

DESCRIPTION

REPAIR JOINT AND SUBAQUEOUS CABLE REPAIR METHOD

5 TECHNICAL FIELD

The present invention relates to a repair joint and a subaqueous cable repair method.

BACKGROUND ART

10 A repair joint that connects terminal parts of cables is used to repair a subaqueous cable in which a fault is generated (for example, refer to Patent Document 1). The subaqueous cable in which the fault is generated is cut in a vicinity of a fault point. One
15 cut end of the cable is connected to one end of a spare cable by a first repair joint, and the first repair joint is immersed, and the other cut end of the cable is connected to the other end of the spare cable by a second repair joint, and the second repair joint is
20 immersed, to repair the subaqueous cable. Accordingly, when repairing the subaqueous cable, the spare cable is inserted between the cut ends of the cable.

Due to a marginal cable length caused by the spare cable that is inserted between the cut ends of the
25 cable, the second repair joint that is immersed afterwards is immersed while being tilted (sideways immersion) in a lateral direction (horizontal direction).

PRIOR ART DOCUMENTS

30 PATENT DOCUMENTS

Patent Document 1: Japanese Laid-Open Patent Publication No. 2006-345623

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

Accordingly, one object of the present invention is to provide a repair joint having a novel
5 structure that is usable to satisfactorily carry out a sideways immersion process, and a subaqueous cable repair method that uses such a repair joint.

MEANS OF SOLVING THE PROBLEM

10 According to one aspect, there is provided a repair joint including

a main repair joint body that is used to connect end parts of subaqueous cables together; and

a movable engaging part that is provided on an
15 outer periphery of the main repair joint body and movable in a circumferential direction with respect to the main repair joint body, and engaged by a sling that hangs the main repair joint body.

According to another aspect, there is provided
20 a subaqueous cable repair method including

a process that cuts a subaqueous cable in which an abnormality is generated;

a process that connects one cut end part of the subaqueous cable to a first end part of a spare cable
25 via a first repair joint;

a process that immerses the first repair joint;

a process that connects the other cut end part of the subaqueous cable to a second end part of the spare cable, on an opposite end from the first end part, via a
30 second repair joint; and

a process that immerses the second repair joint, wherein the second repair joint includes

a main repair joint body that is used to

connect the second end part of the spare cable and the other cut end part of the subaqueous cable, and

a movable engaging part that is provided on an outer periphery of the main repair joint body and

5 movable in a circumferential direction with respect to the main repair joint body, and engaged by a sling that hangs the main repair joint body.

EFFECTS OF THE INVENTION

10 Because the repair joint has the movable engaging part that is movable in the circumferential direction with respect to the main repair joint body, it is possible to satisfactorily carry out the sideways immersion process. For example, it is possible to
15 suppress damage to the cable caused by the sideways immersion.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1(a) is a schematic front view
20 illustrating an entire repair joint according to one embodiment of the present invention, and FIG. 1(b) and FIG. 1(c) respectively are a schematic front view and a schematic side view of a movable engaging part of the repair joint according to one embodiment.

25 FIG. 2(a) through FIG. 2(d) are schematic views illustrating overall processes of a subaqueous cable repair method according to one embodiment.

FIG. 3(a) and FIG. 3(b) are schematic views illustrating a repair joint immersion process in one
30 embodiment.

MODE OF CARRYING OUT THE INVENTION

A description will be given of a repair joint

(joint for subaqueous cable) according to one embodiment of the present invention, by referring to FIG. 1(a) through FIG. 1(c). FIG. 1(a) is a schematic front view illustrating an entire repair joint 100 according to one
5 embodiment, and FIG. 1(b) and FIG. 1(c) respectively are a schematic front view and a schematic side view of a movable engaging part 120 of the repair joint 100.

The repair joint 100 is formed to include a main repair joint body 110 and the movable engaging part
10 120. The main repair joint body 110 is used for connecting terminal parts of subaqueous cables. A device configuration of the main repair joint body 110 for connecting the cable end parts may be appropriately selected according to needs from known configurations.
15 A casing (armored casing) 111 of the main repair joint body 110 is configured to enable the movable engaging part 120 to be mounted thereon.

The movable engaging part 120 is provided on an outer periphery of the main repair joint body 110 and
20 is movable in a circumferential direction with respect to the main repair joint body 110. The movable engaging part 120 is configured to be engaged by a sling for hanging the main repair joint body 110.

