

TITLE: Seafastening of a cantilever on a mobile offshore platform

FIELD AND BACKGROUND OF THE INVENTION

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The invention relates to a mobile offshore platform transformable between a floating condition for displacement between operating locations and a stationary condition supported by the sea bottom. An example of such a mobile offshore platform is a jack-up rig, which has a self-elevating hull that can be jacked up to its stationary operating position above the sea using legs that are first lowered to the sea bottom and along which the hull of the rig is subsequently jacked-up. For displacement to a new operating position, the platform hull is lowered until it floats and subsequently the legs are raised as much as possible to reduce drag when a tugboat tows the rig or the rig is propelled by its own drive.

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In floating condition, a mobile offshore platform is a vessel and accordingly moves as a result of being exposed to waves and swell of the sea surface, while, in stationary condition, the platform legs rest on the sea bottom so that the platform moves very little.

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Such mobile offshore platforms can for example be used to drill for hydrocarbons or to install offshore structures. For drilling operations a drill floor and drilling derrick are usually placed on the aft (distal) end of a cantilever structure. The complete cantilever can be moved relative to the platform hull of the mobile offshore platform with an X-Y movement system to allow precise placement of the drilling derrick above drilling locations in a large area to the rear of the platform hull without displacement of the rig which would require lowering and jacking up of the platform hull. Mobile offshore platforms having a movement system allowing extension and retraction in longitudinal (X) direction of the cantilever and pivoting of the cantilever about a vertical axis are also known.

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An example of such a mobile offshore platform with such a movement system is described in US 6 171 027. Longitudinal rails oriented in a direction

designated as the X-direction are attached to the cantilever, and transverse rails oriented in a direction designated as the Y-direction perpendicular to the X-direction are attached to an upwardly facing side (usually the main deck) of the platform hull.

5 Supporting members between the cantilever and the platform deck, for supporting the cantilever relative to the platform deck, are provided in the form of support runners and guided for movement over the rails in Y direction, while the cantilever is supported and guided by the support runners for movement in the X direction as the rails in X direction of the cantilever move
10 over the support runners. The support runners may slide over the rails or have rollers rolling over the rails. The movement system drive may for instance be of a hydraulic cylinder or of a rack-and-pinion type. The support runners also constitute spacers causing the level of the cantilever above the main deck to be relatively high, so that more vertical space above the main deck is available
15 for other items and the height to which the platform hull has to be lifted for work over an existing jacket is reduced.

When the rig is to be brought into a floating condition, the cantilever is retracted and has to be seafastened to prevent the cantilever from moving relative to the platform hull due to motion of the floating hull in waves and
20 swell (pitch, roll and yaw). At the forward (proximal) end, the retracted cantilever is restrained against movement relative to the platform hull in both longitudinal and transverse directions by pins extending through holes in front end portions of each of the two longitudinal cantilever rails and in a support structure on the platform hull. By holding the corresponding ones of the holes
25 in the rails and in the support structure in mutual alignment, the front end of the cantilever is held in position in both X and Y directions.

In addition to seafastening at the front end of the cantilever, also the aft (distal) end of the cantilever has to be seafastened to avoid pivoting of the cantilever about its front end, which would result in damage to the attachment
30 of the front end. A known solution for seafastening of the aft end of the

cantilever is to arrange a pillar bridging the vertical spacing between the cantilever and the main deck and extending from a pad eye at lower deck level at the aft end of the cantilever to an anchoring point located at one of the ends of the aft transverse deck rail.

5 Due to its size and weight, handling during installation and removal of such a pillar is difficult and time consuming. When not in use as seafastening of the cantilever, it can be removed, causing dropped and swaying object hazards, or it can remain attached to the cantilever, which negatively affects the allowable remaining maximum cantilever load.

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SUMMARY OF THE INVENTION

 It is an object of the present invention to provide a solution for seafastening of a cantilever of a mobile offshore platform, of which easy
15 handling during installation and removal is more easy, avoids risks of dropped or swaying objects, has less impact on allowable cantilever load when left in place and allows realization of a fully remotely controlled or automatic cantilever seafastening in a simple manner.

