly as claimed in claim 1, wherein each radial fluke has a tether attachment.

11. The anchor assembly as claimed in claim 9, wherein the tether attachment is a through hole adjacent an outer edge of the radial fluke at a central portion of the radial fluke.

12. The anchor assembly as claimed claim 1, wherein the leading tip of the shaft facilitates penetration of the shaft into the mooring bed below the body of the water.

13. The anchor assembly as claimed in claim 2, wherein the plate anchor element is engagable with a trailing end of the implanting follower.

14. The anchor assembly as claimed in claim 1, wherein the plate anchor element is substantially symmetrical about a longitudinal axis of the implanting follower when mounted thereon.

15. The anchor assembly as claimed in claim 1, wherein the stop is a flanged head at a trailing end of the shaft.

16. The anchor assembly as claimed in claim 1, wherein four radial flukes are mounted on the sleeve in a cruciform configuration.

17. A method for dynamically embedding a plate anchor element in a mooring bed below a body of water using an anchor assembly,

wherein the anchor assembly includes a plate anchor element and an implanting follower, wherein the plate anchor element has a tether attachment, wherein the plate anchor element is releasably mounted on the plate anchor element on the implanting follower to facilitate dynamically embedding the plate anchor element in the mooring bed below the body of

water, wherein the implanting follower has a shaft with a leading tip at one end and the plate anchor element has a sleeve which is slidably engagable with the shaft, and a stop on the shaft for limiting sliding movement of the sleeve on the shaft away from the leading tip of the shaft, wherein the shaft of the implanting follower passes through the sleeve with the leading tip spaced apart from the sleeve, wherein the plate anchor element has a number of radial flukes mounted on the sleeve which form flights, wherein the method comprises:

mounting the plate anchor element on the implanting follower,

suspending the implanting follower above the mooring bed,

releasing the implanting follower such that the implanting follower freefalls downwardly penetrating the mooring bed, and

disengaging and lifting the implanting follower away from the plate anchor element leaving the plate anchor element embedded in the mooring bed below the body of water.