Preferably, 1 or more pairs of movable
25 engaging parts 120 are provided at symmetrical positions with respect to a center of the main repair joint body 110, relative to a longitudinal direction of the main repair joint body 110. In the example illustrated in FIG. 1(a), 2 pairs of (4) movable engaging parts 120 are
30 provided. The positions and the number of the movable engaging parts 120 that are provided may be appropriately selected according to a hanging condition of the main repair joint body 110 and the like.

The circumferential direction of the main repair joint body 110 (or casing 111) may be simply referred to as a "circumferential direction". In addition, the longitudinal direction of the main repair joint body 110 (or casing 111) may be simply referred to as a "longitudinal direction".

A description will hereinafter be given of more specific configurations. The casing 111 has an approximately cylindrical shape. The movable engaging part 120 is mounted on the outer periphery of the casing 111. The movable engaging part 120 has a ring shape that surrounds the outer periphery of the casing 111 (that is, main repair joint body 110).

A pair of collar parts 112 is provided on the outer periphery of the casing 111 at a part where each movable engaging part 120 is mounted, so as to sandwich the movable engaging part 120 from both sides along the longitudinal direction. Because the movable engaging part 120 is sandwiched between the collar parts 112 from both sides, a movement of the movable engaging part 120 is restricted in the longitudinal direction, and the movable engaging part 120 is movable in the circumferential direction at a predetermined position along the longitudinal direction.

The movable engaging part 120 has a ring-shaped engaging part 121 provided on the outer periphery thereof. The main repair joint body 110 may be hanged by engaging the engaging part 121 by the sling. In this example, the engaging part 121 has the ring shape, however, the configuration of the engaging part 121 is not limited as long as the engaging part 121 can be engaged by the sling. In addition, a type, a configuration, and the like of the sling are not limited

as long as the main repair joint body 110 can be hanged via the movable engaging part 120.

The movable engaging part 120 is formed by a pair of semicircular members 122 and 123, for example, and the engaging part 121 is provided on an outer periphery of one of the semicircular members 122 and 123, such as the semicircular member 122, for example. The semicircular members 122 and 123 are arranged to sandwich the casing 111 from top and bottom, in a recess that is defined between the pair of collar parts 121, and end parts of the semicircular members 122 and 123 are bolted together, for example. Hence, the movable engaging part 120 can be provided in the ring shape mounted on the outer periphery of the casing 111 and movable in the circumferential direction.

A material forming the movable engaging part 120, dimensions of each of the parts, and the like may be appropriately selected according to a weight and the like of the main repair joint body 110 that is hanged via the movable engaging part 120.

Next, a description will be given of a subaqueous cable repair method using the repair joint 100, as an example of a method of using the repair joint 100 in one embodiment, by referring to FIG. 2(a) through FIG. 2(d), FIG. 3(a), and FIG. 3(b). FIG. 2(a) through FIG. 2(d) are schematic views illustrating overall processes of the repair method for a subaqueous cable 200. FIG. 3(a) and FIG. 3(b) are schematic views illustrating an immersion process of a second repair joint 260 (repair joint 100 according to one embodiment).

An xy-plane of an xyz coordinate system illustrated in FIG. 2(a) through 2(d), FIG. 3(a), and FIG. 3(b) indicates a horizontal plane, an x-direction

indicates an extending direction of the subaqueous cable 200 before a fault (before repair), a y-direction indicates a direction perpendicular to the extending direction of the subaqueous cable 200, and a z-direction indicates a vertical direction. The extending direction (x-direction) of the subaqueous cable 200 before the fault may simply be referred to as a "cable extending direction".

FIG. 2(a) through FIG. 2(c) are schematic views of the subaqueous cable 200 viewed from the horizontal (y-direction) perpendicular to the cable extending direction. As illustrated in FIG. 2(a), the subaqueous cable 200 is set along a bottom 300, such as an ocean floor, and the like, for example. A position 230 indicated by an "x-mark" indicates a fault point where an abnormality is generated in the aqueous cable 200. FIG. 2(a) illustrates a situation in which a predetermined range of the subaqueous cable 200, including the fault point 230, is dug out from the bottom 300 for the repair.

A diver cuts the subaqueous cable 200 at a position in a vicinity of the fault point 230. A part of the cut subaqueous cable 200 on one side (rightward direction on drawing sheet) with respect to the cut position may be referred to as an "A-cable 210". A part of the cut subaqueous cable 200 on the other side (leftward direction on drawing sheet) with respect to the cut position may be referred to as a "B-cable 220".