 According to the invention, this object is achieved by providing a mobile
20 offshore platform according to claim 1. In another embodiment, this object is achieved by carrying out a seafastening method according to claim 16.

 Because, in seafastened condition, a first retaining portion of the distal seafastening arrangement and a second retaining portion of the distal seafastening arrangement that is fixed to the platform hull in a position under
25 the cantilever are mutually engaged, the seafastening arrangement can be very compact and easy to handle and operate.

 Particular elaborations and embodiments of the invention are set forth in the dependent claims.

 Further features, effects and details of the invention appear from the
30 detailed description and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic side view of an example of a platform according to the invention standing on the bottom of the sea with a cantilever in a partially
5 extended position;

Fig. 2 is a schematic top plan view of the platform according to Fig. 1 with the cantilever in a fully extended position;

Fig. 3 is a schematic side view of a portion of the platform according to Figs. 1 and 2 including a cantilever in a fully retracted condition and a portion
10 of a platform hull;

Fig. 4 is a schematic top plan view of the platform according to Figs. 1-3 with the cantilever in a fully retracted position;

Fig. 5 is a schematic top plan view of a portion of a lower deck of the cantilever at a distal end of a cantilever of a platform according to Figs. 1-4;

Fig. 6 is a schematic side view in cross-section along a plane VI-VI in Fig. 5;

Fig. 7 is a top plan view of a portion of a transverse rail of a platform according to Figs. 1-6.

Fig. 8 is a schematic side view in cross-section along a plane VIII-VIII in Fig. 7;

Fig. 9 is a schematic side view in cross-section along a plane IX-IX in Fig. 7; and

Fig. 10 is a schematic side view in cross-section along a plane X-X in Fig. 4.

DETAILED DESCRIPTION

In the drawings, an example of a mobile offshore platform 1 according to the invention is shown. The platform has a platform hull 2 allowing the
30 platform to float and three legs 3 movably guided relative to the platform hull

2 for vertical movement relative to the platform hull 2. For driving movement
of the legs 3 between a lowered operating position as shown in Fig. 1, in which
the platform hull 2 is jacked up from a floating level, and a transport position
(not shown) in which a major portion of the legs 3 project above the floating
5 platform hull 2, leg drives 4 are provided.

The platform 1 further has an elongate cantilever 5 movable in
longitudinal directions X of the cantilever 5 between an extended position
(Figs. 1, 2) and a retracted position (Figs. 3, 4, 6, 8, 9, 10). At a distal end 7 of
the cantilever 5 a drilling derrick 6 (shown in Fig. 1 only, in other top plan
10 views, only corners of the derrick are shown) is mounted onto the cantilever 5.
Depending on the operation to be carried out, other equipment may be
provided at the distal end 7 of the cantilever 5. A moon pool deck 8 of the
cantilever 5 is located at a lower level than other parts of the cantilever 5. In
this example, the distal end 7 of the cantilever 5 constitutes the aft end of the
15 cantilever 5, since the cantilever 5 projects to the rear of the platform hull 2
when in extended condition. If the cantilever projects forwardly or at a side of
the platform hull, the distal end of the cantilever may also constitute a front
or, respectively, lateral end of the cantilever.

For displacing the cantilever 5 relative to the platform hull 2 in
20 longitudinal directions X and in transverse directions Y, a movement system is
provided. In this example, the movement system is a skidding system. The
skidding system is formed by a first guide 9 mounted to the cantilever 5 and
oriented in directions X parallel to the cantilever 5 for guiding movement of
the cantilever 5 in the longitudinal directions X, a second guide 10 mounted to
25 the platform hull 2 and oriented in directions Y transverse to the cantilever 5
and the longitudinal directions X for guiding movement of the cantilever 5 in
the directions Y transverse to the cantilever 5, and support members in the
form of support runners 11, 12, 13, 14 each arranged for guided movement
along the first guide 9 and the second guide 10. When skidding the cantilever 5
30 in transverse directions Y, the support runners 11-14 run along the second

guide 10. When skidding the cantilever 5 in longitudinal directions X, the first guide 9 runs over the support runners 11-14.

When the platform 1 is in transit condition, with the platform hull 2 floating on a water surface, the cantilever 5 must be seafastened to the platform hull 2 to prevent it from moving relative to the platform hull 2 due to movements of the platform hull 2 caused by waves, swell and wind. For seafastening the cantilever 5 at its proximal (here forward) end 15, a proximal seafastening arrangement 16 is provided at a proximal end portion of the cantilever 5 for retaining the cantilever 5 in the retracted position in position relative to the platform hull 2. As is best seen in Fig. 10, in this example, the proximal seafastening arrangement 16 is formed by tongues 17 at a proximal end of the cantilever 5 and received in apertures 19 in a stand 18. The apertures 19 each have a lower boundary in the form of a guide and support plate 20 that is flared downwards in aft direction for guiding a chamfered front end 21 of the corresponding tongue 17 into the aperture 19 when the cantilever 5 approaches its retracted position, so that the skidding system is at least partially relieved of bending loads caused by the fact that most of the retracted cantilever 5 is located forwardly of the support runners 11-14. A pin 22 is inserted through aligned bores 23-26 in each of the tongues 17 and apertures 19 retaining the tongues 17 in their positions in the apertures 19. Thus, the proximal end of the retracted cantilever 5 is firmly held in position by the proximal seafastening arrangement 16 in seafastening condition. The skilled person will note that alternative solutions for sea fastening the proximal cantilever end may be provided, such as pins projecting into bores in forward end portions of the guide rails extending in longitudinal direction of the cantilever.

Nevertheless, this is not sufficient for keeping the distal end 7 of the cantilever 5 from moving in transverse directions Y too far, in particular when the sea state is rough or high. Therefore, the platform 1 is also equipped with a distal seafastening arrangement 27 distally of the proximal seafastening

arrangement 16 for retaining the cantilever 5 in the retracted position in position relative to the platform hull 2. When in seafastened condition, a first retaining portion 28 of the distal seafastening arrangement 27 engages a second retaining portion 29 of the distal seafastening arrangement 27 that is
5 fixed to the platform hull 2, in a position under the cantilever 5. This allows the distal seafastening arrangement 27 to be very light and compact and easy to handle and operate during fastening and releasing of the cantilever 5. Therefore, it increases the workability, safety and capacity of the platform. Due to its small weight, the first retaining portion 28 of the distal seafastening
10 arrangement 27 has very little effect on the allowable cantilever load. It is noted that embodiments in which the second retaining portion engages the first engaging portion or in which both engaging portions engage each other are also conceivable.

The first retaining portion 28 of the distal seafastening arrangement 27
15 is mounted to the cantilever 5. Thus, the cantilever 5 is directly retained in position by the distal seafastening arrangement 27, which is more secure than if the distal end of the cantilever 5 would be retained in position in transverse directions Y via one or more of the support runners 11-14, which are not dimensioned for resisting sea fastening loads or would need to be dimensioned
20 very heavily, in particular with regard to tilting loads that would have to be resisted and transferred via the guide structure.

Furthermore, a very secure seafastening of the distal end of the cantilever 5 is achieved, because the first retaining portion 28 of the distal seafastening arrangement 27 is mounted to a lower portion (in this example
25 the moonpool deck 8) of the cantilever 5 projecting downwards relative to more proximal portions of the cantilever 5. In this position the distal seafastening arrangement 27 only needs to bridge a relatively small gap between the cantilever 5 and the platform hull 2.

The gap to be bridged can be particularly small, because the first
30 retaining portion 28 of the distal seafastening arrangement 27 is mounted in a

position lower than the first guide 9. Nevertheless space is left for the support runners 11-14 because the first retaining portion 28 of the distal seafastening arrangement 27 is mounted in a position transverse of the support runners 13, 14 engaging the same rail of the second guide 9 in the transverse direction Y.

5 The first guide 9 and also the second guide 10 are each constituted by a pair of rails 30, 31, 32, 33, which allows precise and stable guiding of the cantilever 5 during skidding.