As illustrated in FIG. 2(b), the cut end part of the A-cable 210 is lifted onto a workboat (platform) 400, and an abnormal part in a vicinity of the cut end part is removed. An end part 211 of the A-cable 210 after removing the abnormal part is subjected to a

provisional terminal treatment, and the A-cable 210 is thereafter immersed into water 301. In some cases, a marker buoy 212 is mounted on the end part 211 of the A-cable 210.

5 The cut end part of the B-cable 220 is lifted onto the workboat 400, and the abnormal part in the vicinity of the cut end part is removed. An end part 221 of the B-cable 220 after removing the abnormal part is connected to an end part 241 of a spare cable 240
10 that is loaded on the workboat 400, via a first repair joint 250.

 A conventional repair joint (not the repair joint 100 according to one embodiment having the movable engaging part 120), or the repair joint 100 according to
15 one embodiment having the movable engaging part 120, may be used for the first repair joint 250.

 As illustrated in FIG. 2(c), the workboat 400 is caused to advance towards the A-cable 210 while feeding the spare cable 240, to immerse the first repair
20 joint 250 to the bottom 300.

 The end part 211 of the A-cable 210 is lifted onto the workboat 400, and the end part 211 of the A-cable 210 is connected to an end part 242 of the spare cable 240, on an opposite end from the end part 241 that
25 connects to the B-cable 220, via a second repair joint 260.

 The repair joint 100 according to one embodiment having the movable engaging part 120, may be used for the second repair joint 260.

30 By inserting the spare cable 240 between the first repair joint 250 and the second repair joint 260, a marginal cable length corresponding approximately to a length of the spare cable 240 is introduced in the

subaqueous cable 200 after the spare cable 240 is connected, when compared to the subaqueous cable 200 before the fault.

For this reason, in the subaqueous cable 200
5 connected with the second repair joint 260, a curved part 270 (curved part 27 configured to include the spare cable 240, the second repair joint 260, and the A-cable 210) projecting in the vertical direction (z-direction) is formed so that the second repair joint 260 is
10 arranged approximately at a vertex position.

As illustrated in FIG. 2(d), the schematic view of the subaqueous cable 200 in FIG. 2(d) is viewed from the vertical direction (z-direction). After connecting the second repair joint 260, the second
15 repair joint 260 is immersed to the bottom 300 by tilting the curved part 270 in the horizontal direction (y-direction) that is perpendicular to the cable extending direction. The horizontal direction (y-direction) that is perpendicular to the cable extending
20 direction may be referred to as a "lateral direction". In addition, the vertical direction (z-direction) may be referred to as a "longitudinal direction".

The curved part 270 including the second repair joint 260 projects in the longitudinal direction
25 when connecting the second repair joint 260, and thus, the second repair joint 260 cannot be immersed similarly to the immersion of the first repair joint 250, that is, cannot be immersed along the extending direction of the subaqueous cable 200 before the fault. Accordingly, the
30 curved part 270 is immersed by tilting the curved part 270 in the lateral direction. An immersion process of the second repair joint 260 may be referred to as a "sideways immersion process".

The sideways immersion process is carried out by moving the workboat 400 in the lateral direction while hanging the second repair joint 260, and moving the second repair joint 260 in the lateral direction to
5 a desired position.

A more detailed description will be given by referring to FIG. 3(a) and FIG. 3(b). FIG. 3(a) illustrates a state before the sideways immersion, that is, a state in which the curved part 270 projects in the
10 longitudinal direction. FIG. 3(b) illustrates a state after the sideways immersion, that is, a state in which the curved part 270 is tilted in the lateral direction and immersed to the bottom 300.

As illustrated in FIG. 3(a), the second repair
15 joint 260 (that is, repair joint 100 according to one embodiment) is hung from a crane that is provided on the workboat 400, via a lifting beam 401, for example. More particularly, the repair joint 260 (100) is hung by engaging a lower end of a sling 402 that hangs from the
20 lifting beam 401, for example, to the engaging part 121 of the movable engaging part 120.

As illustrated in FIG. 3(b), in a state in which the repair joint 260 (100) is hung, the curved part 270 is tilted in the lateral direction while moving
25 the workboat 400 in the lateral direction. Parts of the cable 240 and the cable 210 projecting towards the repair joint 260 (100) from the bottom 300 before a sideways tilting operation are tilted by the sideways tilt operation so that an original longitudinal
30 arrangement are tilted in the lateral direction.