 The distal seafastening arrangement 27 in fastening condition engages one of the rails 32, 33 of the second guide 10, in this example the one closest to
10 a stern of the platform hull 2. Engaging the rail 32 closest to the outside of the platform 1 allows the cantilever 5 to be retained close to its distal end, which is advantageous for secure sea fastening. Furthermore, this avoids the need of passing a lowermost portion of the cantilever 5 that projects downwards until closely above the second guide 10 over a substantial portion of the platform
15 hull 2 when retracting the cantilever 5 to its most retracted position.

 When the platform is afloat in rough seas, the cantilever 5 and the platform hull 2 tend to flex slightly. If, as in the present example, the cantilever 5 is fixed against movement relative to the platform hull 2 in longitudinal directions X at its proximal end 15, flexing of the cantilever 5 and
20 the platform hull 2 can for instance be accommodated by providing that the fixation of the cantilever 5 by the distal fastening arrangement 27, when in a condition retaining the cantilever 5 in the retracted position in position relative to the platform hull 2, allows some displacement of the cantilever 5 relative to the platform hull 2 in longitudinal direction.

25 As is illustrated by Figs. 5-9, the allowed displacement of the cantilever 5 relative to the platform hull 2 in the longitudinal directions X is within a longitudinal clearance (sum of first open spaces 34 in longitudinal directions X) larger than a transversal clearance (sum of second open spaces 35 in transverse directions Y), if any, allowing more displacement of the cantilever 5
30 relative to the platform hull 2 in the longitudinal direction X than in the

transverse direction Y, if any. Preferably the clearance in X direction is larger than 10 mm and, in order of increasing preference, the clearance in X direction may be larger than 20 mm, 30 mm or 40 mm. Preferably, the clearance in X direction is smaller than 150 mm and more preferably smaller than 120 mm.

- 5 Preferably the clearance in Y direction is smaller than 10 mm and, in order of increasing preference, the clearance in Y direction may be smaller than 5 mm or 2mm. Preferably, the clearance in Y direction is larger than 0.25 mm.

In the present example, this is achieved by providing that the first retaining portion 28 of the distal seafastening arrangement 27 is a pin 28
10 projecting into the second retaining portion 29, which is an aperture 29, when the distal seafastening arrangement 27 is in seafastened condition. More specifically, the aperture 29 has dimensions allowing longitudinal movement of the pin 28 relative to the rail 32 and limiting transverse movement of the pin 28 completely or at least more strictly than movement in the longitudinal
15 directions X. The basically rectangular shape of the aperture 29 and of the distal end of the pin 28 provide larger load transfer surface areas in transverse directions than would be provided by a circular or otherwise rounded shape providing clearances in perpendicular directions.

At least the lower end of the pin 28, which is to be inserted in the
20 aperture 29, and the aperture 29 have corresponding shapes with a relatively tight fit in transverse directions Y, while in longitudinal directions X a significant clearance is left to prevent the pin 28 from being loaded with longitudinal loads. The upper part of the pin 28 has larger cross-sectional dimensions than the lower end, providing a shoulder 46 determining vertical
25 movement of the pin 28 towards the guide 10 during seafastening, so that the depth of the aperture 29 and the vertical distance between the cantilever 5 and the guide 10 does not have to meet tight tolerances. Also, the lower end of the pin and the opening may thus be relatively small, so that the structural integrity of the rail is compromised to a small extent only, while the upper

part of the pin may be of a relatively large cross-section, so that the pin has a large bending strength.

For particularly easy operation of the distal seafastening arrangement 27, the distal seafastening arrangement 27 includes a pin actuator 36 for
5 moving the pin 28 between an extended position projecting into the aperture 29 and a retracted position retracted out of the aperture 29. The pin actuator 36 may for instance be in the form of a linear motor, a spindle drive or a hydraulic cylinder. As an addition or alternative, a manually operated spindle may be provided.

10 The pin or the hole may have a tapered portion, or an actuated wedging part may be inserted into the hole, for causing wedging engagement between the pin and the hole in the transverse direction to achieve zero clearance in transverse directions.

The pin 28 is mounted to the cantilever 5 and the pin-receiving aperture
15 29 is provided in the second guide 10. This allows the movable parts to be provided on a bottom side of the cantilever 5, where these parts are shielded relatively well from weather influences, in particular if the pin is inside the cantilever, and are less easily damaged during operations on the platform deck.

20 The pin actuator 28 is preferably arranged for causing the pin 28 to be urged towards the extended position, e.g. by gravity and/or spring force, so that the pin 28 enters into the aperture 29 if the aperture 29 is in line with the pin 28. Thus, the cantilever 5 can simply be skidded slowly in transverse direction until the pin 28 snaps into the aperture 29 and does not have to be
25 skidded into a position in which the pin 28 and the aperture 29 aligned with particular precision.

Depending on the size and weight of the cantilever, the distal seafastening arrangement may provide engagement between first and second retaining portions thereof at one or several positions under the cantilever.

As is best seen in Figs. 5 and 6, the location of the pin 28 in the cantilever 5 is optimized for transferring loads to the cantilever 5 by arranging the pin 28 between the girders 37-40 of the moonpool deck 8 and aligned with longitudinal girders 41, 42 along the moonpool 43. The moonpool deck 8 is
5 locally provided with a stiffening plate 44 with an opening 45 allowing the pin 28 to protrude.

When seafastening the cantilever 5, first the cantilever 5 is retracted and transversely aligned with the stand 18 for seafastening at the proximal end 15 of the cantilever 5. After the cantilever 5 is secured at its proximal end
10 15, the cantilever may be moved transversely at its distal end until the first and second retaining portions of the distal seafastening arrangement are aligned to allow mutual engagement. Then, the pin 28 of the distal seafastening arrangement 27 is lowered or released to descend to make contact with the rail 32 of the second guide 10. The skidding system may also be used
15 to slowly align the first and second retaining portions of the distal seafastening arrangement in transverse directions Y for seafastening at its distal end 7 and, when the pin 28 is aligned with the receiving aperture 29, automatically dropping or driving the pin 28 into the receiving aperture 29. The pin 28 may have been urged in engagement direction continuously, with a
20 slight pre-tension.

Within the framework of the invention, many variations on and alternatives to the described example are conceivable. For instance, the pin 28 of the distal seafastening arrangement may be positioned on or in the platform hull, with the pin extending from the platform hull to the cantilever to be
25 received in an aperture or other pin engagement structure provided as part of the cantilever. The pin may be held and driven by an arrangement in the form of a self-contained structure attached to either the platform hull or the cantilever or that arrangement may be integrated with either the platform hull structure or the cantilever structure.

Several features have been described as part of the shown example or alternative embodiments. However, it will be appreciated that the scope of the invention also includes embodiments having combinations of all or some of these features other than the specific combinations of features embodied in the

5 examples. Also, described effects and advantages of features are applicable in general to the features to which these advantages are attributed and not only in the context of the example or in combination with other described features.

Claims

1. A mobile offshore platform having:
 - a platform hull allowing the platform to float;
 - at least three legs movably guided relative to the platform hull for vertical movement relative to the platform hull;
 - 5 a leg drive for driving movement of the legs between a lowered operating position in which the platform hull is jacked up from a floating level and a transport position in which a major portion of the legs project above the floating platform hull;
 - an elongate cantilever movable in longitudinal directions of the
 - 10 cantilever between an extended position and a retracted position;
 - a movement system comprising a first guide mounted to the cantilever and oriented parallel to the cantilever for guiding movement of the cantilever in the longitudinal directions, a second guide mounted to the platform hull and oriented transverse to the cantilever for guiding movement of the cantilever in
 - 15 the directions transverse to the cantilever, and at least one support runner arranged for guided movement along the first guide and the second guide;
 - a proximal seafastening arrangement at a proximal end portion of the cantilever for retaining the cantilever in the retracted position in position relative to the platform hull; and
 - 20 a distal seafastening arrangement distally of the proximal seafastening arrangement for retaining the cantilever in the retracted position in position relative to the platform hull, wherein, when in seafastened condition, a first retaining portion of the distal seafastening arrangement and a second retaining portion of the distal seafastening arrangement in a fixed position
 - 25 relative to the platform hull are mutually engaged in a position under the cantilever, wherein the first retaining portion of the distal seafastening arrangement is mounted to the cantilever.