The main repair joint body 110 tends to tilt laterally according to twisting of the cable 240 and the cable 210 that are connected to both ends of the main

repair joint body 110. In other words, the main repair joint body 110 tends to rotate in the circumferential direction (with reference to a position before the sideways tilting operation) when the sideways tilting operation is carried out.

On the other hand, the sling 402 that hangs the repair joint 260 (100) is engaged to the repair joint 260 (100) while maintaining a position facing a predetermined direction (downward vertical direction) during the sideways tilting operation. In other words, the engaging part 121 engaged by the sling 402 tends to maintain a position facing a predetermined direction (upward vertical direction) during the sideways tilting operation.

In this embodiment, the engaging part 121 is configured as the movable engaging part 120 that is movable in the circumferential direction, that is, the main repair joint body 110 is movable in the circumferential direction with respect to the movable engaging part 120. Hence, during the sideways tilting operation, the engaging part 121 can maintain the position facing the upward vertical direction, and the main repair joint body 110 can rotate in the circumferential direction.

For this reason, it is possible to carry out the sideways tilting operation on the repair joint 260 (100) so that the hanging main repair joint body 110 tilts in the lateral direction (rotates in the circumferential direction) by naturally following the twisting of the cable 240 and the cable 210.

Next, consideration will be given of the sideways immersion process for a comparison example in which the repair joint does not have a movable engaging

part, such as a case in which the engaging part illustrated in FIG. 3(a) and FIG. 3(b) is fixed with respect to the circumferential direction.

According to the comparison example, because
5 the engaging part tends to maintain the position in the upward vertical direction during the sideways tilting operation, the tilting movement in the lateral direction (rotating movement in the circumferential direction) of the main repair joint body is inhibited. For this
10 reason, unnatural twisting occur intensively at cable connecting parts on both ends of the repair joint, and may cause damage to the cable.

On the other hand, according to one embodiment, during the sideways tilting operation, the tilting
15 movement in the lateral direction (rotating movement in the circumferential direction) of the main repair joint body 110 is not inhibited when compared to the comparison example. For this reason, it is possible to suppress unnatural twisting from occurring intensively
20 at the cable connecting parts on both ends of the repair joint, and suppress damage to the cable.

As described above, by using the repair joint 100 according to one embodiment, it is possible to satisfactorily carry out the sideways immersion process.
25 For example, it is possible to suppress damage to the cable caused by the sideways immersion.

The present inventors created prototypes by applying the repair joint according to one embodiment to the connection of a light composite submarine power
30 cable, and carrying out a simulated test of the sideways immersion process. The movable engaging part moved smoothly as a sideways tilting angle of the cable became larger. From a transmission loss of an optical fiber

within the light composite cable, no abnormal increase was observed from measured results of a power meter during the test. In addition, when an electrical testing was carried out on the repair joint and the
5 cable after adding a mechanical history, the connection was acceptable and it was possible to guarantee a quality of the connection.

The light composite submarine power cable is an illustrative example of the cable to which the repair
10 joint according to one embodiment may be applied, and the type of cable to which the repair joint according to one embodiment may be applied is not limited to a particular type.

The heavier the weight of the repair joint,
15 the more likely the damage to the cable would occur due to the twisting in the case in which the engaging part is not movable (in the case of the comparison example). From this viewpoint, although the type of repair joint to which the movable engaging part according to one
20 embodiment is applied is not limited, effectiveness of applying the movable engaging part according to one embodiment increases as the repair joint becomes larger and heavier.

In the embodiment described above, the
25 direction of the sideways tilting illustrated in FIG. 2(d) and FIG. 3(b) is an example for illustrative description, and the direction of the sideways tilting (the tilting towards the left or right direction when viewed from the longitudinal direction) may be
30 appropriately selected according to needs.

In the embodiment described above, the curved shape of the cable at the curved part illustrated in FIG. 2(c), FIG. 2(d), FIG. 3(a), and FIG. 3(b) is an example

for illustrative description, and the curved shape of the cable may be approximately selected according to needs.

5 In the embodiment described above, the movable engaging part has a ring-shaped configuration, however, the configuration of the movable engaging part is not limited to a particular configuration as long as the movable engaging part is movable in the circumferential direction.