2. A platform according to claim 1, wherein the first retaining portion of the distal seafastening arrangement is mounted to a lower portion of the cantilever projecting downwards relative to more proximal portions of the cantilever.

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3. A platform according to claim 2, wherein the first retaining portion of the distal seafastening arrangement is mounted in a position below the first guide.

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4. A platform according to claim 3, wherein the first retaining portion of the distal seafastening arrangement is mounted in a position transverse of the at least one support runner.

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5. A platform according to any of the preceding claims, wherein at least the first guide or the second guide is constituted by at least one rail.

6. A platform according to claim 5, wherein at least the first guide or the second guide is constituted by a pair of rails.

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7. A platform according to claim 6, wherein the second guide is constituted by a pair of rails and wherein a first retaining portion of the distal seafastening arrangement in fastening condition engages one of the rails of the second guide closest to a nearest side of the platform hull.

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8. A platform according to any of the claims 1 – 7, wherein the distal fastening arrangement, when in a condition retaining the cantilever in the retracted position in position relative to the platform hull, allows displacement of the cantilever relative to the platform hull in longitudinal direction.

9. A platform according to claim 8, wherein the allowed displacement of the cantilever relative to the platform hull in the longitudinal direction is within a clearance larger than a clearance, if any, allowing displacement of the cantilever relative to the platform hull in the transverse direction.

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10. A platform according to any of the preceding claims, wherein the first retaining portion of the distal seafastening arrangement is a pin projecting into an aperture when the distal seafastening arrangement is in seafastened condition.

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11. A platform according to claim 10, wherein the distal seafastening arrangement includes a pin actuator for moving the pin between an extended position projecting into the aperture and a retracted position retracted out of the aperture.

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12. A platform according to claim 11, wherein at least the pin, the hole or a wedging part insertable into the hole with the pin has a tapered portion for causing wedging engagement between the pin and the hole.

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13. A platform according to any of the claims 10-12, wherein the pin is mounted to the cantilever and the pin-receiving aperture is provided in the second guide.

14. A platform according to claim 11 or 12 and according to claim 13, wherein the pin actuator is arranged for causing the pin to be urged towards the extended position so that the pin enters into the aperture if the aperture is in line with the pin.

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15. A method for seafastening a cantilever of a mobile offshore platform having:

a platform hull allowing the platform to float;

at least three legs movably guided relative to the platform hull for
5 vertical movement relative to the platform hull;

a leg drive for driving movement of the legs between a lowered operating position in which the platform hull is jacked up from a floating level and a transport position in which a major portion of the legs project above the floating platform hull;

10 an elongate cantilever movable in longitudinal directions of the cantilever between an extended position and a retracted position; and

a movement system comprising a first guide mounted to the cantilever and oriented parallel to the cantilever for guiding movement of the cantilever in the longitudinal directions, a second guide mounted to the platform hull and
15 oriented transverse to the cantilever for guiding movement of the cantilever in the directions transverse to the cantilever, and at least one support runner arranged for guided movement along the first guide and the second guide;

wherein the cantilever is seafastened by:

fixing a proximal end portion of the cantilever relative to the platform
20 hull for retaining the cantilever in the retracted position relative to the platform hull; and

fixing a distal end portion of the cantilever relative to the platform hull using a distal seafastening arrangement distally of the proximal seafastening arrangement, for retaining the cantilever in the retracted position in position
25 relative to the platform hull, by causing mutual engagement in a position under the cantilever between a first retaining portion of the distal seafastening arrangement mounted to the cantilever and a second retaining portion of the distal seafastening arrangement in a fixed position relative to the platform hull.

16. A method according to claim 15, further comprising transversal movement of the distal portion of the cantilever until alignment of the first retaining portion of the distal seafastening arrangement and the second retaining portion of the distal seafastening arrangement has been reached,
- 5 after the proximal end portion has been fixed relative to the hull and before fixing the distal end portion relative to the hull.