10 The sideways immersion process of the curved part of the cable including the repair joint may be carried out in cases other than the case in which the subaqueous cable is repaired. In such other cases, it is possible to suitably use the repair joint (joint for
15 subaqueous cable) according to one embodiment.

The present invention is described above by way of embodiments, however, the present invention is not limited to the above described embodiments, and for example, various variations, modifications, combinations,
20 and the like may be made as is evident to those skilled in the art.

<Preferable Aspects of Present Invention>

Preferable aspects of the present invention are appended in the following.

25 (Appended Claim 1)

According to one aspect of the present invention, there is provided a repair joint including a main repair joint body that is used to connect end parts of subaqueous cables together, and a movable engaging
30 part that is provided on an outer periphery of the main repair joint body and movable in a circumferential direction with respect to the main repair joint body, and engaged by a sling that hangs the main repair joint

body.

(Appended Claim 2)

In the repair joint recited in appended claim 1, the movable engaging part preferably has a ring shape
5 surrounding the outer periphery of the main repair joint body.

(Appended Claim 3)

In the repair joint recited in appended claim 2, the main repair joint body preferably includes a pair
10 of collar parts on the outer periphery thereof and sandwiching the movable engaging part from both sides.

(Appended Claim 4)

In the repair joint recited in appended claim 3, the movable engaging part preferably is formed by a
15 pair of semicircular members.

(Appended Claim 5)

In the repair joint recited in any of appended claims 1 to 3, the movable engaging part preferably
includes a ring-shaped engaging part on the outer
20 periphery thereof.

(Appended Claim 6)

According to another aspect of the present invention, there is provided a subaqueous cable repair method including a process that cuts a subaqueous cable
25 in which an abnormality is generated, a process that connects one cut end part of the subaqueous cable to a first end part of a spare cable via a first repair joint, a process that immerses the first repair joint, a process that connects the other cut end part of the
30 subaqueous cable to a second end part of the spare cable, on an opposite end from the first end part, via a second repair joint, and a process that immerses the second repair joint, wherein the second repair joint includes a

main repair joint body that is used to connect the second end part of the spare cable and the other cut end part of the subaqueous cable, and a movable engaging part that is provided on an outer periphery of the main repair joint body and movable in a circumferential direction with respect to the main repair joint body, and engaged by a sling that hangs the main repair joint body.

(Appended Claim 7)

In the subaqueous cable repair method recited in appended claim 6, the process that immerses the second repair joint preferably tilts a curved part that is configured to include the spare cable, the second repair joint, and the other cut end part of the subaqueous cable in a lateral direction, while hanging the main repair joint body from a sling via the movable engaging part.

DESCRIPTION OF THE REFERENCE NUMERALS

20	100	Repair Joint
	110	Main Repair Joint Body
	111	Casing
	112	Collar Part
	120	Movable Engaging Part
25	121	Engaging Part
	200	Subaqueous Cable
	210	A-Cable
	220	B-Cable
	230	Fault Point
30	240	Spare Cable
	250	First Repair Joint
	260	Second Repair Joint
	270	Curved Part

300 Bottom
400 Workboat
401 Lifting Beam
402 Sling

CLAIMS

1. A repair joint comprising:

5 a main repair joint body that is used to connect
end parts of subaqueous cables together; and
a movable engaging part that is provided on an
outer periphery of the main repair joint body and
movable in a circumferential direction with respect to
the main repair joint body, and engaged by a sling that
10 hangs the main repair joint body.

2. A subaqueous cable repair method
comprising:

a process that cuts a subaqueous cable in which an
15 abnormality is generated;
a process that connects one cut end part of the
subaqueous cable to a first end part of a spare cable
via a first repair joint;
a process that immerses the first repair joint;
20 a process that connects the other cut end part of
the subaqueous cable to a second end part of the spare
cable, on an opposite end from the first end part, via a
second repair joint; and
a process that immerses the second repair joint,
25 wherein the second repair joint includes
a main repair joint body that is used to
connect the second end part of the spare cable and the
other cut end part of the subaqueous cable, and
a movable engaging part that is provided on an
30 outer periphery of the main repair joint body and
movable in a circumferential direction with respect to
the main repair joint body, and engaged by a sling that
hangs the main repair joint body.

3. The subaqueous cable repair method as claimed in claim 2, wherein the process that immerses the second repair joint tilts a curved part that is configured to include the spare cable, the second repair
5 joint, and the other cut end part of the subaqueous cable in a lateral direction, while hanging the main repair joint body from a sling via the movable engaging part.